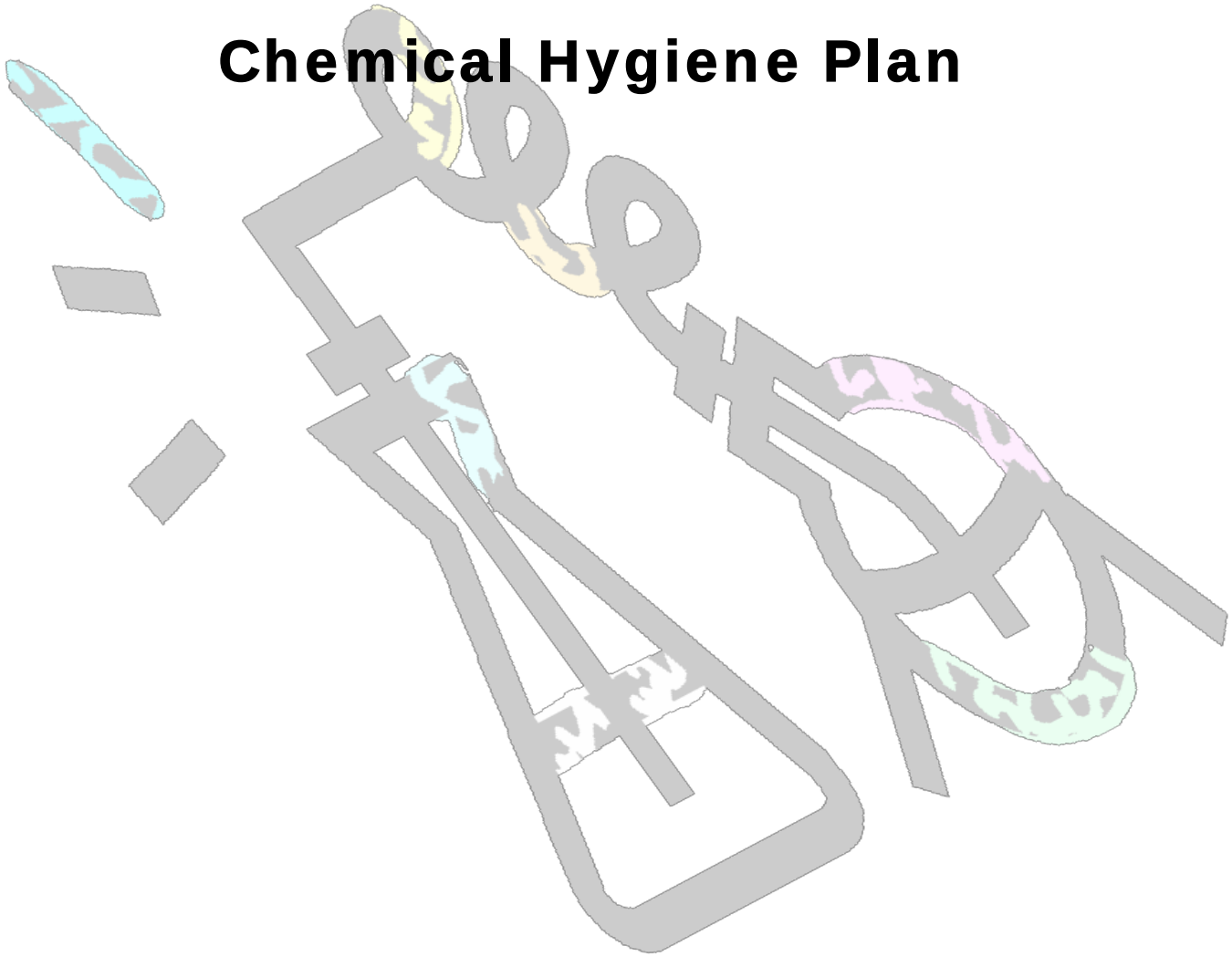
# Chemical Hygiene Plan



Environmental Health, Safety, and Risk Management

Texas State University

# 1. Introduction

## 1.1 Purpose

This Chemical Hygiene Plan (CHP) presents the recommendations of the Environmental Health, Safety and Risk Management Office (EHS&RM) for the use of chemicals in laboratories at Texas State University (Texas State). All personnel involved in laboratory research efforts or teaching should be familiar with this document and the protocols which pertain to their work. Every employee is responsible to ensure these procedures are followed.

This written program should be available during all work and class room periods and to any employee of those work areas. A copy of the CHP should be available either in the lab or work area or a main office of the respective department/building. The EHS&RM's recommendations for the use of chemicals outside of laboratories are presented in the Hazard Communication program.

## 1.2 Scope

Texas State will implement policies and procedures to minimize the exposures to hazardous chemicals in laboratories at the lowest practical levels. These levels will be below the Permissible Exposure Limits (29 CFR 1910.1000, Subpart Z) established by the Occupational Safety and Health Administration (OSHA). The OSHA Standard "Occupational Exposure to Hazardous Chemicals in Laboratories" (29 CFR 1910.1450) was established to protect laboratory workers from harmful exposures to hazardous chemicals. Texas Hazard Communication Act sets forth requirements for the public employer, which is implemented in this CHP. The State Office of Risk Management requires the Texas State University System to follow OSHA regulations. The control of laboratory exposures to hazardous chemicals is accomplished by implementing this CHP and following work practices, procedures, and policies which provide a safe and healthy environment.

## 1.3 Limitations

This CHP is a written program developed and implemented by Texas State University, which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in laboratories. It is not intended to be a fully comprehensive reference but rather a guidebook. There may be chemicals, procedures and circumstances in each laboratory which present an unusual hazard not addressed in this CHP and should be added to the Standard Operating Procedures (SOPs)/CHP for that particular laboratory. Departments and principal investigators wishing to customize this CHP to their specific chemical applications may contact the EHS&RM for assistance.

### 1.4 Terms

- CFR – Code of Federal Register
- CHO – Chemical Hygiene Officer
- CHP – Chemical Hygiene Plan
- OSHA – Occupational Safety and Health Administration
- PPE – Personal Protective Equipment
- EHS&RM – Environmental Health, Safety, and Risk Management
- TDSHS – Texas Department of State Health Services
- PI – Principal Investigator

## 2. Responsibilities

### 2.1 University President

The President is responsible for the implementation of the Texas State University safety policies at all facilities under campus control.

### 2.2 Deans, Chairs, Directors

The Deans, Chairs, and Directors have the primary responsibility for the health and safety of their staff and students. Specific responsibilities include collaborating with faculty and staff to adapt this model Chemical Hygiene Plan to include lab-specific and/or operation specific guidelines and to develop strategies to implement the Plan. This includes making budget arrangements for health and safety improvements.

### 2.3 Faculty and Laboratory Supervisors (PI – Principal Investigator)

Faculty and staff in charge of supervising laboratories (referred to as laboratory supervisors or PIs throughout this document) have the following responsibilities for implementing the Chemical Hygiene Plan:

- Inform and train employees concerning chemical safety as required by this Plan and retain training records and all documentation. All new employees in the laboratories are required to take a department Hazard Communication training and/or take the training provided by EHS&RM (online TRACS or classroom presentations) before working in the laboratories.
- Implement and enforce rules and standards concerning health and safety for laboratories under supervisor's jurisdiction;
- Ensure compliance of laboratory workers with this Plan;
- Develop safe work procedures;
- Ensure the availability and enforce the use of:
  - Personal protective equipment (PPE);
  - Safety Data Sheets (SDSs)
  - Relevant reference materials (i.e. standard operating procedures/SOPs);
- Provide an updated chemical inventory list for EHS&RM by December 15th each year;
- Remain cognizant of chemicals stored and used in labs and their associated hazards;
- Dispose of chemicals no longer needed by contacting EHS&RM at 245-3616;

- Conduct internal inspections of labs for health and safety concerns;
- Follow University CHP or customize the CHP specific for their department;
- If it is determined that a laboratory or a specific department needs a more comprehensive CHP, then submit that CHP for review to EHS&RM and;
- Request assistance from the office of EHS&RM.

### 2.4 Chemical Hygiene Officer (CHO)

The University CHO reports to the director of EHS&RM and is on staff with the EHS&RM department. If a department assigns a Departmental CHO, then that CHO reports to their department Chair. The responsibilities of a CHO include:

- Communicate lab safety regulations that might apply to some or all laboratories that use chemicals;
- Assist lab supervisors, technicians and assistants to comply with the plan;
- Keep and analyze records associated with any chemical accidents;
- Act as an arbiter in all chemical hygiene matters;
- Keep up-to-date on any new legislation in this area;
- Review and approve departmental or research group CHPs;
- Conduct and/or assist in the implementation of safety inspections;
- Conduct and/or assist in the implementation of safety training and
- Identify the need for training.

### 2.5 Employees and Students

Anyone who receives remuneration from Texas State or is a student at Texas State is required to:

- Comply with university, departmental or appropriate individual CHPs;
- Understanding the hazards associated with any chemical stored or used in the laboratory;
- Follow all health and safety policies and procedures;
- Report all hazardous conditions to the supervisor;
- Wear or use prescribed protective equipment;
- Report any job-related injuries or illnesses to the supervisor and seek treatment immediately;
- Refrain from the operation of any equipment or instrumentation without proper instruction and authorization;
- Remain aware of the hazards of the chemicals in the lab and how to handle hazardous chemicals safely and
- Request information and training when unsure how to handle a hazardous chemical or procedure.

2.6 EHS&RM

Responsibilities include:

- Provide training to laboratory supervisory personnel;
- Provide hazardous waste disposal services;
- Assist in hazardous material spill response services; (university police dept. along with EHS&RM will be the primary emergency responder for large spills.)
- Conduct fume hood survey and testing;
- Conduct routine laboratory safety inspections;
- Perform exposure monitoring upon request to determine if the permissible exposure limit or action level has been exceeded;
- Provide guidance for maintaining compliance with federal, state, and local regulations, as well as the procedures stated in this manual;
- Maintain copies of medical consultations and examinations for possible exposures from hazardous chemicals;
- Provide a model CHP;
- Conduct an annual review of this CHP and
- Prepare the annually required Workplace Chemical list by compiling the chemical inventories provided by each Laboratory Supervisor. (See UPPS No.04.05.05 Hazardous Communication Program).

3. Standard Operating Procedures

3.1 General Safety Guidelines

- No horseplay or practical jokes.
- Laboratory experiments should be placed in potentially low hazard condition before leaving them unattended.
- When working with hazardous materials, it is advisable to have a second person present, or at a minimum, maintain surveillance via telephone contact.
- Work areas and floors should be kept clear of excessive storage.
- Exits, aisles and safety equipment must be kept clear of any obstructions.
- Hazardous liquid chemicals should be stored below eye level.
- Chemicals should be stored by hazard class (minimum NFPA color coding system; (See Section 3.5)
- Use proper equipment that is in good condition.
- Shield pressurized or vacuum apparatus and safeguard against bumping or overheating.
- Never use chipped or cracked glassware.
- When inserting glass tubing into stoppers, lubricate the tubing and protect hands from being cut in the event the tubing slips and breaks.
- Gas cylinders should be properly secured at all times. (See Section 3.5)
- Hot oil baths should never be left unattended due to the fire hazard they pose.

3.2 Hygiene and Work Habits

- Wear appropriate PPE (lab coat, gloves, goggles, etc…).

- Confine loose clothing and long hair.
- Use clothing which covers legs (no shorts, cutoffs or miniskirts).
- Use sturdy shoes which cover your feet (no sandals or open-toed shoes).
- No smoking.
- No eating, chewing gum or tobacco, drinking or applying cosmetics in areas where chemicals are stored or used. Food/drinks and associated products should also not be in the laboratories
- Do not store food in the same refrigerator with chemicals, biohazards or radioactive materials.
- Mouth pipetting is not permitted.
- Unless moving chemicals to another location, remove PPE before leaving laboratory.
- Wash hands and arms with soap and water before leaving laboratory.

### 3.3 Housekeeping

Housekeeping is directly related to safety and must be given importance of equal value to other procedures. Lack of good housekeeping reduces work efficiency and may result in accidents. Laboratory personnel must adhere to the following:

- Access to emergency equipment, showers, eyewashes, fire extinguishers, exits and circuit breakers shall never be blocked or obstructed.
- Chemical containers should be regularly monitored for proper labeling and container integrity. Labels which are fading, falling off, or deteriorating must be promptly replaced. Chemicals transferred to containers other than those for immediate use must have secondary labels with: 1) chemical name, 2) manufacture name and address 3) health or physical hazard 4) effects on target organs 5) personal protective equipment required. This does not apply to reaction vessels or bench-top research apparatus in active use. The use of abbreviations on labels should be avoided.
- All chemicals should be placed in their proper storage areas at the end of each workday. Chemicals shall not be stored on desks, laboratory bench tops, floors, fume hoods or in aisles. (See Section 3.5)
- Each laboratory must have a puncture resistant (e.g., cardboard) container specifically designated for broken glassware disposal. (Contact EHS&RM for boxes.)
- At the end of each workday, the contents of all unlabeled containers are to be considered waste and disposed of appropriately.
- Collection containers for wastes must be clearly labeled including hazard identification (Contact EHS&RM for 5 gallon empty containers and waste tags.).
- All work areas, especially laboratory bench tops, should be kept clear of clutter.
- All aisles, corridors, stairs, and stairwells shall be kept clear of chemicals, equipment, supplies, boxes, and debris.
- Empty containers shall be treated in the following manner:
    - For water soluble solvents: triple rinse, deface the label, re-label as "Empty" and dispose with normal trash. Collect rinsate in a container for disposal as hazardous waste.
    - For non-water soluble solvents: triple rinse using a solvent capable of removing the chemical. ALL rinsate must be collected in a hazardous waste disposal container. Deface the label, re-label as "Empty" and dispose with normal trash.

3.4 Personal Protective Equipment (PPE)

- Eye and Face Protection
  - Wear safety glasses, goggles, or face shields at all times where potential eye hazards exist (if one person in the room is using a chemical then everyone in the room must wear eye protection).
  - Full-face shields must be worn when conducting a procedure that may result in a violent reaction.
  - See the table below for selecting the appropriate eye and face protection for chemical handling.

| Chemical Hazard | Risk | Eye protection type | Notes |
|---|---|---|---|
| Acid and corrosive chemicals, irritating or toxic chemicals handling | Splash | Goggles, unvented; goggles, indirect ventilation (chemical splash goggles); severe exposure add face shield | Face shields should be used over primary eye protection. |
| | Irritating mists or vapors | Goggles, unvented | |
| Dust and particles | | Goggles, direct ventilation | |
| Sharp airborne particles | Laceration of skin, eyes | Safety glasses or goggles and face shield. | Face shields should be used over primary eye protection. |

- Hand Protection
  - Always select the correct glove material for the type of chemical you are working with. Remember there is no universal type of glove material which will protect you from all chemical exposure.
  - Use this as a general guide for the chemical resistance of glove types. For more accurate information consult the specific resistances if working with a single hazardous substance. MSDSs provide good information about what kind of glove works best.
  - Cautions: PVA = Polyvinyl Alcohol: provides good protection against many solvents but dissolves in water. Not recommended for general laboratory use.
  - Natural latex: Many people are allergic to natural latex, including the powder used in the gloves. Therefore, Natural Latex gloves are not recommended for laboratory use.
  - Remember that no glove is good for an indefinite period of time.
  - Check gloves after each use for degradation, tears, punctures, or swelling.

## GLOVE TYPE SELECTION FOR DIFFERENT CHEMICAL GROUPS

| CHEMICAL GROUPS | NITRILE | NEOPRENE | PVC | PVA | NATURAL LATEX |
|---|---|---|---|---|---|
| SOLVENTS | Yes | Yes | No | No | No |
| KETONES | No | Yes | No | Yes | Yes |
| CAUSTICS | Yes | Yes | Yes | No | Yes |
| ACIDS | Yes | Yes | Yes | No | Yes |
| HYDRO CARBONS | Yes | Yes | No | Yes | No |
| OILS | Yes | Yes | Yes | Yes | No |
| FATS | Yes | Yes | Yes | No | No |
| ORGANIC SOLVENTS | Yes | Yes | No | Yes | No |

3.5 Hazardous Material Storage, Handling and Transport

- Storage of Chemicals
  - Minimize the chemical quantity which is used and stored in the lab.
  - Keep an updated inventory of the chemicals and provide to EHS&RM by December 15th each year.
  - Make sure all containers are in good condition. Contact EHS&RM to dispose of deteriorated containers.
  - Make sure that the container is appropriate for the chemical stored; for example, hydrofluoric acid must not be stored in glass and some oxidizers must not be stored in plastic containers.
  - Do not store halogenated solvents in metal safety cans due to the potential for corrosion.
  - Record the date of receipt and the date of initial opening of every chemical container on the container label. Assign expiration dates to chemicals that do not have them assigned by the manufacturer.
  - Avoid storing chemical containers in hard to reach areas.
  - Chemicals should be segregated by hazard classification.
  - Only after segregated by hazard class may chemicals may be stored alphabetically.
  - Basic segregations should keep:
    - oxidizers away from organics
    - air/water reactives away from air and water
    - caustics away from acids
    - cyanides, sulfides away from acids
  - See Appendix A for more detailed guidelines for chemical segregation.
  - Unstable or reactive chemicals should be stored in volatile storage cabinets.

- When volatiles must be stored in a cooled atmosphere, flammable material refrigerators, explosion-proof refrigerators or cold rooms designed for this purpose must be used.
- Keep only minimum quantities of flammable liquids in the laboratory for current work. (See Appendix E for regulations)
- Keep small quantities (≤ 5 gallons/20L) of flammable liquids in small safety cans which are approved for flammable chemicals.
- Avoid storing flammable chemicals in glass bottles.
- Store larger quantities in safety cans and away from ignition sources in fire-resistant, properly ventilated flammable liquid storage cabinets.
- See Appendix D for proper storage and safety protocols for picric acid.

■ Handling Chemicals
- Close caps securely;
- Never add water to concentrated acid; rather prepare dilute solutions by adding acid to water and
- Ground containers holding more than two gallons when transferring flammable liquids (e.g. as in the Chemical Stockroom.)
- Make sure all labels are legible;
- Label all containers with the chemical name, date and appropriate health hazard warning(s) before the end of each day if it is not being disposed of by the end of that day;
- Information on chemical health hazards may be found on the Safety Data Sheet.

■ Compressed Gases
- Use appropriate hand carts to move compressed gas cylinders.
- Gas cylinders should be capped and secured to a cart during transport.
- Highly toxic gases should not be moved through the corridors, particularly during business hours.
- Always consider cylinders as full and handle them with corresponding care.
- Gas cylinders should be stored in well-ventilated areas with their protective caps on.
- Gas cylinders should be secured (e.g., strapped or chained in place) to reduce the chance of being knocked over.
- Do not store cylinders near heat or high traffic areas.
- Segregate flammable and oxidizer compressed gases.
- Do not store empty and full cylinders together.
- Storage of large quantities of cylinders should be in an approved gas cylinder storage area.
- Provide training in compressed gas safety.

■ Cryogenic Liquids
- Cryogenic liquids present the potential hazards of fire or explosion, pressure buildup, embrittlement of structural materials, frostbite and asphyxiation.
- Work areas must be well ventilated.
- Cryogenic liquids must be stored, shipped, and handled in containers that are designed specifically for this purpose.

- Because of the extreme cold and splash hazards, skin protection and eye protection (preferably a face shield) should be worn when handling cryogenic liquids.
- Before using cryogenic liquids provide direct supervision and training before attempting transfers from one container to another.

- Peroxide Forming Chemicals
  - Write on the chemical label the received date and date it was opened.
  - Test and/or dispose of them when appropriate.
  - Common examples of chemicals that form peroxides upon exposure to air are:
    - Cyclohexene
    - Ethyl ether
    - Isopropyl alcohol
    - Isopropyl ether
    - Tetrahydrofuran
    - Dioxane
- Transport of Chemicals
  - Use bottle carriers for transporting chemicals which are in glass containers;
  - Transport chemicals in excess of 1 quart in secondary containment with adequate volume to contain the contents.
  - Never transport cryogenic liquids in an elevator, when it is for passenger use.
- Nano-particles
  - Nanoparticles are ultrafine particles measuring in one dimension between 1 – 100 nanometers (nm).
  - Because of the relative lack of information regarding nanoparticles reasonable safety procedures should be implemented in order to protect workers and the general public. (See Appendix F)

## 3.6 Waste Minimization

- A laboratory waste minimization program reduces the chemical hazards in laboratories, and reduces the waste quantity.
- Some of the ways each laboratory can minimize the chemical waste are:
  - Purchase small quantities;
  - Microscale experiments;
  - Maintain updated chemical inventory;
  - Review experimental protocols annually and research new techniques that reduce hazards and quantities of waste produced;
  - Use destruction procedures as the final step in experiments. For example, neutralize corrosive aqueous wastes that do not contain heavy metals and pour down drain.
  - Eliminate use of thermometers and reagents that contain mercury;
  - Eliminate use of chromic acid cleaning solutions and base baths;
  - Maintain waste containers by waste type (do not mix various waste streams) and recycle used chemicals/ establish chemical surplus exchange

- See the Texas State Source Reduction/Waste Minimization Plan for additional information.

### 3.7 Prior Approval Circumstances

Employees must obtain prior approval from the PI or his/her designee to proceed with a laboratory task when:

Radioactive materials will be used,

Recombinant DNA or biological material of Biosafety Level 3 or greater will be used,

It is likely that exposure limit concentrations could be exceeded or that other harm is likely,

There is failure of any equipment used in the process, especially of safeguards such as chemical fume hoods.

Members of the laboratory staff become ill, suspect that they or others have been exposed, or otherwise suspect a failure of any safeguards.

## 4. Controlling Chemical Exposures

### 4.1 Inhalation Hazards

Inhalation of chemicals is the most common route of entry a chemical can take to enter the human body. To avoid significant inhalation exposures, safe work practices, conducting microscale experiments and establishing engineering controls are the first and best options to eliminate or minimize hazards. For example, substituting a less volatile or a less toxic chemical, or substituting a liquid or solid chemical for a gaseous one are the best means of control. If substitution is not practical, ventilation should be used to lessen the chance of overexposure.

The use of well-functioning local exhaust ventilation such as laboratory (fume) hoods, vented glove boxes and other local exhaust systems is often required to minimize exposure to hazardous chemicals. Dilution ventilation may be used to reduce exposure to non-hazardous nuisance odors. For extremely toxic chemicals such as those classified as poison gases by OSHA or Department of Transportation (e.g., arsine, phosgene) the use of closed systems, vented gas cabinets, fail-safe scrubbing, detection or other stricter controls may be required.

Administrative controls can be utilized to reduce the risk of overexposure to hazardous chemicals. Some examples of administrative controls include:

- minimization of exposure time for individual employees;
- restricted access to an area where a hazardous chemical is used;
- allowing a process that emanates nuisance odors to be done only after typical office hours;
- establishing clear emergency procedures;
- practicing regular emergency drills;
- providing proper signage on lab doors to indicate special hazards within, a list of emergency contacts;

- emergency contact signs can be requested from EHS&RM by calling 245-3616.

Finally, if engineering and administrative controls are not an option, the use of personal protective equipment may be required to reduce inhalation exposures. If respirators are worn by laboratory employees, requirements of the OSHA Respiratory Protection Standard (29 CFR 1910.134) must be met. This standard requires a written Respiratory Protection Program; training on the proper use of respirators; medical surveillance to ensure the user is capable of wearing a respirator; and fit testing to ensure that the respirator fits properly. A lab worker or his/her supervisor should contact EHS&RM for assistance with this standard.

### 4.2 Skin/Eye Contact Hazards

The methods of preventing skin and eye contact include wearing eye protection, face shields, gloves, appropriate shoes, lab aprons, lab coats, and other protective equipment appropriate to the hazard. (See Section 3.4 for additional information.)

### 4.3 Ingestion

Ingestion of chemicals is the least common route of entry into the body. However, a laboratory worker can easily ingest chemicals into the body via contaminated hands if they are not washed after handling chemicals. Use engineering controls, such as isolating the hazardous substance so that minimal contact is required (e.g., use glove box), to help prevent exposures.

Food, drinks, gum and cigarettes are not allowed in the laboratories at any time. These items are not to be stored in refrigerators or heated in microwaves that are exposed to chemical or biological agents. Cups, drinking bottles or other food type products should not be stored in the laboratory. Designating a well-marked non-chemical area where eating, drinking and the application of cosmetics is permitted is also beneficial in preventing chemical exposures via ingestion. This area should be outside the laboratory.

Administrative controls such as restricting mouth pipetting, encouraging good personal hygiene, and Personal protective equipment, such as gloves, may also be used.

## 5. Fume Hoods and Other Engineering Controls

Laboratory fume hood velocities for all hoods on campus are currently evaluated on a monthly basis by EHS&RM. The face velocity of the hoods measured in feet per minute (fpm) with the sash positioned at approximately half-open will be recorded on the inspection sticker. In general, laboratory hoods should not be used with the sash fully open.

The hoods will be calibrated annually by EHS&RM using procedure RMS-05.02 “Constant Flow Fume Hood Calibration.” If the average face velocity is between 100 and 150 fpm on the day of calibration, the laboratory hood will bear an inspection sticker on the cabinet with an indication for the appropriate sash position. If the face velocity is different from the above criteria, the hood will have a label indicating that the hood is not calibrated.

Upon finding a hood out of the specified range, EHS&RM will contact the PI or the departments administrator so that they can contact Facility Operations for adjustment. Once the hood has been adjusted, a sticker will be attached with an arrow indicating the appropriate sash position and the face velocity in fpm.

Facilities Operations (Electric Shop) performs routine maintenance on the exhaust fans tied to the hoods twice per year. For safety of maintenance personnel, all chemicals and experiments must be removed from the hoods prior to service. Failure to do so could result in inhalation and skin/eye contact hazards to the maintenance personnel due to acids and or volatile organic compounds. The procedures outlined in Appendix B will safeguard against these potential exposures.

Additionally, if a fume hood has been inoperable or out of service, it will be calibrated prior to putting it back in service.

## 6. Training

### 6.1 Initial Training

All Texas State University-San Marcos employees and students who work with hazardous chemicals must be apprised of the hazards of chemicals present in their work area. Each Department is responsible for providing site specific training and documenting this training. The training must be provided before initial assignment and before new exposure situations. Personal protective equipment necessary for the safe handling of hazardous substances must also be provided.

In addition, EHS&RM requires each employee to complete a basic Hazard Communication Program. This program can be completed online, or arrangements can be made to have an EHS&RM staff member conduct training for a department.

Employees who work with chemicals in laboratories must be trained on the OSHA Laboratory Standard. Employees who work with chemicals in places other than laboratories must be trained under the Hazard Communication (Worker Right-to-Know) program.

Topics to be covered during training include:

- CHP for the particular laboratory;
- specific hazards that might be encountered when working in this laboratory;
- how to read an SDS and
- emergency spill response procedures.

### 6.2 Refresher Training

Refresher training should be provided by the department or PI of each lab. Refresher training is required immediately if there is indication the employee's knowledge on the safe work practices or chemical hazards has deficits.

Additional training is required when new exposure situations arise. Such situations include the use of new chemicals, greater quantities of chemicals, and different procedures.

### 6.3 Safety Data Sheets (SDSs)

SDSs should be the first source of information about the hazards associated with a chemical. Typically, SDSs will contain information, usually in separate sections on the sheet:

- Identification of the substance/mixture and manufacturing company
- Hazards identification
- Composition/information on ingredients
- First aid measures
- Firefighting measures
- Accidental release measures
- Handling and storage
- Exposure controls/personal protection
- Physical and chemical properties
- Stability and reactivity
- Toxicological information
- Ecological information
- Disposal considerations
- Transport information
- Regulatory information
- Other information

Manufacturers are required to provide an SDS for each chemical product sold. The SDSs should be readily available to employees. SDSs can also be obtained via online databases such as MSDS Xchange.

Each Supervisor is responsible for providing training on the proper use and limitations of the PPE prior to employee using them.

EHSRM personnel are available for work area assessment and training of individuals or small groups about specific chemical hazards and alternatives for mitigating those hazards.

## 7. Medical Consultation Program

Texas State University-San Marcos Employees are eligible for medical surveillance and consultation if they perform work-related tasks that might be reasonably anticipated to cause occupational exposure to a potential hazard. The program does not include pre-employment medical examinations.

Medical examinations and consultation shall be performed by or under the direct supervision of a licensed physician, at a reasonable time and place without cost or loss of pay to the employee. It is the responsibility of the individual campus unit to bear the full cost associated with the medical examination of its employees.

An opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, shall be provided to employees under the following circumstances:

- When an employee develops signs or symptoms associated with occupational exposure to a hazardous chemical;
- When air sampling reveals exposure levels routinely above the action level, or in its absence the PEL for an OSHA regulated substance. Medical surveillance shall comply with the requirements of that particular standard;
- Medical consultation shall be provided whenever an abnormal event such as a spill, leak or explosion takes place in the laboratory. Its purpose shall be to determine whether subsequent medical examination is necessary.

For required medical examinations and consultations, the examining physician shall provide a written opinion which includes the following:

- Any recommendations for further medical follow-up;
- Results of the medical examination and diagnostic tests;
- Any medical condition which may be revealed in the course of the examination that places the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace;
- A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination.

See section 8.4 for more information for a work related injury or accidental exposure.

## 8. Emergencies

### 8.1 Emergency Plan

Each building with laboratories shall have a written Laboratory Emergency Plan which includes the following elements:

- Emergency Alarm System
  - Laboratories should have a system available to alert personnel in the event of an emergency that may require evacuation.
  - Personnel should be familiar with the location and operation of the alarm system and evacuation routes.
- Evacuation Procedures
  - Primary and alternate routes shall be established as necessary.
  - Establish a designated meeting area for emergencies.
  - Shutdown Procedures – Instructions for shutting down equipment or apparatus in the event of an emergency.
  - Return Procedures – Return procedures to follow once the emergency is over.

8.2 Chemical Spills

Detailed Spill Response procedures are in Appendix C. These procedures can be modified to tailor them to specific building/department requirements.

8.3 Medical Emergency Number

Policy/Ambulance/Fire: 911

8.4 First Aid

- It is recommended that Laboratory personnel and supervisors have adequate first aid training and be certified in basic first aid and CPR by the American Red Cross or other recognized agency.

- For severe injury or illness dial 911, report the nature and extent of the emergency and await medical support.

- Render the appropriate first aid without endangering yourself. Always consult the SDS for specific instructions.

- Chemical Contact in Eyes
  - Immediately (within 10 seconds) flush eyes with water for at least 15 minutes.
  - Hold eyelids apart to ensure adequate irrigation.
  - Seek prompt medical attention.

- Chemical Contact with Skin
  - Immediately (within 10 seconds) flush the affected area with water for 15 minutes. Remove contaminated clothing immediately before flushing the affected area.
  - Wash the area with hand soap or mild detergent to remove any residual contamination.
  - Seek prompt medical attention.

- Ingestion of Chemicals
  - Non-corrosives.
    - If the victim is conscious, dilute by drinking a glass of water or milk.
    - Discontinue dilution if it makes the victim nauseous.
    - Seek prompt medical attention.
  - Caustics
    - Do not induce vomiting.
    - Seek prompt medical attention.

- Inhalation of Chemicals
  - Move employee away from the exposure to fresh air.
  - Begin rescue breathing if breathing has stopped.
  - Use CPR if the heart has stopped.

Supervisors should ensure that a Supervisors Report of Incident/Injury/Illness is completed within 24 hours for all work-related injuries or illnesses involving activities for which campus persons are paid. These reports should be completed and faxed or delivered to the EHS&RM Workers Compensation Coordinator regardless of where or whether the person received medical follow-up.

As a state employee Texas State University-San Marcos employees are covered through the State Office of Risk Management's Workers' Compensation Program who serves as the state's insurance carrier. The Workers' Compensation Act covers on-the-job injuries that occur in the course and scope of employment and that result in damage or harm to the body. It also covers occupational diseases directly caused by exposure in the workplace. The Worker's Compensation Program pays for medical treatment and lost wages for employees who are injured or become ill as a result of their work. If you have an injury on the job, notify your supervisor and claims coordinator immediately. Supervisor are responsible of completing a "Supervisor's Report of Incident, Injury, or Illness" within 24 hours of date of injury (form is located in EHS web site). The report is immediately signed by supervisor and send to EHS Specialist-Worker's Compensation who is responsible of submittal of claim (within 3 days) for university compliance. Injured employee must obtain clearance through EHS Specialist-Worker's Compensation to return to work.

## 8.5 Fire

Laboratory personnel shall not attempt to extinguish large fires. The following steps should be taken:

- Confine the fire by closing the hood sash or laboratory doors and fire doors as appropriate.
- Immediately evacuate the fire area, pull building alarms, and dial 911 once outside the building.
- Implement the Laboratory Emergency Plan.

Incipient stage fires may be extinguished by designated laboratory personnel trained in the use of portable fire extinguishers. Ideally, at least two people should be available when the fire is extinguished. The following steps should be taken:

- Alert other personnel and have them dial 911.
- Extinguish the fire by directing the discharge at the base of the flames.
- If the fire cannot be controlled, evacuate the area and implement the Laboratory Emergency Plan.

See Appendix E for proper storage of flammables and combustibles.

# Appendix A
# Chemical Storage Code

## Chemical Compatibility Chart

Below is a chart adapted from NFPA regulations which demonstrates how chemicals should be stored by hazard class. This chart is not complete, but it will aid in making decisions about storage. For more complete information on a specific chemical please refer to the MSDS. These are minimum segregation requirements for Texas State University-San Marcos.

| Group/ Code | Color | Hazard Class | Storage Location | Special Instructions |
|---|---|---|---|---|
| G | Grey, Green, Orange | General | On shelves or in cabinets | Presents no more than moderate hazard in any of the categories. For general chemical storage. |
| B | Blue | Health Hazard | On shelves or in cabinets | Toxic if inhaled, ingested or absorbed through skin. Store in a secure area. |
| Y | Yellow | Reactive | On shelves or in cabinets | Reactive & oxidizing reagents. May react violently with air, water or other substances. Store away from flammables or combustibles. |
| R | Red | Flammable | In flammable storage cabinet | Store in area away from white & yellow storage. |
| W | White | Corrosive/ Contact Hazard | *In corrosive storage cabinet | May harm skin, eyes, & mucous membranes. Store away from red, yellow, and blue coded reagents. |

*Within this storage group you must segregate acids and bases. In addition, nitric acid is always to be stored alone.

- Storage location should clearly indicate which group/code is stored in that location. Each shelf or cabinet should indicate the color.
- Groups should always be separated by a vertical divider not horizontal divider. (see diagrams below)
- Each chemical container should be clearly labeled by its storage color.
- Ideally liquids should be isolated by secondary containment.

Shelf/Cabinet Diagram 1: Correct

| | | |
|---|---|---|
| G-Grey Storage | B-Blue Storage | Y-Yellow Storage |
| G-Grey Storage | B-Blue Storage | Y-Yellow Storage |

Shelf/Cabinet Diagram 1: Incorrect

| | | |
|---|---|---|
| W-White Storage | B-Blue Storage | B-Blue Storage |
| R-Red Storage | Y-Yellow Storage | Y-Yellow Storage |

# Appendix B
# Routine Maintenance Procedures for Exhaust Fans

## Procedures for Chemical Exhaust Fan Maintenance

These procedures shall be followed by the Electric Shop personnel when a dedicated exhaust fan provides ventilation for a chemical fume hood or a small number of grouped chemical hoods within a laboratory or laboratories. In addition, contractors needing to perform work on engineering controls that are also designed for removing hazardous fumes shall coordinate with EHS & RM before shutting the systems off. Communication is vital to prevent potential chemical exposure to individuals working in the lab or on the roof, the following procedures must be followed:

- One week prior to beginning work send the Principle Investigator (P.I.) or the designated representative for the lab a notice via email of the upcoming scheduled hood maintenance. Indicate date that preventative maintenance will occur. Request that the hood be cleared of all experiments, chemicals and wastes.

- See file: S:\Labsafety\Ventillation_AllExhFans.xls for a list of contacts.

- On the date/time of hood maintenance, inspect the hood to see if the hood has been cleared. After the hood has been cleared, post a “Maintenance Notice” sign (attached) on the glass (sash). If the exhaust system provides ventilation for the entire room, place a “Maintenance Notice” on the door of the lab. Proceed with the maintenance.

- If the hood has not been cleared, contact the P.I. or designated representative to reschedule the preventive maintenance or cover chemicals that could be venting. Do not shut down the exhaust fan or remove chemicals or equipment from the hood without permission from an authorized person.

- After the maintenance is complete, remove the Maintenance Notice from the hood. Removing the sign should inform all lab workers including the P.I. or designated representative that the maintenance work is completed.

- If major modification or replacement on the exhaust system is performed, contact EHS&RM to recalibrate the affected hood(s).

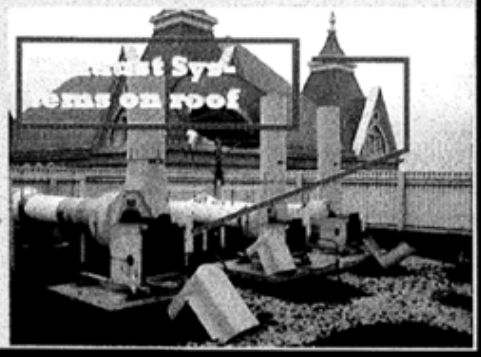
- If major modification or replacement on the exhaust system is performed, contact EHS&RM to recalibrate the affected hood(s).

- The Contact spreadsheet is also updated annually

* EHS&RM phone number 245-3616.

# Maintenance Notice

**Facilities Operations/Electric Shop will be shutting down this Chemical Fume Hood/Local Exhaust System on:**



Start Date: _____ @ **8:00 AM**

End Date: _____ @ **5:00 PM**

## DO NOT USE this fume hood during this time!

**If you need to contact the electric shop servicing your hood please call:**

**Name: ELECTRIC SHOP Phone# 245-2145**

# Appendix C
# Laboratory Chemical Spill CLEAN-UP Procedures

# Laboratory Chemical Spill CLEAN-UP Procedures

## 1. Introduction

### 1.1 Purpose

The purpose of this Laboratory Chemical Spill Clean-up Procedure is to establish guidelines for managing chemical spills in laboratories at Texas State University. This plan seeks to prevent chemical emergencies from occurring, but also provides the procedures to follow if chemical spills occur,including the steps to take in order to respond effectively and safely.

### 1.2 Scope

This plan applies to all chemical spills occurring in the laboratories. The Laboratory Chemical Spill Clean-Up Procedure was created to give researchers and laboratory personnel a starting point for developing a chemical spill kit and providing guidelines to follow for cleaning up chemical spills.

Chemical spills and accidents need to be minimized as much as possible. If a chemical spill should occur, a quick response with a stocked chemical spill kit will help minimize potential harm to personnel, equipment and laboratory space and other property.

Attachment 1 outlines the minimal equipment required for a spill kit. You may add equipment to the kit, provided all personnel are proficient in its use. Contact EHS&RM for information and guidance in construction of an advanced spill kit.

It is the responsibility of each laboratory to have proper spill kits readily available, and have all the people working in the lab properly trained in chemical hazards and spill clean-up procedures. EHS&RM has provided spill kits to many areas on campus, and does inspect and resupply a majority of them when necessary.

### 1.3 Limitations

This plan should not be used in lieu of proper training for responding to chemical spills. Chemical Spill Clean Up Training is required for anyone who uses the Chemical Spill Response Kit. Contact the Environmental Health Safety and Risk Management Office to schedule a training session.

This plan does not address the actions to take in the case of radioactive material spills. For radioactive spill response, follow the procedures outlined in the radioactive material procedures manual.

1.4 Terms

*Minor Spill* - Limited quantity spill (<5 gallons/≈20L) which does not spread rapidly; it has low health and safety risk to people; it does not endanger property or the environment. A minor spill can be cleaned up by the laboratory personnel and is not likely to become an emergency.

*Major Spill* – Large quantity spill (>5 gallons/≈20L) which poses safety and health hazards for people, property or environment (such as fire, explosion, or is toxic, corrosive, oxidizer); spreads rapidly; or is an unidentified chemical.

*EHS&RM* – Environmental Health, Safety and Risk Management Office

2. Procedure

2.1 Types of Spills that Can Be Handled by Laboratory Personnel

Laboratory personnel can clean up the majority of chemical spills that occur in the lab. Due to the hazardous properties of certain chemicals, the size of the spill or the likelihood that a spill might become an emergency, assistance from University Police or EHS&RM may be necessary.

Minor spills do not necessarily need outside assistance for proper clean-up. Laboratory workers who have had the proper training and possess the appropriate equipment can safely and effectively handle the majority of chemical spills that occur in the laboratory. Records of spill response training need to be on file in the lab or lab supervisors office.

2.2 Planning and preparation includes:

- Post the Emergency Numbers near lab phones.
- Make sure lab personnel are trained and understand the chemical spill response procedures.
- If the chemicals in your lab require specific instructions not listed in the Spill Response Procedures, establish standard operating procedures for special conditions in your facility and train the applicable personnel in it.
- Assemble a spill kit, tailored to clean up small spills of chemicals commonly used in your lab. More information on items needed in a spill kit is in Attachment 1.
- Keep the spill kit fully stocked and easily accessible.
- Train personnel how to use the spill kit and when it is safe to clean up a spill.
- Make sure everyone working in the lab knows:
    - Locations of manual pull stations, eye washes, showers, & telephones
    - Locations of fire extinguishers and how to operate the fire extinguisher and when it's safe to do so

2.3 Spill Response

The appropriate response to a chemical spill depends upon the severity of the incident including the hazardous properties of the chemical, size of the spill, likelihood that it can become an emergency, and location of the spill.

2.4 Minor Spill

Minor spills are spills that can be cleaned by the laboratory personnel and meet each of the following list of requirements:

- The spill is <5 gallons/≈20L of a known, not highly toxic material
- Only involves one chemical
- Lab personnel clean spill w/o putting themselves or others in danger
- It is not likely to become an emergency

2.5 Minor Spill Response Procedures include:

- Evaluate the spill and decide if it can be handled by lab personnel.
- Alert people in the area.
- Avoid breathing vapors.
- Determine what was spilled to decide how to safely clean spill and what spill kit materials will be needed.
- If someone has been splashed with chemicals, immediately (within 10 seconds) flush the affected area with water for at least 15 minutes, removing the contaminated clothing while continuing to flush the affected areas. Get medical attention to the affected person.
- Wear personal protective equipment including chemical splash goggles, gloves, and a long-sleeved lab coat during cleanup.
- Confine the spill to a small area. Use a commercial kit or absorbent material from your spill kit to absorb spilled materials.
- Place the saturated absorbent in a chemical waste bag.
- Clean the spill area with water and detergent such as simple green.
- Place all cleaning materials into the chemical waste bag in the spill kit and seal it.
- Label the bag with a chemical waste tag and include it in the next hazardous waste collection by EHS&RM staff.
- Clean the spill area with water.
- Replenish your spill kit supplies, if kit is maintained by EHS&RM call 245-3616 to have kit resupplied.

2.6 Major Spill

Major spills are spills that should not be cleaned by the laboratory personnel because they are large or extremely dangerous spills and meet the following list of requirements:

- Spills that present an immediate hazard (fire, explosion, chemical exposure, etc.)
- Any spill of highly dangerous chemicals
- Moderate or large-scale chemical spills (>5 gallons/≈20L)
- Unidentified chemical spills

2.7 Major Spill Response Procedures include:

- Alert people in the area and evacuate, closing all doors. If the whole building needs to be evacuated, pull the fire alarm at a safe location. Post a sign on the door for people to stay out of the room until the spill has been cleaned up.
- Avoid breathing vapors.
- Identify the spilled material if you can do so safely.
- If the spill involves a flammable liquid, turn off all ignition sources if you can do so safely.
- If someone has been splashed with chemicals, flush the affected area with water for at least 15 minutes. Seek medical attention.
- Call university police at 911; report the spill and any personnel injuries.
- Keep people away from the spill area until qualified spill responders arrive. Lock doors and post warning signs.
- Have someone available who is knowledgeable about the spilled material to provide information to the spill responders.

2.8 Spill Reporting

Following notification to 911, all major spills, or spills involving chemical exposure should be reported to the EHS&RM by telephone at 245-3616 (or 512-738-6650 On-Call Phone). This is important to ensure that you have not been exposed or injured and that the spill is reported to the appropriate regulatory agencies. The spill reports are also used to develop practices to reduce the likelihood of future spills.

Minor spills which are handled quickly are considered near miss accidents and may be an indication of potential for more significant incidents. You are encouraged to report these minor spills to EHS&RM. Doing so will provide information regarding trends in the laboratory and where remedial actions should be taken. Such actions include modification of work practices, additional training on chemical handling and storage, and spill response.

2.9 Special Spill Response

The following chemicals have specific spill response procedures listed in Attachments:

- Mercury (Attachment 2)
- Hydrofluoric Acid (Attachment 3)
- Perchloric Acid (Attachment 4)
- Formaldehyde (Attachment 5)

Your area may have additional chemicals which require specific procedures.

Questions regarding spill clean-up or chemical waste issues may be addressed to EHS&RM at 245-3616.

| Emergency Number | |
|---|---|
| Police / Fire / Ambulance | **911** |

3. Performance Metrics

The spill reports will be reviewed by EHS&RM. The procedures will be reviewed annually, ensuring the procedures are being followed and meet the workplace and regulatory requirements.

4. Revision History

Initial Draft by Minna Miller 08.12.2004
Revised by Lisa Arceneaux/Karen Serna 12/05/2007
Revised by Karen Serna 4/15/2009 (formatting only)
Revised by Chad Thomas 12/15/2014

## Chemical Spill Kit Suggested Contents

This Appendix outlines the content of a spill kit for a laboratory. There are several vendors who sell spill cleanup materials. Other suppliers and manufacturers may be substituted.

Each Texas State University lab that prepares its own chemical spill kit is responsible for keeping the spill kit fully stocked and readily available.

The following list contains examples of spill response products for illustrative purposes. However, it is not intended for endorsement of any product. Each lab can select their own products that provide the similar spill response capabilities.

After using any products in the spill response kit, the used products will need to be replaced immediately. All personnel working with chemicals will need to be trained on spill response.

- Universal Sorbent Pads, such as 3M Folded Sorbent
  - Absorbs aggressive chemicals as well as non-aggressive compounds
  - Good for all chemicals
- Universal Chemical Absorbent Powder, such as MAGIC SORBTM
  - High Capacity
  - Dust free
  - Absorbs all chemicals (except Hydrofluoric Acid) and all viscosities, including oil and paint.
- Neutralizer Ampho-MagTM or other similar product for neutralizing acids and bases
  - Neutralizes and contains both acids and bases, or mixtures
  - Good for : Acids, Bases, Organics, and Hydrocarbons
- Plastic Scoop
  - Anti-Static
  - Polypropylene Plastic
- Polyethylene Bags
  - Strong Construction
  - Leak Proof
  - At least 7-gallon capacity
  - 4mm in thickness
- Silver Shield®/4H Gloves – at least two pairs
- Chemical Splash Goggles – at least two pairs
- Chemical Waste Labels (can be obtained from EHS&RM at 245-3616)

## Mercury

1. Spill Prevention Measures

- Metallic mercury should always be stored in unbreakable, sealed containers.
- Replace broken devices with a mercury-free alternative.
- Inventory all remaining mercury-containing devices and chemicals, and replace them with mercury free alternatives. Contact EHS&RM at 245-3616 for disposal of all mercury compounds.
- Use mercury free (electronic or mechanical) thermometers and manometers. If mercury thermometers are required metal cases can be purchased to help prevent their breaking (VWR or Fischer are two sources with these thermometer accessories.)
- Transfer of mercury should always be carried out carefully in a laboratory hood with secondary containment provided.
- Do not handle near sinks or open floor drains
- To prevent violent chemical reactions, do not store near
  - Ammonia
  - Nitric acid
  - Chlorine dioxide
  - Nitrates
  - Ethylene oxide
  - Chlorine
  - Methylazide

2. First Aid

If overexposed to mercury vapor, move to fresh air immediately. Should mercury contact your skin, remove your clothing immediately and wash the area with mild soap and large amounts of water for 15 minutes. In case of eye contact, flush your eyes with water for a full 15 minutes. Seek medical attention immediately. All wash water containing mercury should be collected and kept out of the sanitary sewer system. (See Section 8.4 concerning work related injury.)

3. Spills

- If you use mercury in your lab or have any equipment which contains mercury, you should have a mercury spill kit available.
- Suggested spill kit for a small mercury spill:
  - Mercury vapor adsorbent, such as MerconsprayTM
  - Hg Absorb™ Jar
  - Cleanup and containment all in one
  - Amalgamates mercury to the sponge surface of the jar, eliminating vapors
  - Safety goggles
  - Gloves (polyethylene, nitrile, pvc)

3.1 Small Mercury Spill

A small spill is less than two tablespoons (one pound of mercury). Unless hazardous conditions exist or the spill happened in an area which makes the spill clean-up difficult, it can most often be cleaned by the laboratory personnel.

- Evacuate the spill area. Block off from foot traffic approx. 6 ft. radius around the spill. Before people leave, be sure that their shoes, clothing, and other articles have not been splashed with mercury.
- Turn off ventilating or aid conditioning systems that are connected to other areas of the building.
  - Prevent the mercury vapors from spreading from spill area to other parts of the building.
  - Close interior doors
- Ventilate the room to the outdoors.
  - Open exterior windows, if possible, to improve ventilation.
  - Use fans to force air circulation for a minimum of one hour after clean up. The danger of mercury exposure is greatest in small, confined, poorly ventilated areas.
- Protect yourself.
  - Use protective gloves
  - Use safety goggles.
  - Avoid breathing any dust, vapors, mist, or gas. Avoid contact with eyes, skin, and clothing. Do not clean-up directly over the mercury spill to minimize breathing vapors.
- Contain the spill
  - Surround or block off the mercury to keep it from spreading onto sloped or porous surfaces.
  - Divert all mercury away from floor drains, cracks, or crevices that may impact groundwater, surface water, and soils.
- Clean the spill
  - Spray Mercury Vapor adsorbent into the air, starting at the breathing level and working down towards the floor, concentrating on the actual spill. This will minimize the mercury vapors in the air.
  - Use Hg Absorb® Jars to absorb and contain the spill. Make sure you will pick up all the visible mercury droplets.
  - Hard to reach areas, cracks and porous surfaces should be cleaned using a special Mercury vacuum. Never use a household vacuum cleaner or shop vac to clean up mercury! (These devices are not adequately filtered and will spread mercury vapors.) Special mercury vacuum is available at the EHS&RM, call 245-3616 if needed.
  - Never use a broom on a mercury spill because it will only scatter the mercury droplets, making them harder to find and pick up.
  - Remove and dispose of all carpeting and other articles that the mercury contaminated.
  - Close the jar lids tightly after clean-up.

- To ensure decontamination, repeat the steps a - f. Use a new Hg Absorb® jar.

- Clean-up supplies and any possible rinsate from decontamination of clothing, PPE, spill area and/or equipment. Contain, seal and label all mercury waste as "Elemental Mercury, Hazardous Waste". Be sure to list the building name and room number on the waste label.
- Never pour liquid mercury or mercury compounds down the drain. In addition to contaminating the water system, it will accumulate in the S-trap of your drain and may continue to emit harmful vapors.
- Monitor spill zone for mercury vapors if the spill was larger than a broken thermometer.
- Use mercury vapor analyzer to ensure you have successfully removed all mercury from the spill area. Contact EHS&RM for mercury vapor analyzer.

*Note: Everything used during the cleanup procedure will need to be managed as hazardous waste.*

### 3.2 Large Mercury Spill

Large spills are considered more than two tablespoons (i.e. greater than one pound) and are more safely handled by trained professionals (i.e. Fire Department or Outside Contractors). For a large spill the procedure is:

- Evacuate the area immediately.
- Close doors to other indoor areas
- Turn off heating, ventilation and AC that circulate air from the spill area to other parts of the building.
- Call 911 and report your location and the nature of the accident.
- After the cleanup, EHS&RM will use a mercury vapor analyzer to verify that all mercury has been removed.
- EHS&RM will determine if the spill must be reported under federal, state, or local reporting requirements. Note: It is recommended that any mercury spill equal to or greater than 1 pound (more than two tablespoons) impacting the environment (i.e., groundwater and surface water), or threatening public health be reported immediately. Mercury is a regulated hazardous waste (EPA Waste # D009). CERCLA reportable quantity is one pound (approximately 2 tablespoons).

4. Alternatives to Mercury (source: American Chemical Society)

| Chemical | Alternative |
|---|---|
| Mercury (II) chloride<br>Zenker's solution<br>Histological fixatives | Zinc formalin<br>Freeze drying<br>Zinc chloride |
| Staining solutions and preservatives<br>Thimerosal, immu-sal, Carbol-fuchin stain, Gram iodine stain, Phenolic mercuric, Acetate, Alum, Hematoxylin "Solution A" | Replace with a variety of chemical compounds |
| Mercury (II) oxide | Copper Catalyst or sodium iodate |
| Mercury (II) chloride | Magnesium chloride/sulfuric acid |
| Mercury (II) sulfate | Silver nitrate/potassium sulfate/chromium-(III) sulfate |
| Mercury iodide | Phenate method |
| Mercury nitrate (for corrosion of copper alloys) | Ammonia/copper sulfate |
| Colorimetric chloride analysis | Ion-selective electrode method |

## HYDROFLUORIC ACID

Hydrofluoric Acid (HF) is a severe skin, eye and respiratory irritant. Skin contact results in painful deep-seated burns that are slow to heal. Burns from dilute (<50%) HF solutions do not usually become apparent until several hours after exposure; more concentrated solutions and anhydrous HF cause immediate painful burns and tissue destruction. Therefore, HF can penetrate deep into tissue without warning causing delayed pulmonary edema or deep tissue burns requiring immediate medical attention. HF which penetrates tissues may cause slow tissue death resulting in very severe effects such as the loss of a finger, limb or even death.

HF readily penetrates the skin, damaging underlying tissue; fluoride ion can then cause destruction of soft tissues and decalcification of the bones. Hydrofluoric acid and HF vapor can cause severe burns to the eyes which may lead to permanent damage and blindness. Exposure to higher concentrations can result in serious damage to the lungs, and fatal pulmonary edema may develop after a delay of several hours. Ingestion of HF can produce severe injury to the mouth, throat, and gastrointestinal tract and may be fatal.

1. HF Exposure Prevention

- Ensure that everyone who handles or is potentially exposed to HF has been trained and is aware of its properties and dangers.
- Utilize all appropriate engineering controls and make sure that the controls are functioning properly.
- Require everyone who handles or uses HF to have the proper safety and personal protective equipment, to be trained to use the equipment, and to always use the equipment when necessary.
- Arrange ahead of time the provisions for first aid and medical treatment measures. Coordinate with the local hospital for HF exposure response. Ensure that they have calcium gluconate I.V. or injections available at the local emergency room.

2. First Aid Kit

The following supplies should be maintained in a first aid station near hydrofluoric acid handling and storage areas:

- SDS for HF
- Calcium gluconate gel, 2.5% (has a shelf-life and should be refrigerated)

3. Safe Work Procedures

- Prior to initial assignment to the operation, read the Safety Data Sheet and become familiar with the hazards of HF.
- HF work may only be performed inside a laboratory fume hood.
- Recommended PPE:
    - Unvented Goggles
    - Face shield (plastic)
    - Acid resistant glove – black polypropylene gloves

- Disposable gloves, such as 4, 6 or 8 mil blue nitrile glove to be worn as inner gloves – dispose of immediately when contamination is suspected.
- Acid resistant apron
- Long pants, long sleeves and closed toe shoes (always required when working in a lab)

- Locate spill control materials and ensure that an adequate supply is available. Ensure it also includes an appropriate container to hold any contaminated spill clean-up materials (polyethylene or polypropylene containers).
- Locate the HF first aid kit, which should include the MSDS and the Calcium Gluconate gel. This gel must be inspected before each use of HF or at least monthly to ensure the gel has not been removed or has not reached the expiration date. If a tube of the gel has been opened, a new container must be purchased and the old container discarded. No work with HF can be done with an expired tube of calcium gluconate gel.
- Ensure that an eyewash and safety shower is located nearby to flush the eyes or skin in the event of eye contact. Make sure they function properly.
- Do not leave tongs, stirrers, etc., which have been contaminated with HF in fume hoods where other people may pick them up or otherwise come into contact with them.
- Any unattended containers must be labeled. If it is not feasible to do this, and containers must be left in the laboratory fume hood unattended by the HF user, place a placard or sign in the fume hood indicating the HF hazard.
- When the work has been completed wash outer gloves with soap and water before removing. Then remove outer layer and inner layer of gloves, and wash hands thoroughly with soap and water (Dial is recommended).

4. First Aid Procedures

Any splash or exposure, even if initially painless, requires attention. Personnel rendering first aid or assistance should avoid contact with contaminated surfaces or clothing. The MSDS should always be consulted when rendering first aid.

4.1 Skin Exposure:

- Immediately flood the affected body area with cool water for 5 minutes, if calcium gluconate is available. If no calcium gluconate is immediately available, continue rinsing the affected area until emergency medical responders arrive, using copious amounts of water. Remove contaminated clothing and footwear while rinsing.
- Call for medical assistance (911 from any Texas State phone). Be sure to indicate that the victim was exposed to hydrofluoric acid.
- Gently rub Calcium Gluconate ointment onto the affected area. Continue applying until emergency medical responders arrive.

4.2 Eye Exposure:

- Flush eyes with plenty of cool tap water for 15 minutes.
- Call for medical assistance (911 from any Texas State phone). Be sure to indicate that the victim was exposed to hydrofluoric acid.

4.3 Inhalation Exposures:

- Move inhalation exposure victim to fresh air.
- Call for medical assistance (911 from any Texas State phone). Be sure to indicate that the victim was exposed to hydrofluoric acid.

4.4 Ingestion:

- In the unlikely event that an individual ingests HF, immediately call for medical help at 911.
- Do not induce vomiting.
- If the victim is conscious, give several glasses of milk or milk of magnesia, or water if milk is not available, until medical assistance arrives.

5. Training

The supervisor or responsible person shall supply this procedure to employees and verify that they understand it. Employees should understand the health and physical hazards of HF. The ability of HF to inflict damage without initial pain should be emphasized.

6. Spill Procedures

Refer to the product Material Safety Data Sheet for proper spill clean-up procedures. Do not attempt to clean up any large spills especially if the vapors from the spill result in noticeable eye or respiratory irritation. For *large spills* (>10 ml) of concentrated HF or for quantities over 100 ml of diluted HF, restrict access to the spill area and dial 911 for University Police for spill response.

6.1 HF Spill Kit

- Absorbents – pads, paper towels – no silica based absorbents because the HF releases a poisonous gas upon contact.
- HF Neutralizer (caustic soda or lime) or commercial HF spill kit (If sodium bicarbonate is used it will form a poison sodium fluoride salt).
- 2 pairs of thick 22 mil Neoprene gloves
- Goggles
- Face shield
- Waste disposal bag
- Chemical waste labels

6.2 Small Spill Clean Up Procedures

- Small spills may be cleaned up by the person who caused the spill.
- Always use gloves, apron, eye, and face protection.
- If there is any possibility of contamination of footwear while cleaning up the spill, do not proceed unless adequate shoe coverings or rubber boots can be obtained.
- Absorb the spill with lime or another absorbent material designated for HF spills. Scoop the material into a suitable container. Note that HF will react with metal to form hydrogen. Use plastic materials to clean up the spill.
- Carefully rinse contaminated areas with water. Any paper towels or absorbent pads used to absorb the rinse water should be added to the spill clean-up wastes.
- Label the waste container and contact EHS&RM (245-3616) for pick up of the spill clean-up materials.

7. Waste Disposal Procedures

Regardless of the concentration of HF it may not be put down the drain. It may also not be neutralized and put down the drain.

Collect waste HF in a clearly labeled, appropriate container with a screw cap. The original HF container is suitable if one is available. Glass and metal are unsuitable containers. Do not mix HF with other acids. The Chemical Waste labels are available from EHS&RM (call 245-3616). When the waste container is sufficiently full or when the experiment using HF is complete, contact EHS&RM for waste pick up.

8. Incompatibles and Storage

Store HF in a cool, dry place away from incompatible materials. HF reacts with many materials. Contact with glass, concrete, metals, water, other acids, oxidizers, reducers, alkalis, combustible, organics and ceramics should be avoided. HF should be stored in containers made of polyethylene, polypropylene, or fluorocarbon plastic. Place storage bottles in secondary containment trays made of polyethylene or polypropylene.

# Perchloric Acid ($HClO_4$)

Perchloric Acid is a strong oxoacid of chlorine and is a colorless liquid soluble in water. It forms an azetrope with water, about 72.5% Perchloric acid. Commercially available concentrated Perchloric acid is around this concentration. In this form the acid is stable indefinitely. If left unsealed, the concentrated acid dilutes itself by drawing water from the air. Perchloric acid is extremely hazardous. It is very corrosive to the skin and eyes and should be handled with the utmost care. It can ignite or explode when combined with common organic material such as cloth or wood.

Pure anhydrous perchloric acid is an oily liquid. It can explode, and it slowly decomposes at room temperature. Perchloric acid monohydrate is a crystalline substance. It is more stable, but it can also explode.

1. Guidelines for Using Perchloric Acid

   Perchloric acid ($HClO_4$) is a strong mineral acid. Under some circumstances it may act as an oxidizer and/or present an explosion hazard. These guidelines present information on how to handle and store perchloric acid safely. Please notify EHS&RM at 24245-3616 if you are using perchloric acid in your laboratory.

2. Using Perchloric Acid (< 72%) at Room Temperature

   At room temperature, perchloric acid up to concentrations of 72% has properties similar to other strong mineral acids. It is a highly corrosive substance and causes severe burns on contact with the eyes, skin, and mucous membranes. When used under these conditions, perchloric acid reacts as a strong non-oxidizing acid. The following precautions should be taken when using perchloric acid under these conditions:

- Substitute with less hazardous chemicals when appropriate. Use dilute solutions (< 60%) whenever possible.
- Conduct operations involving cold perchloric acid in a properly functioning chemical fume hood with current certification. If operations are conducted frequently or in large quantities contact EHS&RM at 24245-3616 to determine if
  a specially designed fume hood dedicated for perchloric acid use is required.
- Always use impact-resistant chemical goggles, a face shield, neoprene gloves, and a rubber apron when handling perchloric acid.
- When using or storing even dilute perchloric acid solutions avoid contact with strong dehydrating agents (concentrated sulfuric acid, anhydrous phosphorous pentoxide, etc.). These chemicals may concentrate the perchloric acid and make it unstable.
- Always transfer perchloric acid over a sink or other suitable containment in order to catch any spills and afford a ready means of cleanup and disposal.
- Perform all operations on chemically resistant surfaces. Avoid contact with cellulose materials such as wood, paper and cotton. Perchloric acid may become concentrated and cause a fire or explosion.

3. Using Heated Perchloric Acid (<72%)

When heated to temperatures above 150°C, perchloric acid becomes a strong oxidizer and eventually becomes unstable. Concentrated solutions are very dangerous and can react violently with many oxidizable substances, such as paper and wood, and can detonate. Vapors may also contaminate work surfaces or ventilation equipment with perchlorate residues, which may form highly unstable compounds, such as metallic perchlorates. These compounds may ignite or detonate under certain conditions. The following additional precautions should be followed when heating perchloric acid:

- Perchloric acid digestions and other procedures performed at elevated temperatures should be done in a specially designed perchloric acid fume hood.
- Lower the fume hood sash as much as possible so that it can function as a physical barrier or use a safety shield to provide splash/splinter protection. Perchloric acid fume hoods should have shatterproof glass.
- Never heat perchloric acid in an oil bath or with an open flame. Electric hot plates, electrically or steam-heated sand baths, heating mantles, or steam baths are preferred. Use explosion proof electrical equipment.
- Avoid allowing hot perchloric acid to come into contact with any organic materials including paper or wood because a fire or explosion can occur. Avoid storing these materials in perchloric acid work hoods. Avoid using greases or hoses that are incompatible with perchloric acid.
- Be sure you understand the reaction(s) that can occur when using perchloric acid. Perchloric acid may react violently with many chemicals including acetic anhydride, alcohol, reducing agents, and many metals.
- In wet digestions with perchloric acid, treat the sample first with nitric acid to destroy easily oxidizable matter.
- Do not distill perchloric acid in a vacuum because an unstable anhydride may be formed and cause a spontaneous explosion.
- Wash down perchloric acid hoods after each use by following operating instructions provided by the manufacturer of the perchloric acid hood.
- When handling beakers of hot acid use properly designed tongs or other remote-handling devices.

4. Using Anhydrous Perchloric Acid

Anhydrous perchloric acid (> 85% concentration) is very unstable and will usually explode when it comes in contact with organic materials. Follow these additional precautions when working with anhydrous perchloric acid.

- Allow only experienced research workers to handle anhydrous perchloric acid. These workers shall be thoroughly familiar with the literature on the acid. Assure that a second worker is informed of the intended use of the anhydrous perchloric acid. This second worker should be in sound or sight contact with the worker using anhydrous perchloric acid.
- Use a safety shield to protect against the effects of a possible explosion.
- Use the acid in a designated, properly designed perchloric acid hood with a minimum of equipment present. No extraneous chemicals should be present in the hood.
- Use thick gauntlets in addition to PPE previously recommended.

- Use only freshly prepared acid. Do not make any more anhydrous perchloric acid than is required for a day/shift.

5. Perchloric Acid Spills

CLEAN UP SPILLS OF PERCHLORIC ACID ONLY IF YOU HAVE BEEN TRAINED TO DO SO AND THE APPROPRIATE EQUIPMENT IS AVAILABLE! For large spills (>10 ml) of concentrated perchloric acid or for quantities of 100 ml for dilute perchloric acid, restrict access to the area and contact University Police at 911 for spill response. To clean a spill, neutralize it with soda ash (sodium carbonate) or other appropriate neutralizing agents. Soak up the neutralized spill with an inorganic based absorbent, if possible. If rags, paper towels are used, wet them and place them in a plastic bag and seal it. Do NOT use rags, paper towels, or sawdust and then put them aside to dry out as such materials may spontaneously ignite. A second neutralization and rinsing of the wetted area is recommended. Label waste as flammable hazardous waste and contact EHS&RM at 24245-3616 for pickup.

6. Storage

The quantities of perchloric acid in storage should be kept to a minimum. Perchloric acid should be stored in its original container within compatible secondary containment, preferably glass or porcelain. Glass trays should be wiped periodically. It should be separate from other chemicals but may be stored with other inorganic acids, preferably in a metal cabinet designed for acid/corrosive storage. Perchloric acid must be stored away from organic chemicals, flammable or combustible materials and strong dehydrating agents such as sulfuric acid and anhydrous phosphorus pentoxide.

If a bottle containing perchloric acid has turned dark and has crystals forming around the bottom of the bottle, there is a potential explosion hazard. Do NOT move the bottle, but contact EHS&RM at 24245-3616 for immediate assistance.

7. Inappropriate and Appropriate Materials

7.1 The following materials are not recommended for use with 72% perchloric acid:

- Nylon/polyamides, Dynel/modacrylic ester, Dacron/polyester, Bakelite, Lucite, vegetable-based Micarta, cellulose-based lacquers, copper/brass/bronze (which form shock sensitive salts), aluminum (dissolves), high nickel alloys (dissolve), cotton, wool, wood, and letharge (glycerin and lead oxide).

7.2 The following materials are suitable for use with 72% perchloric acid:

- Viton, tantalum, chemically pure titanium, zirconium, niobium, Hastelloy C (slight corrosion rate), PVC, Teflon, polyethylene, polypropylene, Kel-F, vinylidene fluoride, Saran, epoxy resins, glass, glass-lined steel, alumina, and Fluorolube.

8. Design and Maintenance of Perchloric Acid Fume Hoods

The following procedural and design guidelines apply to chemical fume hoods where perchloric acid is heated regularly. They are intended to minimize the build-up of potentially explosive perchlorates on the inside of the hood, its ductwork, and fan. If you need more information on perchloric acid fume hoods, call EHS&RM at 24245-3616.

- Construct hood interiors using materials that will not corrode or react with perchloric acid such as type 316 stainless steel and ceramic. Polyvinyl chloride may be used for light-duty systems or as a liner for a stainless steel hood.
- Construct the exhaust ducting using non-reactive and perchloric acid resistant materials. Type 316 stainless steel or PVC is acceptable. Never manifold the ductwork to any other ventilation system. Use the steepest, straightest, and shortest route for ductwork. Avoid sharp turns. Slope horizontal runs of ductwork at least 1 inch per foot back toward the hood. Where possible, avoid horizontal runs where condensed perchloric acid can accumulate. Never use flexible connections. Seal ductwork to prevent liquid from escaping. Preferred methods are welded stainless steel or welded PVC. Use screws of 316 stainless steel or equivalent corrosion-resistant and non-reactive material to connect sections of ductwork. Use only gaskets or sealants that are non-reactive and resistant to perchloric acid.
- Install fan blades that are non-reactive, spark and corrosion-resistant. Teflon or PVC coated blades can be used. The exhaust fan motor shall not be installed in the ductwork and the pulley shall be conductive as specified by NFPA 45.
- Equip the ventilation system with a built-in water wash-down system. Ensure that the system will adequately spray all interior surfaces of the ducting, tack, fan, plenum, baffles, and hood. The hood shall be washed down at least each day after use or more frequently if specified in a safety plan. The water shall be drained to an appropriate holding tank pending removal for treatment and disposal.
- Inspect new systems for the presence of inappropriate gaskets, caulking, or other materials that may be potentially explosive as part of acceptance procedure. Require vendors and contractors to furnish blueprints and specifications describing the materials of construction.
- Design and construct perchloric acid ventilation systems to allow for the easiest possible visual inspection. Include easily removed hood baffles for routine inspection of perchlorate buildup.
- Specify shatterproof hood sashes.
- Assure that hoods in which perchloric acid is heated are designated as perchloric acid hoods, dedicated to perchloric acid work, and are labeled: "WARNING: Perchloric acid work is done in this hood."
- Thoroughly flush the interior of a perchloric acid hood just prior to maintenance or removal of the hood. Wash duct joints, the fan motor, and its housing. Check the various surfaces and joints using the methylene blue or diphenylamine tests. If perchlorates are detected, further washing is required. Collect the rinse water. Call EHS&RM at 24245-3616 for an evaluation to determine if the rinsate must be disposed of as hazardous waste.
- Test hoods and exhaust systems for perchlorate residues before doing any inspection, maintenance, or cleaning if the perchloric acid was heated above

ambient temperature. Also test perchloric acid hoods being put into use for any other purpose after water washing them to remove perchlorate residues.

# Formaldehyde

The chemical compound formaldehyde (also known as methanal), is a gas with a pungent smell. It is the simplest aldehyde. Its chemical formula is $H_2CO$.

Formaldehyde readily results from the incomplete combustion of carbon-containing materials. It may be found in the smoke from forest fires, in automobile exhaust, and in tobacco smoke. In the atmosphere, formaldehyde is produced by the action of sunlight and oxygen on atmospheric methane and other hydrocarbons. Small amounts of formaldehyde are produced as a metabolic byproduct in most organisms, including humans.

1. Properties

   Although formaldehyde is a gas at room temperature, it is readily soluble in water; and it is most commonly sold as a 37% solution in water called by trade names such as formalin or formol. In water, formaldehyde polymerizes, and formalin actually contains very little formaldehyde in the form of $H_2CO$ monomer. Usually, these solutions contain a small percentage of methanol to limit the extent of polymerization.

   Formaldehyde exhibits most of the general chemical properties of the aldehydes, except that it is generally more reactive than other aldehydes. Formaldehyde is a potent electrophile. In the presence of basic catalysts, formaldehyde undergoes a reaction to produce formic acid and methanol.

   Formaldehyde is readily oxidized by atmospheric oxygen to form formic acid. Formaldehyde solutions must be kept tightly sealed to prevent this from happening in storage.

2. Uses

   Formaldehyde kills most bacteria so a solution of formaldehyde in water is commonly used as a disinfectant. It is also used to preserve biological specimens and as a preservative in vaccinations. In medicine, formaldehyde solutions are applied topically to dry the skin such as in the treatment of warts. Formaldehyde based solutions are used in embalming to disinfect and temporarily preserve human remains pending final disposition.

   Most formaldehyde, however, is used in the production of polymers and other chemicals. When combined with phenol, urea, or melamine, formaldehyde produces a hard thermoset resin. These resins are commonly used in permanent adhesives such as those used in plywood or carpeting and as the wet-strength resin added to sanitary paper products such as (listed in increasing concentrations injected into the paper machine headstock chest) facial tissue, table napkins, and roll towels. They are also foamed to make insulation or cast

into molded products. Production of formaldehyde resins accounts for more than half of formaldehyde consumption.

Formaldehyde is also used to make numerous other chemicals even in personal care products such as toothpaste.

3. Spill Response

Contain spill. Consult material safety data sheet for guidelines for spill containment. Use light weight absorbent material such as pads, socks or commercially available formaldehyde spill neutralizer to reduce vapors and contain spills. Remove all sources of ignition. Ensure adequate explosion-proof ventilation for cleanup.

Clean up spill material. Use absorbent material to clean up spilled material. Use non-metal, non-sparking tools for clean up procedures. Do not allow material to enter any sewer or to contaminate soil. Place spill cleanup materials in chemical resistant containers (i.e. polyethylene bags or buckets with lids) for pickup by EHS&RM staff for proper disposal.

4. Physical Health Hazards

Some health risks include: carcinogen, irritant, can cause dermatitis and pulmonary edema.

5. Safety Protocol

Personal Protective Equipment

- Chemical resistant gloves (rubber, neoprene, nitrile)
- Goggles or face shield
- Chemical resistant apron
- Other universal equipment such as but not limited to: respirator with organic vapor/formaldehyde cartridges, booties, rubber boots, disposable Tyvek suit, etc.

# Appendix D
# Picric Acid Storage and Safety Protocol

# Picric Acid

Introduction: Picric acid (tri-nitrophenol) is a water-soluble chemical that can be highly sensitive to heat and shock. Picric acid is especially reactive with concrete, amines, bases, metals, or metallic salts where it can form unstable and explosive picrate salts. Dry picric acid (less than 30% solution) is friction and heat sensitive and is considered a highly shock sensitive chemical. Metal caps and lids are especially susceptible to the formation of highly sensitive picrate salts. If dry crystals are present inside the container or cap threads, the friction from removing the cap may be sufficient to detonate the container. Picric acid is also a strong irritant and allergen. It can cause skin staining and skin damage at the contact site as well as systemic poisoning when ingested or absorbed. See the MSDS for more details.

1. Purchase

1.1. Do not purchase large quantities of picric acid. Purchase the minimum amount of picric acid for your work.

1.2. When possible, purchase picric acid in solution (not as a dry solid).

2. Storage

2.1. Store solid picric acid or picrate salts in distilled water (e.g., > 30% hydrated). Visually check the hydration every two months and add distilled water as necessary. Label all picric acid with date of last hydration.

2.2. DO NOT STORE picric acid (solution or solid) in containers with metal caps or ground glass stoppers. These are especially susceptible to the formation of highly sensitive picrate salts.

2.3 Picric Acid should be kept separate from all other chemicals. Its location should be clearly marked. In addition a log sheet should be kept with the chemical to indicate when visual checks were done.

3. Handling and Use

3.1. After each use, wipe the bottleneck and cap threads with a damp cloth before closing the container of picric acid. Wear protective gloves.

3.2. Do not use metal spatulas with picric acid solids.

3.3. DO NOT TOUCH OR OPEN a container of dry picric acid; a minor disturbance or the friction caused by opening a crystallized lid can cause an explosion. CALL EHS&RM IMMEDIATELY at 24245-3616 for stabilization and disposal.

4. Disposal

4.1. Picric acid must be disposed through the University's chemical waste program as long as the chemical is hydrated and no crystal formation is evident.

4.2. If the picric acid is dry or crystal formation is evident, CALL EHS&RM IMMEDIATELY at 24245-3616 for stabilization and disposal. DO NOT TOUCH OR OPEN CONTAINER. When in doubt, call EHS&RM for a determination.

## Picric Acid Log Sheet

| Date Checked | Lot # | Initials | Good Condition (y/n) | Comments |
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Location: _____ Lab Manager/PI: _____

# Appendix E
# Flammable & Combustible Liquids Protocol

(NFPA 30/29 CFR 1910.106)

1. Classifications

Flammable liquids are categorized into three groups as follows:

- Class IA – Liquids having flashpoints below 73° F (22.8° C) and having boiling points below 100°F (37.8°C) (1910.106(a)(19)(i)). Examples: Acetaldehyde, ethyl ether and cyclohexane.
- Class IB – Liquids having flashpoints below 73° F (22.8° C) and having boiling points at or above 100° F (37.8°C) (1910.106(a)(19)(ii)). Examples: Acetone, benzene and toluene.
- Class IC – Liquids having flashpoints at or above 73° F (22.8° C) and having boiling points below 100° F (37.8°C) (1910.106(a)(19)(iii)). Examples: Hydrazine, styrene and turpentine.

A combustible liquid is any liquid having a flashpoint at or above 100° F (37.8° C) (1910.106(a)(18)). Combustible liquids are divided into two classes:

- Class II – Liquids having flashpoints at or above 100° F (37.8° C) and below 140° F (60° C), except any mixture having components with flashpoints of 200°F (93.3°C) or higher, the volume of which make up 99 percent or more of the total volume of the mixture (1910.106(a)(18)(i)). Examples: Acetic acid, naptha and stoddard solvent.
- Class III – Liquids having flashpoints at or above 140°F (60°C) (1910.106(a)(18)(ii)). Class III liquids are subdivided into two subclasses:
  - Class IIIA – Liquids having flashpoints at or above 140°F (60°C) and below 200°F, except any mixture having components with flashpoints of 200°F (93.3°C) or higher, the total volume of which make up 99 percent or more of the total volume of the mixture (1910.106(a)(18)(ii)(a)). Examples: Cyclohexanol, formic acid and nitrobenzene.
  - Class IIIB – Liquids having flashpoints at or above 200°F (93.3°C) (1910.106(a)(18)(ii)(b)). Examples: Formalin and picric acid.

Per 1910.106(a)(18)(ii)(b) "Class IIIB liquids" shall include those with flashpoints at or above 200°F (93.3°C). This section does not cover Class IIIB liquids. Where the term "Class III liquids" is used in the section, it shall mean only Class IIIA liquids. (Class IIIB is used in this document for reference purposes only.)

*Note: When a combustible liquid is heated for use to within 30°F (16.7°C) of its flashpoint, it shall be handled in accordance with the requirements for the next lower class of liquids (1910.106(a)(18)(iii)).

2. Storage Container Requirements

One technique to reduce the hazards associated with flammable and combustible liquids is the use of safety cans. OSHA defines a safety can as ". . . An approved container, of not more than 5 gallons capacity, having a spring-closing lid and spout cover and so designed that it will safely relieve internal pressure when subjected to fire exposure" (1910.106(a)(29)).

In addition to the storage of flammable and combustible liquids in safety containers, 29 CFR 1910.106 limits the amount of liquid in a single container. The following chart shows what the allowable amounts of liquid are for each class of liquid.

| **MAXIMUM ALLOWABLE SIZE OF CONTAINERS AND METAL PORTABLE TANKS** | | | | | |
|---|---|---|---|---|---|
| ***Container Type*** | ***Flammable Liquids*** | | | ***Combustible Liquids*** | |
| | Class IA | Class IB | Class IC | Class II | Class III |
| Glass or approved plastic | 1 pt. | 1 qt. | 1 gal. | 1 gal. | 1 gal. |
| Metal (other than DOT drums) | 1 gal. | 5 gal. | 5 gal. | 5 gal. | 5 gal. |
| Safety Cans | 2 gal. | 5 gal. | 5 gal. | 5 gal. | 5 gal. |
| Metal Drum (DOT spec.) | 60 gal. | 60 gal. | 60 gal. | 60 gal. | 60 gal. |
| Approved Metal Portable Tanks | 660 gal. | 660 gal. | 660 gal. | 660 gal. | 660.gal |

3. Storage Quantities

29 CFR 1910.106 also limits the total amount of a liquid kept outside of a cabinet or storage room. The quantity of liquid that may be stored outside of an inside storage room or a cabinet in any one fire area/laboratory of a building cannot exceed:

| | | **Quantity** | | **Special Notes** |
|---|---|---|---|---|
| | **Liquid Class(es)** | **gal** | **L** | |
| **Flammable liquids** | IA | 30 | 115 | 1 , 2 |
| | IB and IC | 120 | 460 | 1, 2 |
| | IA, IB, IC combined | 120 | 460 | 1, 2, 3 |
| **Combustible liquids** | II | 120 | 460 | 1, 2 |
| | IIIA | 330 | 1,265 | 1, 2 |
| | IIIB | 13,200 | 50,600 | 1, 4 |

Special Notes:

(1) Quantities are permitted to be increased 100 percent where stored in approved flammable liquids storage cabinets or in safety cans in accordance with the fire code. Where Note 2 also applies, the increase for both notes is permitted to be applied accumulatively.

(2) Quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*. Where Note 1 also applies, the increase for both notes is permitted to be applied accumulatively.

(3) Containing not more than the maximum allowable quantity per control area of Class IA, Class IB, or Class IC flammable liquids, individually.

(4) Quantities are not limited in a building equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13,

4. Storage Cabinets

The volume of Class I, Class II, and Class IIIA liquids stored in an individual storage cabinet shall not exceed 120 gal (460 L).

The total aggregate volume of Class I, Class II, and Class IIIA liquids in a group of storage cabinets shall not exceed the maximum allowable quantity of flammable and combustible liquids per control area based on the occupancy where the cabinets are located.

# Appendix F
# Nanotechnology Protocol

## Safe Practices in Nanotechnology

1. Background information

- Nanoparticles are ultrafine particles measuring in one dimension between 1 – 100 nanometers (nm).
- Nanotechnology involves the use of nanoscale structures, devices and systems that may have utility in biological or other systems that require nanoscale applications.
- Nanotechnology comprises the study of processes, applications and materials related to biological, chemical, electronic, physical or engineering applications.
- In addition to the novel size of nanoparticles or structures, uses are also derived from unique properties related to reactivity or conductivity.

2. Limitations

- Information regarding nanoparticles and their resultant effects on humans is difficult to find.
- Some studies have shown that nanoparticles are able to enter the body through respiration or skin contact.
- Because of their incredibly small size, nanomaterials may be able to pass from the bloodstream into the brain.
- Particles at the nano-scale display properties that differ from the meso-scale, some materials are magnetic at the meso level and not at the nano-size.
- Because of the relative lack of information regarding nanoparticles, reasonable safety procedures should be implemented in order to protect workers and the general public.
- As a rule, when working with nanomaterials, one should follow safe lab practices in order to avoid exposure.

3. Nanomaterials Handling Recommendations

- Total enclosure of the particle handling process - Nanoparticle stocks that are dry should be handled inside an appropriate glove box. Workers should wear protective equipment, including safety goggles, lab coats, and gloves if handling or transporting materials outside of a glovebox.
- Total enclosure of stored stocks and nano-materials.
- Contact the Office of Environmental Health, Safety & Risk Management (EHS&RM) to determine if stocks can be handled outside of a glove box, using local exhaust ventilation with HEPA filtration.
- Nanoparticle solutions may be handled on the lab bench once placed in solution. Workers should wear protective equipment, including safety goggles, lab coats, and gloves.

- Transport of nano-materials should employ a sealed secondary containment device.
- Limit access in areas where processes are being carried out. Only trained personnel may be permitted to work in these areas while nano-materials are being used. Training procedures and operating procedures must be implemented before beginning work with nano-materials. EHS&RM will provide postings for laboratories working with nanoparticles.
- Nanoparticle waste must be contained and labeled for chemical content in compliance with EHS&RM hazardous waste management requirements. Contact EHS&RM for waste pickup or for further information about how to handle specific wastes.
- Nanoparticle spills should be cleaned immediately using spill mitigation procedures developed by the laboratory. Consult EHS&RM for assistance in developing a spill control and cleanup protocol.
- Regular cleaning of bench tops, floors and other surfaces should be implemented; the cleaning schedule should be documented. The cleaning solution should be compatible with the vehicle in which the nanoparticles are suspended. Contact EHS&RM for assistance with development of a cleaning protocol.
- Prohibition of eating and drinking in laboratories and controlled areas.
- Equipment used for handling of nanoparticles must be evaluated for safety concerns before it may be repaired, reused for other laboratory purposes or released for disposal.
- The use of respirators is not generally required for worker protection. For special circumstances in which respirator use is required, the use of HEPA filtered respirators for protection against nanoparticle exposure must be evaluated by EHS&RM prior to implementation.

4. Source - Florida State University, Office of Environmental Health & Safety