University of Houston Clear Lake

Chemical Hygiene Plan

Environmental Health and Safety Department

Adapted from UT Health Science Center CHP

August 1, 2024

PREFACE

The University of Houston – Clear Lake (UHCL) is committed to providing a safe and healthy working and learning environment for all faculty, students, employees, visitors, and contract employees. Environmental Health & Safety's mission is to work in conjunction with the UHCL community and ensure that education, research, and health-care related activities take place in conditions that are optimally safe and healthy for students, faculty, staff, visitors, the surrounding community, and the general public.

The objective of the UHCL Chemical Safety Program is to assist personnel at all levels in fulfilling the commitment to furnish a place of employment and learning that is as free as possible from recognized hazards that cause or are likely to cause harm to UHCL personnel or the surrounding community. Faculty, staff, and students must have enough information available to aid them in the safe conduct of their daily work activities relating to hazards throughout their workplace.

The purpose of this manual is to provide employees with general guidelines for implementing a quality and proactive safety program regarding the use of chemical agents. The information contained herein satisfies the requirements for the university to provide a written Chemical Hygiene Plan and Hazard Communication Program. It is not intended to be an exhaustive reference, but rather a guide for all UHCL personnel to become familiar with and conduct their operations accordingly. Further advice concerning chemical hazards associated with specific processes and the development of new or unfamiliar activities should be obtained through consultation with your supervisor, the FSSC Environmental, Health & Safety Subcommittee, the Research Safety Committee, or the UHCL Department of Environmental Health and Safety (EHS).

All users of chemicals must be familiar with the requirements outlined in this manual and applicable state and federal regulations and must conduct their operations in accordance with them.

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1. INTRODUCTION

The purpose of this Chemical Hygiene Plan (CHP) is to define work practices and procedures to help protect students, laboratory workers, researchers, and supervisors at The University of Houston – Clear Lake (UHCL) from health hazards associated with the use of hazardous chemicals. The Chemical Hygiene Plan is consistent with the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) standard entitled "Occupational Exposure to Hazardous Chemicals in Laboratories" (Code of Federal Regulations, 29 CFR 1910.1450) and the Texas Hazard Communication Act (Chapter 502 of the Texas Health and Safety Code).

OSHA has defined a hazardous chemical as "a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees." In addition, OSHA defines a laboratory as "a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis." Finally, laboratory workers are defined in the OSHA Lab Standard under the definition of "employee" as "an individual employed in a laboratory workplace that may be exposed to hazardous chemicals in the course of his or her assignments." An example of a laboratory worker would include researchers in laboratories and principal investigators (the students in the academic laboratory would not be considered laboratory workers according to OSHA; however, they are covered by this plan). If there is any confusion about whether a particular workplace is considered a laboratory that utilizes hazardous chemicals, or whether someone is considered a laboratory worker, the Chemical Hygiene Officer will, upon request, make this determination.

Laboratory workers, researchers, supervisors, and students conducting laboratory procedures should be familiar with this Chemical Hygiene Plan and together share the responsibility for creating a safe and healthy work environment. In addition to the CHP, the laboratory workers shall be cognizant of and adhere to the Chemical Safety Program of Environmental Health & Safety (EHS) which represents prudent health and safety practices in a number of areas. Copies of the CHP are available from EHS.

The laboratory supervisor is responsible for maintaining a written record stating that each laboratory worker has reviewed the Chemical Hygiene Plan along with copies of SOPs, SDSs, training records, and other documents relevant to work being done in the lab.

This Chemical Hygiene Plan (CHP) will be reviewed annually by the Chemical Hygiene Officer or the Research Safety Committee.

2. REGULATIONS

A hierarchy of information sources exist when making safety related decisions. The hierarchy is first based on whether the information has the force of law followed by how well-reviewed the information is. Codes/Regulations have the most force, followed by standards, best practices, other sources (i.e. journal articles, books, websites, and expert judgement), and personal knowledge.

1. Codes (regulations), promulgated by regulatory bodies. Codes have the force of law and adherence to codes is non-optional. For general and chemical laboratory safety at UHCL, the following are some of the key codes:

a. TAC Title 25, 31, and 37 regulations
b. National Fire Protection Association (NFPA) including NFPA 45 Standard on Fire Protection for Laboratories Using Chemicals

2. Formal standards and official guidelines from generally recognized professional associations, industry bodies, non-profit standards organizations, and government agencies. Standards do not intrinsically have the force of law, though some are given the force of law by being specifically referenced in codes. All standards, whether mandatory or not, represent an accepted source of best practice that should be followed. Some organizations publish safety guidelines, which are also a valuable source of best practices. Relevant standard/guideline-promulgating bodies include, but are not limited to:

a. OSHA publications, guidelines, and fact sheets
b. American National Standards Institute (ANSI)
c. National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards
d. American Congress of Government Industrial Hygienists (ACGIH)
e. American Chemical Society (ACS; official ACS publications, not simply journal articles)
    i. Laboratory hazard identification and evaluation
    ii. Creating Safety Cultures in Academic Institutions
    iii. Classroom chemical safety
    iv. Various resources
f. National Research Council (National Science Foundation)
g. Official safety information from other states
h. National Institute of Health (NIH)

3. If a safety inquiry is not resolved or covered by the authoritative information sources mentioned above, or the question is too specific to be covered by those sources, then recourse can be had to:

a. Standard practice, as determined from:
    i. Peer-reviewed journal articles
        1. Journal of Chemical Education
        2. Current Protocols series of journals
        3. Newer experimental procedures, which incorporate safety warnings

ii. Other universities' safety information
iii. Safety information from US Government labs

3. RESPONSIBILITIES

Specific to this Chemical Hygiene Plan, the responsibilities of EH&S's Chemical Safety Program include the following:

- Provide technical assistance to laboratory personnel concerning appropriate storage, handling, and disposal of hazardous chemicals.
- Provide guidance and technical assistance regarding appropriate personal protective equipment (PPE) and laboratory safety equipment.
- Perform industrial hygiene sampling to determine if exposure risks are present upon request.
- Facilitate occupational medical surveillance services where hazards exist.
- Provide general and specialized laboratory safety training upon request.
- Conduct laboratory inspections on an annual basis and upon request. As best practice recommendations, inspections may be conducted more frequently based on risk.
- Track the status of all lab inspection action items until completion using EHS software.
- Provide inspection reports, including action items, to PI, Chair, Dean, relevant committees, Office of Sponsored Programs (OSP), and regulatory committees as needed to assure adherence to Chemical Safety and the CHP.
- Provide annual reports to relevant safety committees, OSP, and schools, regarding the results of laboratory inspections, corrective action data, safety concerns, regulatory concerns, corrective action history, and training adherence, within the laboratories.
- Facilitate access to manufacturer's Safety Data Sheets and other laboratory and chemical safety literature.
- Remain current on rules and regulations concerning chemicals used at UHCL.
- Accept and monitor laboratory room registrations. Maintain the laboratory registration database in coordination with lab owners.

Deans, Directors, Chairs, and Leaders of Academic and Administrative Units including the Office of Sponsored Programs (OSP) are primarily responsible for their staff members and students' health and safety. Specific responsibilities regarding the implementation of the Chemical Hygiene Plan include:

- Collaborate with faculty, principal investigators (PI), and laboratory staff to adopt this plan, including lab-specific guidelines, and develop strategies to implement it within their units.
- Ensure Faculty, PIs, and laboratory managers respond to EHS and complete corrective action identified in laboratory inspections as per section 7 of this document.
- Review inspection information.
- Ensure Faculty, PI, and laboratory staff follow all requirements written within the CHP.
- Be aware of individual lab safety inspection issues and actions, and recommended

corrections

- Communicate will all lab end users the above information
- Make budget arrangements for health and safety improvements required for safe research, engineering controls, and adequate PPE.
- Review research grants and consult with EHS to review future program needs, safety and health requirements, training requirements, equipment, and chemicals before agreements and purchases are made. Note: research delays due to lack of engineering controls because regulatory requirements were not met are not EHS's responsibility to fund.
- Ensure direct contact with a PI in charge of the lab and that the individual maintains up-to-date records of laboratory occupants assigned within the given lab space and the training required to occupy that space.
- Inform UHCL Police Department and EHS of any changes in lab access privileges for PIs and lab managers.
- Notify EHS of any changes in laboratory room assignments for registration purposes.

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

- Ensure that all employees are informed and trained concerning chemical safety as required by this Plan and retain training records and all documentation for inspections.
- Implement and enforce rules and standards concerning health and safety for laboratories under their jurisdiction.
- Respond to and correct EHS Lab Inspection Action Items as per section 7 of this document.
- Ensure that correct Hazard Door Signage Information, and emergency contacts for laboratory personnel, including names and telephone numbers of key lab personnel such as the PI, lab manager, and safety officer are kept up-to-date for each lab. Contact EHS for assistance with changing hazard door signage.
- Ensure compliance of laboratory workers with this Plan.
- Notify EHS of accidents involving hazardous materials and any significant changes in lab design or procedures and laboratory assignments.
- Prepare Standard Operating Procedures (SOP), including procedures on safe work practices for all routine processes involving hazardous materials, hazardous procedures, or hazardous equipment. Ensure EHS is included in the development of SOPs. A blank SOP template is provided in Appendix 11.
- Ensure the availability and enforce the use of the following: appropriate personal protective equipment (PPE), Safety Data Sheets (SDSs), and relevant reference materials.
- Remain cognizant of chemicals stored and used in labs and their associated hazards.
- Dispose of chemicals no longer needed by following the waste disposal SOP in Appendix 1. Call EHS at 281-283-2106 if further assistance is needed.
- Conduct internal inspections of labs for health and safety concerns.

- Maintain all labs in a clean and orderly manner. Projects should be closed and chemicals returned to the correct storage areas when not in use.
- Maintain and ensure up-to-date records of laboratory occupants assigned within the lab space. Report to management and to EHS any personnel changes that require additional training. Report to the UHCL Police Department any changes in lab access privileges for any lab employees (including TAs and students involved in research).
- Request assistance as needed.

Laboratory Employee and Student responsibilities adhering to the Chemical Hygiene Plan are as follows:

- Take all safety training courses required by EHS and the principal investigator.
- Maintain all training requirements outlined by your department, EHS, and the University to work in a laboratory.
- Follow all health and safety policies and procedures.
- Follow and adhere to the CHP and any SOPs and protocols developed for the lab work being done.
- Know egress routes and assembly locations.
- Know the locations of eye wash and safety shower stations, first aid kits, fire extinguishers, fire alarm pull stations, and gas shut-off valves throughout all lab and office areas in which they work.
- Report any hazardous conditions to the supervisor.
- Wear or use prescribed personal protective equipment.
- Report any job-related injuries or illnesses to the supervisor and seek treatment immediately. Fill out the Injury Report Form (staff, student, or visitor) as soon as possible.
- 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.
- Request information and training when unsure how to handle a hazardous chemical or procedure.
- Maintain standard housekeeping in labs. Clean and close out all projects. Return all chemicals to storage.
- Contact EHS for any additional questions or concerns.

UHCL Police Department's responsibilities for implementing the Chemical Hygiene Plan are as follows:

- Ensure that card access to labs and stockrooms is kept up-to-date according to the information provided to them by Deans, Directors, Chairs, PIs, Laboratory Managers, and other personnel as directed in the above responsibilities.
- Provide keys to employees to access restricted areas as requested by Deans, Directors, Chairs, PIs, Laboratory Managers, and other personnel as directed in the above

responsibilities.

4. STANDARD OPERATING PROCEDURES

"Standard operating procedures relevant to safety and health considerations are to be followed when laboratory work involves the use of hazardous chemicals". 29 CFR 1910.1450(e)(3)(I)

The CHP represents a minimum set of guidelines for the handling of toxic chemicals on campus. All individuals are required to develop more detailed procedures as their situations warrant. In all situations, individual faculty or staff will be responsible for enforcing adequate safety and hygiene measures in laboratories they supervise. If necessary, additional assistance from EHS is available.

Some rules or standard operating procedures, that apply to all laboratories at UHCL, include the following:

4.1 General Guidelines

Respect and understand the safety and health hazards associated with the chemicals and equipment in your laboratory, and practice the following general safety guidelines at ALL times:

- **No smoking.**
- **Unattended experiments**. Laboratory experiments **should not** be left unattended. If an experiment must be unattended, it shall be placed in potentially low-hazard conditions before leaving it unattended. An SOP must accompany this project that requires continuous operation. In addition, the unattended project must have emergency contact information in clear sight with a date of the project length while left unattended.
- **Housekeeping.** Exits, aisles, and safety equipment must be kept clear of any obstructions, such as equipment, furniture, etc. Hazardous liquid chemicals should be stored below eye level. Work areas and floors should be kept clear of excessive storage. All laboratory benches must be cleaned, chemicals returned to storage areas, and fume hoods cleared.
- **Food, drink, cosmetics.** Eating, drinking, and the application of cosmetics are not permitted in laboratories where hazardous chemicals are used or stored. Do not store consumable food and drinks in laboratory freezers or refrigerators.
- **No horseplay.** Practical jokes or other behavior that might confuse, startle, or distract another worker are not permitted.
- **Equipment.** Use proper equipment that is in good condition. For example, never use chipped or cracked glassware. Shield pressurized or vacuum apparatus and safeguard against bumping or overheating. Ensure that the proper tool(s) is(are) used for the job.
- **Waste Minimization.** A laboratory waste minimization program is coordinated by EHS. In general, this plan includes:

1. An up-to-date review of the chemical inventory.
2. Waste Stream profile reviews and inspection.
3. Waste collection method reviews (recycling options, vessel containment, alternatives, bulking, etc.)
4. Use of the chemical redistribution program
5. Annual review of experimental protocols and research of new techniques that consider the hazards and quantities of waste produced
6. Destruction procedures as the final step in experiments. For example, neutralization of corrosive wastes that do not contain heavy metals should be a standard operating procedure.
7. Elimination of thermometers and reagents that contain mercury and chromic acid cleaning solutions. The use of other hazardous materials such as heavy metals and halogenated solvents should also be eliminated or reduced.

For further information, see the directives listed in Appendix 1. Additional technical information on waste minimization is available from EHS at 281-283-2106.

- **Disposal of chemicals.** In general, to request a pick-up of chemicals, call the EHS Coordinator for Waste Disposal at 281-283-2104. Disposal of all laboratory waste shall follow the procedures outlined in Appendix 1. Additional resource materials relating to waste disposal are available from EHS.
- **Chemical spills and accident response.** In the event of a large or extremely hazardous chemical spill, please evacuate the area and call the UHCL Police Dispatch at 281-283-2222 or X2222 if using a desk phone. In the event of an injury requiring evacuation of the victim by ambulance, call the UHCL Police Dispatch at 281-283-2222 or X2222 if using a desk phone This line is monitored 24 hours a day/seven days a week. For small spills/leaks that you are unable to respond to or require assistance to respond to, call EHS at 281-283-2106 during normal business hours. For after-hours response to incidents involving spills or injury call the UHCL Police Dispatch at 281-283-2222 or X2222 if using a desk phone.
- **Mouth pipetting.** Mouth pipetting is not permitted.
- **Mercaptans (thiols, sulfhydryl reagents).** Should mercaptans be used in a laboratory in such a manner that persons outside of the laboratory would smell the mercaptan and suspect a natural gas leak in the building, EHS should be contacted at 281-283-2106 to avoid false reporting of natural gas leaks. Mercaptans should be used in a chemical fume hood.
- **Perchloric acid.** If perchloric acid is heated above ambient temperature it will give off vapors that can condense and form explosive perchlorates. Hence, when heating perchloric acid above ambient temperature, a perchloric acid fume hood with a wash-down system or a local scrubbing or trapping system must be used.

4.2 Working Alone and After Hours

The researcher is responsible for ensuring that all students, interns, grad students, and visitors are supervised or have a "buddy" system within the lab spaces at all times. For UHCL, normal business hours are defined as being between the hours of 8:00 a.m. and 6:00 p.m. Monday through Friday. Evening classes at UHCL can extend from 7:00 p.m. to 10:00 p.m. during the week.

After-hours laboratory work must be approved in writing by the PI responsible for the lab space and include a method of signing in and out of the lab in tandem. Principal Investigators and laboratory managers are responsible for developing SOPs for all students working after hours if allowed. The UHCL Police offers escort services for university members 24 hours a day by request.

- **Undergraduates.** Undergraduate Students are not allowed to work alone in a lab. The PI or TA must be present to oversee students and close the lab.
- **Undergraduate after-hours.** Undergraduate laboratory work past 10:00 p.m. must have an SOP developed. The PI responsible for the lab space must develop the SOP to justify why normal business hours do not allow sufficient time to complete an undergraduate project, and contain emergency response notification information. The SOP must also include a method of signing in and out of the lab for at least two people leaving at the same time. The UHCL Police Department needs to be notified of any students remaining after hours and they must contact police when they leave the lab.
- **Graduate Students.** Graduate students are not allowed to work alone except if they receive an approved exemption.
- **Graduate Student's Exemption request for working alone or working alone after hours.** Graduate students can work alone and after hours if approved by a combination of the PI, Chemical Hygiene Officer, Research Committee, and Dean. The PI must develop an SOP and a written justification for why they are requesting the student be allowed to work alone on a specific project or after hours. This request will require special review and consideration in three ways:
    1. The PI can make this request to the Research Safety Committee during the High-Risk Protocol review for specified chemical use as outlined in the CHP.
    2. The PI can make this request to the Research Safety Committee for a specified project not identified as a High-Risk as outlined in the CHP.
    3. The PI can make this request to the Chemical Hygiene Officer if the Research Safety Committee is not in session. The CHO may wait to bring the request to the Committee for additional review. If not, the CHO can obtain the Dean's signature for finalization.

The SOP must contain emergency response notification information, and a method of signing in and out of the lab. The UHCL Police Department needs to be notified of any graduate students remaining after hours and they must contact police dispatch

when they leave the lab. The Graduate Student Permission to Work Independently After Hours form is located in Appendix 6.

4.3 Personal Protection and Personal Hygiene

Personal protection and personal hygiene are two very basic aspects of laboratory safety. Wearing appropriate personal protection and practicing good personal hygiene, as described below, will minimize exposures to hazardous chemicals during routine use and in the event of an accident.

- **Attire.** Wear a lab coat or apron as necessary, cover legs and feet (no sandals, open-toed shoes, or shorts), and confine loose clothing and long hair.
- **Gloves.** Gloves are essential when working with hazardous substances. The proper gloves will prevent skin absorption, infection, burns, or death. All glove materials are not equally effective in protection from chemical hazards. ***In many cases, latex examination gloves do not provide adequate protection from hazardous chemicals.*** Consult a chemical resistance chart such as the one found in Appendix 4, a glove manufacturer, or contact EH&S for assistance in appropriate selection.
- **Eye protection.** All personnel including students, staff, and visitors in laboratories shall wear safety glasses, goggles, and face shields as required at all times where potential eye hazards exist. Goggles are required when chemical splashes are possible.
- **Face shields.** Full-face shields must be worn when conducting a procedure that may result in a violent reaction. Full-face shields with bottom caps to protect under the chin are preferred due to the tendency to raise the chin when a splash occurs.
- **Glass tubing.** When inserting glass tubing into stoppers, lubricate the tubing and protect hands from being cut in the event the tubing slips and breaks.
- **Personal hygiene.** Hands should be washed frequently throughout the day, before leaving the lab, after contact with any hazardous material, before eating, etc.

4.4 Hazardous Material Handling and Storage

Hazards associated with various chemicals and gases vary widely. Understanding the hazards associated with a compound and minimizing the quantity used and stored in the lab will decrease the chance of injury.

- **Chemical storage (general).** Chemicals must be stored by compatibility, not by alphabetical arrangement. For example, oxidizers should be separated from organics, air-reactive materials should be stored under an inert gas, water-reactive materials must be kept dry and cyanides should be stored away from acids. Storage of all laboratory chemicals shall follow the recommendations outlined in Appendix 7, Chemical Segregation and Incompatibilities Guidelines.
- **Storage of volatile chemicals.** Volatile toxic substances shall be stored in storage cabinets adequate to their purpose or in hoods when cabinets are unavailable. If volatile substances are stored in a hood, other uses of the hood shall be restricted to activities compatible with the chemical and physical properties of the chemicals

being stored or used. When volatiles must be stored in a cooled atmosphere, refrigerators or cold rooms designed for this purpose must be used. Refrigerator/freezer units for the storage of flammables are located throughout UHCL. Call EHS at 281-283-2106 for further information.

- **Chemical handling.** Use secondary containment when transporting chemicals by placing the chemical being transported inside a protective container. For example, use poly-coated bottles or bottle carriers for transporting chemicals that are in regular glass containers. Close caps securely and avoid storing chemical containers in hard-to-reach areas. Pour chemicals carefully, and never add water to concentrated acid or base. Metal containers and non-conductive containers (e.g., glass or plastic) holding more than five gallons must be grounded when transferring flammable liquids.
- **Cylinder storage.** Cylinders must be stored in accordance with 29 CFR 1910.101, the OSHA Compressed Gases Standard. Cylinders must be stored in well-ventilated areas with their protective caps screwed on and the cylinder secured (e.g., strapped or chained down) to reduce the chance of the cylinder being knocked over. For assistance in securing gas cylinders, call EHS at 281-283-2106. Do not store cylinders near heat or high-traffic areas. Do not store flammables and oxidizers together. Do not store empty and full cylinders together. Storage of large quantities of cylinders must be done in an approved gas cylinder storage area.
- **Cylinder handling.** Use appropriate handcarts to move cylinders. Cylinders must be secured to the 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. Utilize the service elevator to move cylinders between different floors. Do not ride in the elevator with a gas cylinder. Ensure the cylinder and cart are labeled in a manner to discourage others from boarding the elevator while it is going to its assigned floor. Ensure someone is on the floor to receive it as it arrives.
- **Labels.** Make sure all labels are legible. Label all secondary containers with the chemical name (as it appears on the original label or SDS) and appropriate hazards. Health hazard warning information should include the target organs that may be affected and any of the following terms that are appropriate: carcinogen, toxic or highly toxic agent, reproductive toxin, irritant, corrosive, sensitizer, hepatotoxin, nephrotoxin, neurotoxin, agents that act on the hematopoietic system, or agents which damage the lungs, skin, eyes, and mucous membranes. Physical hazard warning information should include any of the following terms that are appropriate: combustible liquid, compressed gas, explosive, flammable, organic peroxide, oxidizer, pyrophoric, unstable (reactive), or water-reactive. Date all peroxidizable (i.e. ethyl ether) and other peroxide forming chemicals that may become unstable over time; test and/or dispose of them when appropriate.
- **Containers.** Check the integrity of containers. Ensure that the container used is compatible with the chemical, for example, hydrofluoric acid must not be stored in glass and some oxidizers should not be stored in plastic containers.

5. CONTROLLING CHEMICAL EXPOSURES

"*Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment, and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous."* 29 CFR 1910.1450(e)(ii)

There are three major routes of entry for a chemical to enter the body: inhalation, skin and eye contact, and ingestion. Three types of controls for the prevention of these various routes of entry include the following: engineering controls, personal protective equipment, and administrative controls. Each route of entry can be controlled in several ways, as explained below.

At the request of faculty, staff, or students, exposure evaluations may be conducted by the EHS for substances regulated by OSHA and/or with threshold limit values published by the American Conference of Governmental Industrial Hygienists (ACGIH). EHS will periodically perform Industrial Hygiene monitoring within your lab and in the event of any suspect exposure.

5.1 Inhalation Hazards

Inhalation of chemicals is the most common route of entry a chemical can take to enter the body. To avoid significant inhalation exposures, substituting a less hazardous chemical is the best option 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 chemical is the best means of control. If substitution is not practical, engineering controls such as ventilation are the next best choice and 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 the State or Federal 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, when most of the staff in the building have gone home; and,
- proper signage on lab doors to indicate special hazards within, a list of lab personnel who should be contacted in the event of an emergency, and appropriate telephone

numbers. Door signs are provided by EHS.

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 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 must contact EHS if respiratory protection is needed to control exposure to hazardous chemicals. Respiratory protection, should it be required for your research, will be included as part of the laboratory inspection review.

5.2 Skin/Eye Contact Hazards

To reduce the risk of a chemical entering the body via skin and eye contact, substituting a less hazardous chemical is the best option to eliminate or minimize hazards. Engineering controls are the next best choice. The more obvious means of preventing skin and eye contact is the wearing of personal protective equipment such as eye protection, face shields, gloves, appropriate shoes, lab aprons, lab coats, and other protective equipment appropriate to the hazard. Since the chemical resistivity of the different types of protective equipment varies significantly, the lab supervisor should consult Appendix 4 or other references to ascertain that the protective equipment material is resistant to the chemical being protected against.

Administrative controls to reduce skin/eye contact include enforcement of policies for skin and eye protection, and discarding or repairing cracked or broken eyewear.

5.3 Ingestion

Ingestion of chemicals is the least common route of entry into the body. A laboratory worker can easily ingest chemicals into the body via contaminated hands if they are not washed before eating, smoking or sticking part of the hand, or sticking a writing tool that has been in contaminated hands, into the mouth. Use engineering controls, such as isolating the hazardous substance so that minimal contact is required (e.g., use a glove box), to help prevent exposures. Administrative controls such as prohibiting mouth pipetting, encouraging good personal hygiene, and designating a well-marked non-chemical area where eating, drinking, and the application of cosmetics are permitted, are also beneficial in preventing chemical exposures via ingestion. Personal protective equipment, such as gloves, may also be used.

6. LABORATORY INSPECTIONS

Laboratory safety inspections within chemical-containing labs are conducted on at least an annual basis. The focus of the inspections is to ensure compliance with general safety, fire safety, environmental compliance, chemical safety, physical safety, and

other potential compliance issues. The EHS department takes a proactive approach to compliance problems found in the laboratories and in most cases facilitates the corrective action process. The following outlines the criteria by which the laboratory safety surveys are inspected.

- **General Housekeeping**
  It is the responsibility of each laboratory worker to ensure that the laboratory is maintained in a clean and orderly fashion. Excessive storage of equipment, supplies, and chemicals can pose various hazards to laboratory employees and other building occupants.

- **Current Emergency Information and Warning Signs Posted**
  All laboratories shall have posted near the telephone or door entrance, the telephone numbers of persons to call in the event of an emergency. In addition to numbers for chemical spills, fire, and medical emergencies, the name of the responsible person (PI) along with the office and home phone.

  The campus emergency phone number is the UHCL Police Dispatch at 281-283-2222 or X2222 if using a desk phone This line is monitored 24 hours a day/seven days a week. UHCL Police Dispatch maintains up-to-date lists for all emergency contacts.

  Radioactivity work areas, laboratories, and containers of radioactive materials must be posted with appropriate warning signs. Refer to the UHCL Radiation Manual for safety, inspection, signage, waste procedures, and training requirements. Biohazardous labs where human blood or other potentially infectious materials are stored or used must bear the universal biohazard symbol. Refer to the UHCL Biosafety Manual and Bloodborne Pathogens Plan for, inspection, signage, waste procedures, and training requirements.

  Emergency postings shall also be placed on the laboratory electrical panel and emergency gas shut-off valve if available. These two emergency cut-offs are utilized in emergency situations and shall never be obstructed with equipment or storage.

- **No Food or Drink Rule Observed**
  Food and drink brought into areas of chemical or radiological use can easily become contaminated by these hazards. Airborne particulates can settle on exposed food, eating surfaces, or utensils. Even though work surface contamination may not be readily apparent, it can adhere to hands and then be transferred to food items. Upon ingestion these harmful substances will be carried into the body, increasing the opportunity for toxic effects.

- **Appropriate Personal Protective Equipment Available**

Chemical-resistant gloves should be available and worn during procedures. To choose the best glove for a particular operation one must weigh the ability of the glove material to resist permeation and degradation by the chemicals in use against the dexterity needed to conduct the experimental protocol. There is no single glove material universally resistant to all classes of chemicals; glove selection must be individualized for each experimental protocol. Eye protection should be available and worn during procedures. The eyes are particularly sensitive to chemical or physical insults and should be protected at all times against chemical splashes or sprays, flying particles, and other hazards. Protective clothing should be available and worn during procedures (lab coat, apron, etc.). Lab coats not only protect street clothing from being soiled; they also provide an additional layer of splash and burn protection and help protect family members by reducing take-home toxins.

- **All Applicable Safety Binders/Manuals Available**
  Safety manuals for each hazard division available include this CHP, Biological Safety Manual, Laser Safety Manual, and the Radiation Safety Manual. Every laboratory using hazardous chemicals, radioactive, laser, or biological hazards must have a copy of their respective Laboratory Safety binder/manual in the lab or otherwise readily available for inspection. The Lab Safety Binder should include such items as SDS, SOP, Memorandums of Understanding for each affected chemical or process, Training Records, Chemical Hygiene Acknowledgement Form, Chemical Inventory List, and other forms as necessary. Thoroughly review all applicable safety manuals with laboratory staff. [OSHA 29CFR 1910.1450 (e) (2)]

- **Occupant's Safety Concerns Solicited**
  During routine inspections conducted by EHS, the inspector is expected to talk with the laboratory staff and students and ensure they have no specific safety concerns. If the individual raises concerns, the inspector will make every effort to address the issue directly and immediately given the hazard, or document the concern by bringing it to the attention of the departmental management chain as part of the laboratory inspection. Notifications of Laboratory inspections and safety concerns will be presented to management teams in the following manner:
  1) Notify Principal Investigator
  2) Remind Principal Investigator
  3) Notify Department Chair
  4) Notify Dean
  5) Notify EHS Subcommittee

  When notifying management, a time will be specified for re-inspection or to address the individual's concern. If the issue has not been addressed by the time determined, it should be passed on to the next step in the notification chain until the issue is resolved.

- **Appropriate Records Shall be Maintained**

Laboratory employees and PIs are to keep documentation of all certificates of required training for working in a laboratory. Training requirements can vary depending on the type of research being conducted. For all laboratory employees, including PIs: General Lab Safety, Advanced Lab Safety, and RCRA-regulated and Hazardous Waste Management are required annually for all laboratory occupants. Additional training could be required by the Research Safety Committee, EHS, the PI, the Research division, or the University. Training awareness is often identified through project hazard reviews, protocol reviews, SOP development, and during the inspection process. Contact EHS if there are any questions regarding training requirements.

- **Egress Pathways Unobstructed**
  Laboratories shall be maintained in such a manner that there is at least 36 inches of clearance between obstructions to exit from the laboratory into the corridor. The corridors must have a minimum of 48 inches of clearance and shall be maintained free of obstructions to ensure clear egress to the nearest stairwell in the event of an emergency. Many times, emergency safety equipment i.e. safety showers and eyewashes are also located in the main corridors and this equipment shall be maintained free of any obstruction. Contact EHS at 281-283-2106 for further guidance.

- **Fire Extinguishers Available and Inspected**
  Fire extinguishers shall be located inside all laboratories or, in some instances, a minimum of 75 feet from the laboratory. Extinguishers are inspected and maintained by Emergency Management & Fire Safety. Laboratory workers should routinely inspect for broken seals, damage, and low gauge pressure (depending on the type of extinguisher). If problems are identified, repairs are requested by contacting Emergency Management & Fire Safety at 281-283-2707.

- **Heat Sources Separated from Combustibles**
  One of the easiest methods of fire risk reduction is to remove ignition sources from a flammable system (fuel + oxygen + ignition source). Ignition sources include electrical outlets, lighting fixtures, switches, exposed machinery components, as well as open flame. Flammable solvents should be used inside a chemical fume hood so vapors will be prevented from reaching flammable proportions. In the special case of a flammable solvent being heated (as in a distillation), all ignition sources (electrical outlets, Variac controllers, outlet strips, etc.) must be located outside of the hood.

- **Appropriate Clearance to Ceiling**
  It is required that there is an 18-inch clearance to the ceiling to comply with NFPA codes for sprinkler systems. This regulation does not include shelving and storage attached to a wall, as this does not impede the overlap of spray from other sprinkler heads. Minimizing the “stacking” of combustible material will also decrease the

fuel package arrangement of the laboratory and help contain fire to one laboratory unit in the event of a fire.

- **Electrical Circuit Loading and Cords**
  Insufficient or overloading of electrical outlets should be avoided. A sufficient number of outlets will eliminate the need for extension cords. Overloading electrical circuits and extension cords can result in a fire.

  A cord should not be pulled or dragged over nails, hooks, or other sharp objects that may cause cuts in the insulation. In addition, cords should never be placed on radiators, steam pipes, walls, and windows. Particular attention should be placed on connections behind furniture, since files and bookcases may be pushed tightly against electric outlets, severely bending the cord at the plug.

  When the outer jacket of a cord is damaged, the cord may no longer be water-resistant. The insulation can absorb moisture, which may then result in a short circuit or excessive current leakage to the ground. If wires are exposed, they may cause a shock to a worker who contacts them. These cords must be replaced. Electric cords shall be examined on a routine basis for fraying and exposed wiring.

  Household extension cords and multi-use plugs are prohibited. Check that cords on equipment are in good condition with no fraying. Equipment supplied with a grounded plug requires attachment to a ground source. Removal of the grounding prong interferes with this electrical safety feature and can result in shock or electrocution.

- **Minimize Trip Hazards**
  Laboratories shall be maintained free of trip hazards. This includes items such as power cords on the floor, excessive equipment in the laboratory, and/or damaged flooring.

- **Compressed Gas Cylinders Secured**
  Compressed gas cylinders under great pressure, often exceeding 2000 pounds per square inch or 136 atmospheres. To prevent the accidental and uncontrolled release of energy, or gas, it is important to protect cylinders from toppling over and rupturing the valve stem. All compressed gas cylinders, including lecture bottles, “empty” cylinders, and cylinders in transit, must be secured in racks, clamping devices, stands, or other protective structures. Any cylinders not in use must have the regulator removed and the cylinder cap tightly in place.

- **Guards for Mechanical Hazards in Place**
  Some common pieces of lab equipment present physical hazards due to rotating parts, nip points, or other mechanical actions. Particularly prevalent in the lab are vacuum pumps that have had their belt guards removed. To prevent injury due to entrapment of hair, clothing, or other items these areas must remain locked. Any

piece of equipment with a detached, disengaged, or inoperable guard must be prominently tagged and removed from service.

- **Electrical Panel Not Obstructed**
  Building safety codes prohibit the placement of any items within 36 inches of the front or 30 inches of the side of electrical panels. To maintain accessibility of the electrical panel in case of an emergency, no items should be placed in such a way as to diminish access to the panel.

- **Proper Segregation of Chemicals**
  Storage of chemicals as a general group alphabetically is not recommended as it may place incompatible materials together on a shelf. Instead, separate chemicals into organic and inorganic families and then into related and compatible groups. Suggested chemical storage schemes and compatibility lists can be found in several lab safety resources available from EHS. A quick and very general rule of thumb is to separate acids from bases, flammables from oxidizers, and reactive chemicals from air or water. Chemicals should never be stored on the floor.

- **Chemicals Properly Labeled**
  Manufacturers are required to label every chemical container with hazard information that includes the chemical name, physical and health hazard information, and the name of the manufacturer. These labels relay valuable information that can assist in hazard evaluation and control, and cannot be removed or defaced from the original container unless the contents have been altered or removed. Secondary containers that will remain in use for a period of time (storage vials, squirt bottles) should bear an abbreviated label that includes the chemical name and hazard warning such as flammable, caustic, sensitizer, carcinogen, absorbed through the skin, etc.

- **Flammables Properly Stored**
  Many common solvents have flash points close to or below the temperature at which most refrigerators operate (around 39°F or 4°C). Flammable solvents evaporate rapidly, even at lowered temperatures, so they can quickly reach equilibrium inside the small, well-sealed space of a refrigerator. When this "off-gassing" reaches the lower explosive limit (LEL), sources of ignition inside a conventional refrigerator such as the thermostat, interior light, defroster, compressor, or fan can set off an explosion. Flammable liquids that must be stored at reduced temperatures require a specially designed refrigerator, termed a "flammable material storage refrigerator," where ignition sources are isolated from the inside space.

  Flammables not requiring refrigeration must be stored in a flammable storage cabinet. In the case of large amounts of flammables being stored in a lab, special attention must be paid not the exceed the amount of storage authorized by NFPA 30.

- **Controlled Substances Secured**
  Controlled substances are heavily regulated by the State of Texas and the Federal DEA Control Substance Act. Controlled substances must be secured following Chapter 481 of the *Texas Controlled Substances Act* which includes the following criteria:

  - Establishing adequate security to prevent unauthorized access to controlled substances and dangerous drugs, including a preliminary security inspection outlined in the requirements.

  - Not allowing any individual access to controlled substances and dangerous drug storage areas except those authorized for efficient operations during business activities.

  - Storing controlled substances and dangerous drugs listed in schedules I, II, III, IV, and V in a securely locked substantially-constructed cabinet or security cabinet or safe.

  - Chemical substances and pharmaceuticals not yet listed in the Texas Controlled Substance Act or DEA, but require a prescription by a Licensed Medical Professional (MD) or Veterinarian (DVM) shall be secured in the same fashion as controlled substances here at UHCL.

- **Absence of Old or Potentially Explosive Chemicals**
  Out-dated, expired, or unknown chemicals should be promptly disposed of by the appropriate means. Many materials, as they age, become unstable, possibly forming peroxides and explosive byproducts or undergoing rapid and violent decompositions. Other materials simply lose purity as contaminants are introduced or residues form. Chemicals that may no longer be used, that are of questionable purity, or that are past their expiration dates should be removed from the lab and placed in the hazardous waste storage rooms. For all chemicals that may be unstable or explosive, immediately isolate the chemical and contact the UHCL EHS to inspect the material. DO NOT MOVE the affected material.

- **Hazardous Liquid Chemicals Stored Below Eye Level**
  Every chemical should have assigned to it a definite storage place and should be returned to that place after each use. Do not store materials on top of high cabinets where they will be hard to reach and see.

- **Air Flow in Chemical Fume Hood Adequate**
  Hazardous chemicals that are flammable, volatile, or gases should be manipulated inside a properly functioning chemical fume hood. Optimum height is the sash height at which airflow is maximized without creating turbulence, generally between 80 and 120 linear feet per minute (fpm). A sticker placed on the hood face

indicates the most recent inspection results. Hoods can malfunction at any time without warning. It is important to confirm hood operation before each work session. Check the digital air flow display if so equipped. In the absence of a display, one can tape an inch-wide strip of tissue to the lower corner of the sash. Airflow can be visually assessed by noting that the tissue is pulled gently into the hood. Variable air volume valves have been calibrated to maintain 100 fpm. If the flow rate is not within the acceptable range, the correction is to be made by FMC by contacting 281-283-2247.

- **Chemical Fume Hood Sash Closed When Not in Use**
  To promote safety and conserve energy, the chemical fume hood sash must be closed when not in use. If a reminder sticker is needed, please contact EHS at 281-283-2106.

- **Ventilation Negative to Hallway**
  The primary objective in controlling occupational exposures is to prevent contamination of the work atmosphere. This shall be achieved first by use of a chemical fume hood, or other enclosure. The second way in which this is achieved is by making sure the ventilation is such that the air pressure in the laboratory is negative with respect to the hallway, thus preventing the release of chemicals from the laboratory.

- **Safety Shower/Eyewash Station Available**
  Emergency shower and eyewash equipment shall be maintained in accordance with the American National Standards Institute (ANSI) code Z358.1 – 1998. If there are any questions or concerns with this equipment please contact EHS 281-283-2106.

- **Tracking and Review of Past Deficiencies**
  EHS will review past laboratory inspections and compare them to the current inspection. If the same violations are repeated from the previous survey, they will be identified as a "Repeated Violation" on the inspection report and communicated to management in the following manner until it has been resolved:
    1) Notify Principal Investigator
    2) Remind Principal Investigator
    3) Notify Department Chair
    4) Notify Dean
    5) Notify EHS Subcommittee

  When notifying management, a time should be specified for re-inspection. If the issue has not been addressed by the timeline identified, it should be passed on to the next step in the notification chain until the issue is resolved.

- **Biosafety and Animal Laboratories**
  Biosafety Laboratories and Animal Research facilities must abide by the CHP since they contain, use, and store chemicals. Biohazards are a concern in laboratories in which microorganisms or material contaminated with them is handled. These

hazards are usually present in clinical and infectious disease research laboratories, but may also be present in any laboratory in which bodily fluids or tissues of human or animal origin are handled. Identify what bioagents are being used, whether the agents are infectious, and whether the research includes the use of recombinant DNA (rDNA) which can generate Chemical Hazardous Waste bioproducts. In addition, evaluate that the research has a current protocol approval from the Biosafety Committee during the chemical laboratory inspection.

- **Biological Safety Cabinet Certified within the Past Year**
  Biosafety cabinets should be certified when installed or moved, and annually thereafter. The biosafety cabinet's (BSC) ability to filter out microscopic particles relies on the seals being intact and the HEPA filter is free of micro-tears or breaks that can easily occur during moving installation or careless handling. To ensure continued proper operation, each BSC should be tested and certified at least annually. [CDC/NIH Primary Containment for Biohazards: Selection, Installation and Use of Biological Safety Cabinets p. 29; NRC Biosafety in the Laboratory p. 26]. During a Chemical Laboratory Inspection, biosafety cabinets are checked that they have been inspected annually.

- **Chemical Waste**
  Ensure that all chemical waste containers are kept closed and marked "Hazardous Waste" or equivalent.

  Label all hazardous waste containers with the words "hazardous waste" and list the individual waste chemical constituents on the label. Labels are provided in the Hazardous Waste Storage Rooms. Containers should be dated when full and moved from their Satellite Waste Accumulation areas to the waste storage room for pickup. Call the EHS Hazardous Waste Coordinator at 281-283-2104 if any assistance is needed.

7. INSPECTION DISCREPANCY CORRECTION

Discrepancies discovered during routine inspection will be addressed in the following manner:

- **Step One - Verbal Notification**
  If, during a routine evaluation or inspection, a problem involving chemical safety procedures is observed, a verbal recommendation will be provided. If upon receipt of a verbal recommendation, the laboratory staff or the Environmental Health and Safety staff takes immediate steps to correct the problem, then no further response regarding the discrepancy will be requested.

- **Step Two - Written Notification**
  Following the survey, a written summary of the findings and recommendations including corrections during the survey will be sent to the PI responsible for the

laboratory. The PI will then be requested to take corrective action within 30 days. A response made through the EHS software is required. Communication and corrective action responses will be recorded in EHS software. If EHS software is unavailable, all communications should be routed through UHCL emails.

- **Step Three - Documentation**
  A list of discrepancies will be maintained by EHS, or within the inspection software and a follow-up will be conducted within 60 days of the inspection to determine if corrective actions have been taken.

- **Step Four - Follow-up**
  If the follow-up reveals that the same discrepancy exists, notification of the situation will be re-sent to the PI. A response detailing specific steps taken to ensure correction of the discrepancy is required. This response shall be made through the EHS software. If no response is received from the PI within two weeks, continue to step 5.

- **Step Five – Written Notification Forwarded to Department Chair**
  If the PI does not respond, notification will be sent to the Department Chair. The Department Chair is expected to either provide a written response to EHS, or direct the PI to provide a written response to EHS. This response shall be made through the EHS software. If no response is received from the Chair or the PI within two weeks, continue to step 6.

- **Step Six – Written Notification Forwarded to the Dean**
  If the Chair does not respond, notification will be sent to the Dean. The Dean is expected to either provide a written response to EHS, or direct the Chair or the PI to provide a written response to EHS. If no response is received from the Dean, the Chair or the PI within two weeks, continue to step 7.

- **Step Seven – EHS Subcommittee Action**
  If the problem continues, the PI, Department Chair, and Dean will be notified that the inspection will be discussed during the next Research Safety Committee meeting and the FSSC Safety Subcommittee meeting.

- Any operation causing a high or unacceptable risk to employees or personnel exposure to any chemical hazard will be suspended immediately by EHS without regard to the above procedure. In the event of this action, the situation will be promptly reported to the Research Safety Committee and the FSS Safety Committee.

8. LABORATORY FUME HOODS AND OTHER ENGINEERING CONTROLS

"A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment." 29 CFR 1910.1450 (e)(3)(iii)

All laboratory (fume) hoods at UHCL shall comply with EHS guidelines. Laboratory (fume) hoods and other engineering controls such as vented gas cabinets shall be surveyed annually by EHS. Laboratory (fume) hood velocities for all hoods on campus are currently evaluated on an annual basis by EHS. The face velocity of the hoods should fall between 80 and 120 feet per minute (fpm) with the sash positioned at approximately half-open unless specified otherwise. (In general, laboratory hoods should not be used with the sash fully open.) If the face velocity is between 80 and 120 fpm on the day of the evaluation, the laboratory hood will bear a sticker on the cabinet indicating the results of the inspection. If the face velocity is less than or equal to 79 fpm or greater than or equal to 121 fpm, the hood will be marked with a sticker indicating that it should not be used for protection from highly toxic substances. Upon finding a hood out of the specified range, EHS will contact FMC for adjustment. Once the hood has been adjusted, an inspection sticker will be attached. The fume hood may be equipped with a variable airflow valve that keeps the hood face velocity at a constant 100 fpm. The rate is measured constantly and displayed by a digital readout on the fume hood.

Laboratory personnel should be certain that their hood has a sticker on it and that the date on the sticker is less than a year old. Because the status of a hood can change within one year, continuous airflow indicators are recommended for all fume hoods. New laboratory (fume) hoods should be equipped with airflow monitoring devices that will alert the user if there is a problem with airflow. For older hoods without airflow monitoring devices, a simple visible test to ensure flow into hoods and other ventilating devices is to tape a Kimwipe® to the hood and note its movement when the exhaust fan is on.

Air exhausted from chemical fume hoods and other special local exhaust systems shall not be recirculated. Ductless chemical fume hoods that pass air from the hood interior through an adsorption filter and then discharge the air into the laboratory are only applicable for use with nuisance vapors and dusts that do not present a fire or toxicity hazard (See NFPA 45 8.4.1.).

Protective equipment other than laboratory hoods should be checked periodically by the laboratory supervisor to ensure that the equipment is functioning properly. Any questions or requests for assistance in the evaluation of hoods and other protective equipment may be directed to EHS at 281-283-2106.

9. PRIOR APPROVAL FOR THE ACQUISITION AND USE OF HAZARDOUS CHEMICALS

"The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation." 29 CFR 1910.1450(e)(3)(v)

The principal investigator/laboratory supervisor should obtain approval for the acquisition and use of toxic chemical agents. Certain materials including toxic chemical agents, radioactive materials, recombinant DNA, and certain biological agents require prior approval from the respective safety committee at various levels. Questions concerning the need for approvals should be directed to EHS.

The principal investigator/laboratory supervisor is responsible for obtaining approval from the Research Safety Committee for the acquisition and use of toxic chemical agents. Forms for Research Safety Committee approval for the use of hazardous chemicals may be found in Appendix 6. To determine whether a chemical requires approval before acquisition and use, consult Appendix 5 – Chemical Protocol Review. For additional assistance, contact the EHS at 281-283-2106.

Note: EHS is not responsible for the payment of any licenses, permits, or fees required by any governing authorities pursuant to a PI working with a regulated chemical or agent. EHS is also not responsible for the procurement of any engineering controls required pursuant to a PI working with a regulated chemical or agent. The responsibility for procuring funds for the work resides with the PI.

10. MEDICAL CONSULTATION

"Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section." 29 CFR 1910.1450(e)(3)(vi)

An opportunity to receive medical consultation shall be provided under the following circumstances: if an employee develops any symptoms thought to arise from chemical overexposure; after an event such as a major spill, leak, or explosion which may have resulted in an overexposure; or, if an overexposure is identified as the result of an evaluation by the Chemical Hygiene Officer or designee. These suspected or actual exposures must be reported as an Injury. Faculty, staff, and students must fill out the UHCL First Report of Injury Form for Employees or Students. Incident Report forms are required in each lab and can be found on the Human Resources and EHS websites. Following notification of overexposure, arrangements for an appropriate medical examination must be completed before the exposed individual may return to work. Any medical examination required by this CHP shall be provided without cost to the employee, without loss of pay, and at a reasonable time and place. Students are covered by Student Insurance unless are enrolled in a medical surveillance program covered by an approved research protocol.

11. CHEMICAL HYGIENE OFFICER

"Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer and, if appropriate, establishment of a Chemical Hygiene Committee." 29 CFR 1910.1450(e)(3)(vii)

The Research Safety Committee serves as the Chemical Hygiene Committee at UHCL. A qualified member of the EHS Department is designated as the acting Chemical Hygiene Officer for UHCL.

12. SPECIAL PROVISIONS FOR SELECT CARCINOGENS, PYROPHORIC/EXPLOSIVE SUBSTANCES, ANTINEOPLASTICS, ACUTELY TOXIC CHEMICALS, AND NANOSCALE PARTICLES

"Provisions for additional employee protection for work with particularly hazardous substances: These include "select carcinogens" and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

(A) Establishment of a designated area;
(B) Use of containment devices such as fume hoods or glove boxes;
(C) Procedures for safe removal of contaminated waste; and
(D)Decontamination procedures." [29 CFR 1910.1450(e)(3)(viii)]

Carcinogens, acutely toxic chemicals, explosives, pyrophorics, antineoplastics, and nanoscale particles may require approval from EHS and the Research Safety Committee before acquisition and use. A listing of required protocol chemicals can be found in Appendix 5 or obtained from EHS by calling 281-283-2106. In addition to the general safety guidelines mentioned in the first section and throughout the Plan, special precautions are needed when handling these types of chemicals. A minimum set of guidelines that should be followed is listed below. The lab supervisor should ensure that these and other precautions designed to minimize the risk of exposure to these substances are taken.

- Quantities of these chemicals used and stored in the laboratory should be minimized, as should their concentrations in solutions or mixtures.

- Work with carcinogens, acutely toxic chemicals, explosives, pyrophorics, antineoplastics, and nanoscale particles should be performed within a functioning laboratory (fume) hood, ventilated glove box, sealed system, or other system designed to minimize exposure. (The exhaust air from the ventilation systems may require scrubbing before being released into the atmosphere.) In all cases, work with these types of chemicals shall be done in such a manner that the OSHA permissible exposure limits or similar standards are not exceeded.

  Note: any use of explosive materials needs to address the need for an explosion-resistant containment area and documented specialized training for work with said

explosive materials. Currently, UHCL does not have any areas suitable for working with explosive materials.

- Compressed gas cylinders larger than lecture bottle size that contain acutely toxic chemicals such as arsine and nitrogen dioxide shall be kept in ventilated gas cabinets. Lecture bottles will be either in a ventilated gas cabinet or in a hood.

- The ventilation efficiency of the designated hood, glove box, or gas cabinet, and the operational effectiveness of mechanical and electrical equipment used to contain or manipulate these special substances should be evaluated periodically by laboratory personnel at intervals determined by the laboratory supervisor. The interval of evaluating systems may vary from weekly to biannually depending upon the frequency of usage, quantities employed, and level of hazard.

- Each laboratory utilizing these substances must designate an area for this purpose and must sign or mark this area with an appropriate hazard warning. The designated area may be an entire laboratory, an area of the laboratory, or a device such as a fume hood or glove box. The designated area should be marked with a DANGER, specific agent, AUTHORIZED PERSONNEL ONLY, or comparable warning sign.

- All laboratory workers who work in a laboratory that has an area designated for use with carcinogens, acutely toxic chemicals, explosives, pyrophoric, antineoplastics, and nanoscale particles must be trained about the deleterious effects of these substances as well as signs and symptoms regarding exposure to these substances, whether or not they work with the substance themselves. Training to ensure the safe handling and storage of these substances is required for those who use these materials. This training is the responsibility of the laboratory supervisor and must be done before the use of any of these materials.

- All laboratory workers who work in a laboratory that has an area designated for use with carcinogens, acutely toxic chemicals, explosives, pyrophoric, antineoplastics, and nanoscale particles require a project hazard review and SOPs written for safe use.

- Laboratory workers working with these chemicals must have access to appropriate protective equipment and clothing (available at no expense to the workers) and must be trained on how to properly utilize the equipment. Training must be documented in writing. If assistance is required, contact EHS at 281-283-2106.

- Detection equipment may be required in laboratories where chemicals (especially poisonous gases) with a high degree of acute toxicity are utilized. All detection equipment must be checked and/or calibrated at the frequency indicated by the manufacturer. It is the responsibility of the investigator or lab manager to maintain the equipment properly.

- All wastes contaminated with these substances should be collected and disposed of in a timely manner and appropriately as outlined in the EHS waste disposal guide in Appendix 1. For special disposal information, call EHS at 281-283-2104.

- The designated working area shall be thoroughly and appropriately decontaminated and cleaned at regular intervals as determined by the laboratory supervisor. The interval may be as short as one day or as long as six months depending upon the frequency of usage and level of hazard.

- Special precautions to avoid release and exposure to highly toxic chemicals, carcinogens, explosives, pyrophorics, antineoplastics, and nanoscale particles must be utilized. For instance, volatile substances should be kept cool and contained; gases should have properly functioning valves, check valves, regulators, containment which can withstand pressure buildup, and appropriate piping; and dispersive solids should be kept in closed containers, used in places with minimum air currents, and appropriate contact materials should be used to avoid static charging. Additionally, the shipment of any highly toxic chemicals, genotoxins, reproductive toxins, and/or nanoscale particles (Appendix 9) from UHCL to any other location must be coordinated through EHS.

- Emergency response planning for releases or spills shall be prepared by the lab supervisor and included in the training of the laboratory workers and others who may be affected in the building. EHS can be contacted for assistance.

- More information on the use of controlled substances in research can be obtained by referring to DEA Guidelines.

APPENDIX 1: LABORATORY CHEMICAL WASTE DISPOSAL PROCEDURES

BACKGROUND

In general, all chemicals and their disposal should be treated with a healthy measure of respect. Because of the tremendous number of chemicals available in today's research institutional environment, their deleterious effects on personnel, and the "cradle to grave" responsibility under the Resource Conservation Recovery Act (RCRA) and Superfund Amendments and Reauthorization Act (SARA Title III) regulations, it is essential that an institution conduct a chemical waste disposal program that limits both health and monetary liability.

Generally, a hazardous chemical is one that is highly flammable, toxic, corrosive, carcinogenic, explosive, reactive, or is contained under pressure. **Because of the complexity of rules that govern the disposal of hazardous waste, all hazardous and nonhazardous chemical waste shall be disposed of through EHS.**

DISPOSAL OF CHEMICAL WASTES

When disposing of chemical waste, the following procedures shall be followed:

1. **Place waste in the proper container.**

    a. The outside of waste containers must be contamination-free, the lid should be securely attached, and the container must be in good condition and compatible with the waste stored within. If you need assistance with container compatibility, please contact EHS at 281-283-2104.

    b. All containers should be a maximum of five gallons with a minimum of two inches of head space on top. For ease of handling, one-gallon containers are preferred. Strong acids, bases, and poisons should be placed in containers no larger than ~~½~~ 1 gallon. All containers should be made of glass or HDPE plastic. No metal containers are allowed.

    c. Small amounts of dry waste should be bagged in 2 mil thick bags unless otherwise incompatible. Wide-mouth HDPE plastic containers may be used for larger amounts. All other containers should be made of glass or HDPE plastic. No metal containers are allowed.

2. **Label the waste with a Hazardous Waste sticker. Ensure that the sticker is properly filled out with the following:**

    a. The name of the person generating the waste.

b. The date provided, unless the sticker is being used to label waste at a satellite accumulation area. In the case of a satellite waste accumulation area, do not put the date on the container until the container is full and moved to the waste storage room; AA in the Bayou Building and 3125 in the STEM building.

c. The complete chemical name(s) of the contents. List percentages if known.

d. The hazards of the waste. Check each given hazard on the sticker as required by the contents.

e. Hazardous Waste tags are available in the waste storage rooms (Bayou Bldg. AA and STEM 3125). If they are not available, please contact EHS at 281-283-2104. In the case where they are not available and EHS does not pick up, the containers may be marked "Hazardous Waste", dated, and have the ingredients along with any known hazards marked on the side of the container with a Sharpie. Whoever is doing this must ensure that the writing is legible and the container is sealed so the writing cannot be erased by any spillage. A Hazardous Waste label should be placed on the container as soon as they become available.

3. **Move Hazardous Waste containers to Waste Storage Rooms.** Hazardous Waste containers shall be moved to either AA in the Bayou Building and placed on the identified shelves in the room or shall be moved to room 3125 in the STEM Building. It is not normally necessary to notify EHS that the waste containers have been moved. They will be picked up automatically in the next waste shipment. If you have moved an extremely high-hazard material, or if you have dropped off an unknown chemical, you must immediately notify EHS of the transfer at 281-283-2104. Ensure that all containers have been properly labeled, and placed in secondary containment and that no incompatible chemicals are stored in the same secondary containment.

4. **Assistance with complying with Laboratory Hazardous Waste Disposal Procedures.** For assistance with any part of this procedure, please contact EHS at 281-283-2104. If immediate assistance is not available, please contact the EHS hotline at 281-283-2106.

DISPOSAL OF EMPTY CONTAINERS

Empty containers with a volume of less than five gallons can be disposed of in the regular trash provided the **labels are defaced.** Before containers greater than five gallons can be discarded in the regular trash, they must be rinsed a minimum of three times, making sure the washings are collected and disposed of as chemical waste. Empty five-gallon drums can alternatively be left in the waste storage room and disposed of as contaminated drums rather than triple rinsing.

BROKEN GLASSWARE/CONTAINERS

If broken (or unbroken) glassware or a broken container is contaminated with a hazardous chemical residue, call 281-283-2104 for a pickup. The contaminated materials will need to be packaged for waste disposal. Otherwise, uncontaminated broken glassware or containers should be disposed of in a broken glass box. When filled, the container should be closed, taped, labeled "Basura" and placed near the regular trash for pickup.

CONTROLLED SUBSTANCES, EXPIRED DRUGS, & PHARMACEUTICALS

Assistance in the disposal of controlled substances, expired drugs and pharmaceuticals can be obtained by contacting EHS at 281-283-2104. Please note that all controlled substances will need to remain under their standard security protocols while their disposal is being arranged. Expired drugs and pharmaceuticals will be picked up by EHS and removed to a waste storage area for disposal.

SINK DISPOSAL

UNDER NO CIRCUMSTANCES should any *hazardous or non-hazardous waste* be disposed of by pouring it down the drain (through the sanitary sewer) or by evaporation. All chemical waste is to be packaged, labeled, and removed to the appropriate waste storage room for proper disposal. Call EHS at 281-283-2104 for any questions regarding waste disposal.

APPENDIX 2: REFERENCE MATERIALS

References available from Environmental Health & Safety:

Dangerous Properties of Industrial Materials, 8th ed., Irving Sax and Richard J. Lewis, Sr., Van Nostrand Reinhold Company, 1992.

Handbook of Compressed Gases, 3rd ed., Compressed Gas Association, Arlington, Virginia, 1990.

Handbook of Laboratory Safety, 3rd ed., edited by A. Keith Furr, CRC Press, 1990.

Hawley's Condensed Chemical Dictionary, 11th ed., Irving Sax and Richard J. Lewis, Sr., Van Nostrand Reinhold Company, 1978.

Industrial Ventilation, 20th ed., American Conference of Governmental Industrial Hygienists, 1992.

NIOSH Pocket Guide to Chemical Hazards, DHHS (NIOSH), June 1997, DHHS (NIOSH) Publication No. 97-140.

OSHA Safety and Health Standards, (29 CFR 1910), United States Department of Labor, U.S. Government Printing Office, 1995.

Patty's Industrial Hygiene and Toxicology, 3rd ed., Patty, F.A., Volumes 1,2(A,B,C),and 3(A,B), Wiley-Interscience, 1978.

Prudent Practices for Disposal of Chemicals from Laboratories, National Research Council, National Academy Press, 1983.

Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Research Council, National Academy Press, 1981.

Safety in Academic Chemistry Laboratories, 5th ed., Committee on Chemical Safety, American Chemical Society: Washington, D.C., 1990.

Threshold Limit Values for Chemical Substances and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, 1999.

APPENDIX 3: CHEMICAL RESISTANCE CHART

Resistance to Chemicals of Common Glove Materials
(E=Excellent, G=Good, F=Fair, P=Poor)

CHEMICAL	NATURAL RUBBER	NEOPRENE	NITRILE	VINYL
Acetaldehyde	G	G	E	G
Acetic acid	E	E	E	E
Acetone	G	G	G	F
Acrylonitrile	P	G	-	F
Ammonium hydroxide	G	E	E	E
Aniline	F	G	E	G
Benzaldehyde	F	F	E	G
*Benzene	P	F	G	F
*Benzyl chloride	F	P	G	P
Bromine	G	G	-	G
Butane	P	E	-	P
Butyraldehyde	P	G	-	G
Calcium hypochlorite	P	F	G	F
Carbon disulfide	P	P	G	F
*Carbon tetrachloride	P	F	G	F
Chlorine	G	G	-	G
Chloroacetone	F	E	-	P
*Chloroform	P	F	G	P
Chromic acid	P	F	F	E
Cyclohexane	F	E	-	P
CHEMICAL		**NEOPRENE**	**NITRILE**	**VINYL**

	NATURAL RUBBER			
Dibenzyl ether	F	G	-	P
Dibutyl phthalate	F	G	-	P
Diethanolamine	F	E	-	E
Diethyl ether	F	G	E	P
**Dimethyl sulfoxide	-	-	-	-
Ethyl acetate	F	G	G	F
*Ethylene dichloride	P	F	G	P
Ethylene glycol	G	G	E	E
*Ethylene trichloride	P	P	-	P
Fluorine	G	G	-	G
Formaldehyde	G	E	E	E
Formic acid	G	E	E	E
Glycerol	G	G	E	E
Hexane	P	E	-	P
Hydrobromic acid (40%)	G	E	-	E
Hydrochloric acid (conc)	G	G	G	E
Hydrofluoric acid (30%)	G	G	G	E
Hydrogen peroxide	G	G	G	E
Iodine	G	G	-	G
Methylamine	G	G	E	E
Methyl cellosolve	F	E	-	P
*Methyl chloride	P	E	-	P
Methyl ethyl ketone	F	G	G	P
*Methylene chloride	F	F	G	F
	NATURAL	**NEOPRENE**	**NITRILE**	**VINYL**

CHEMICAL	RUBBER			
Monoethanolamine	F	E	-	E
Morpholine	F	E	-	E
*Naphthalene	G	G	E	G
Nitric acid (conc)	P	P	P	G
Perchloric acid	F	G	F	E
Phenol	G	E	-	E
Phosphoric acid	G	E	-	E
Potassium hydroxide	G	G	G	E
*Propylene dichloride	P	F	-	P
Sodium hydroxide	G	G	G	E
Sodium hypochlorite	G	P	F	G
Sulfuric acid (conc)	G	G	F	G
*Toluene	P	F	G	F
*Trichloroethylene	P	E	G	F
Tricresyl phosphate	P	E	-	F
Triethanolamine	F	E	E	E
Trinitrotoluene	P	E	-	P

* Aromatic and halogenated hydrocarbons will attack all types of natural and synthetic glove materials. If swelling should occur, the user should change to fresh gloves and allow the swollen gloves to dry and return to normal.

** No data on the resistance of dimethyl sulfoxide of natural rubber, neoprene, nitrile rubber, or vinyl materials are available; the manufacturer of the substance recommends the use of butyl rubber gloves.

Appendix 4 taken from the following source: Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Research Council, National Academy Press, 1981.

APPENDIX 4: GENERAL TRAINING CERTIFICATE ACKNOWLEDGMENT FOR UHCL CHEMICAL HYGIENE PLAN

Name: _____ Date: _____

Building/Room: _____ Phone: _____ Department: _____

I certify that I have read the Chemical Hygiene Plan for the University of Houston – Clear Lake (UHCL) and that I have received the general training related to the Chemical Hygiene Plan, which included the following:

1. Location of the potentially hazardous chemicals in the workplace.
2. Recognition of the chemical labeling and its meaning.
3. Location of the SDS's in the workplace.
4. Location of the health hazard, physical hazard, environmental protection, and special protection sections of the SDS and an explanation of their use.
5. Identification of the Chemical Hygiene Officer by name and title.
6. The major components of the laboratory's standard labeling system.
7. The appropriate protective clothing for the area and its proper usage.
8. Emergency procedures in the events of a hazardous chemical spill.
9. The environmental monitoring protocol for the laboratory.
10. Location and safety precautions for potentially hazardous equipment.
11. Physical and health effects of hazardous chemicals associated with task assignments.
12. Methods and observation techniques used to determine the presence or release of hazardous chemicals in the laboratory.
13. How to lessen or prevent exposure to hazardous chemicals through controlled work practices and personal protective equipment.
14. Emergency and first-aid procedures to follow if employees are exposed to hazardous chemicals.

In addition, I understand that I have the responsibility to read the SDS's for any chemical that I will work with in the laboratory.

_____
Laboratory User Signature

APPENDIX 5: CHEMICAL PROTOCOL REVIEW

Before using certain chemical agents, Research Safety Committee (RSC) approval must be obtained. The principal investigator/laboratory supervisor is responsible for obtaining approval before the initiation of any procedure involving the referenced chemicals. The five-step RSC Protocol Review process is as follows:

1. **Determine if the Chemical requires Chemical Safety Committee Review and Approval**
   The Research Safety Committee of UHCL reviews any chemical agent listed in the Mandatory Protocol Review Chemical List; however, any agent not found to be on the list may meet the criteria based on specific toxicological (LD50, LC50) data. The ***Mandatory Protocol Review Chemical List*** is found at the back of this appendix. A protocol is required to be evaluated by the Research Safety Committee if it meets the following criteria:

   A. Select Carcinogens

   A select carcinogen is any substance which meets one of the following criteria:
   - It is listed under Group 1 ("carcinogenic to humans") or Group 2A ("probably carcinogenic to humans") by the International Agency for Research on Cancer monographs (IARC); or
   - It is listed under the category, "Known to be Human Carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP);

   B. Select Agent Toxins and Other Biological Toxins

   Select Agent Toxins are biological agent toxins that have the potential to pose a severe threat to public health and safety. The U.S. Centers for Disease Control and Prevention (CDC) and U.S. Department of Agriculture (USDA) oversee the National Select Agent Registry program.

   C. Pesticides

   A pesticide is defined as "any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest" by the Federal Insecticide, Fungicide, and Rodenticide Act. The U.S. Environmental Protection Agency oversees the regulation of pesticides.

   D. Explosives/Pyrophoric chemicals

   An explosive is defined as "any chemical compound, mixture, or device which is designed to function by an explosion that is substantially instantaneous with the release of gas and heat" by the U.S. Department of Transportation. Explosives are regulated by the Bureau of Alcohol, Tobacco, Firearms, and Explosives. Chemicals that form peroxides over time can become explosive as well if not tested and handled properly.

   "Pyrophoric" means a chemical that will ignite spontaneously in air at a temperature of 130 0 F (54.4 0 C) or below, as defined by OSHA (29 CFR 1910.1200(c)).

E. Poison Gases

Gases that are known to be poisonous by inhalation are listed under Class 2.3 of the US DOT Hazardous Materials Table

F. Antineoplastic Agents

Antineoplastic agents are chemotherapeutic agents that control or kill cancer cells, as defined by NIOSH.

G. Highly Toxic

Chemical agents that are classified as "highly toxic" are substances that have a high degree of acute toxicity. Such agents meet the following criteria:

- Chemical has a median lethal dose (LD50) of 50 milligrams or less when administered orally to rats [LD50 < 50 mg/kg]; or
- Chemical has a median lethal dose (LD50) of 200 milligrams or less when administered by continuous dermal contact for 24 hours (or less if death occurs within 24 hours) to the skin of rabbits [LD50 < 200 mg/kg]; or
- Chemical has a median lethal concentration (LC50) in the air of 200 parts per million by volume when administered by continuous inhalation for one hour (or less if death occurs within one hour) to rats [LC50 < 200 ppm]

H. Nanoparticles
The agent is classified as measuring in the nanoscale (1-100 nanometers) or research that utilizes nanoparticles or nanochemistry.

Note: *The Research Safety Committee may require a review of other highly hazardous chemicals that do not fall under any of these categories mentioned above. Please contact EHS at 281-283-2106 for assistance or to verify if a specific chemical agent meets the RSC review requirement.*

2. Completion of the form titled "High Risk Chemical Review"

If a chemical requires committee review, then a "High Risk Chemical Review" form must be completed and submitted to the office of EHS. EHS can assist you with completing the form in conjunction with a consultation.

3. Submission and approval by the Research Safety Committee

Once the appropriate forms are completed and submitted, the Research Safety Committee evaluates the protocol based on the criteria included for the "High Risk Chemical Review". The Research Safety Committee will then evaluate the protocol and grant approval to use the chemical agent. In some cases, approval may be granted with the stipulation that certain recommendations are adhered to during the protocol.

4. Completion of a "Memorandum of Understanding and Agreement (MUA) for the Use of Chemical Agents"

Once Research Safety Committee approval is granted, then a "Memorandum of Understanding and Agreement (MUA) for The Use of Chemical Agents" is completed. This MUA requires obtaining signatures from the Research Safety Committee Chair, the Chemical Hygiene Officer or their designee, and the Principal Investigator.

5. Renewal of approved protocols

All approved protocols go through a complete review every three years. If there are no significant changes, then the MUA will be resigned and the project may continue until the next review cycle. Any significant changes in the protocol, such as the introduction of a different chemical, increased quantities, or different engineering controls, will trigger the requirement for an immediate full review.

THE MANDATORY PROTOCOL REVIEW CHEMICAL LIST FOLLOWS ON THE NEXT PAGE.

LIST OF CARCINOGENS MANDATING CHEMICAL PROTOCOL REVIEW

CAS No	Agent	CAS No	Agent
000079-06-1	Acrylamide	013909-09-6	1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1- nitrosourea (Methyl-CCNU, Semustine)
023214-92-8	Adriamycin	000095-69-2	4-Chloro-ortho-toluidine
001402-68-2	Aflatoxins (naturally occurring mixtures of)	054749-90-5	Chlorozotocin
000092-67-1	4-Aminobiphenyl		Chromium [VI]
	Androgenic (anabolic) steroids	015663-27-1	Cisplatin
	Aristolochic acid	008001-58-9	Creosotes
007440-38-2	Arsenic and arsenic compounds	027208-37-3	Cyclopenta[cd]pyrene
001332-21-4	Asbestos	000050-18-0, 006055-19-2	Cyclophosphamide
000320-67-2	Azacitidine	079217-60-0	Cyclosporine
000446-86-6	Azathioprine	000053-70-3	Dibenz[a,h]anthracene
000071-43-2	Benzene	000191-30-0	Dibenzo[a,l]pyrene
000092-87-5	Benzidine	000056-53-1	Diethylstilboestrol
000050-32-8	Benzo[a]pyrene	000064-67-5	Diethyl sulfate
007440-41-7	Beryllium and beryllium compounds	000079-44-7	Dimethylcarbamoyl chloride
000494-03-1	N,N-Bis(2-chloroethyl)-2-naphthylamine (Chlornaphazine)	000540-73-8	1,2-Dimethylhydrazine
000542-88-1, 000107-30-2	Bis(chloromethyl)ether and chloromethyl methyl ether (technical-grade)	000077-78-1	Dimethyl sulfate
000154-93-8	Bischloroethyl nitrosourea (BCNU)	000106-89-8	Epichlorohydrin
000106-99-0	1,3-Butadiene	066733-21-9	Erionite
000055-98-1	1,4-Butanediol dimethanesulfonate (Busulphan, (Myleran®)		Estrogens, nonsteroidal
007440-43-9	Cadmium and cadmium compounds		Estrogens, steroidal
002425-06-1	Captafol	000051-79-6	Ethyl carbamate (urethane)
000305-03-3	Chlorambucil	000106-93-4	Ethylene dibromide
000056-75-7	Chloramphenicol	000075-21-8	Ethylene oxide
000098-87-3, 000098-07-7, 000100-44-7, 000098-88-4	a-Chlorinated toluenes (benzal chloride, benzotrichloride, benzyl chloride) and benzoyl chloride (combined exposures)	000759-73-9	N-Ethyl-N-nitrosourea
013010-47-4	1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)	033419-42-0	Etoposide

LIST OF CARCINOGENS MANDATING CHEMICAL PROTOCOL REVIEW

CAS No	Agent	CAS No	Agent
033419-42-0	Etoposide in combination with cisplatin and bleomycin	000062-75-9	N-Nitrosodimethylamine
000050-00-0	Formaldehyde	000062-44-2	Phenacetin and analgesic mixtures containing
001303-00-0	Gallium arsenide	001336-36-3	Polychlorinated biphenyls
000556-52-5	Glycidol	000366-70-1	Procarbazine hydrochloride
022398-80-7	Indium phosphide	014808-60-7	Silica, crystalline
076180-96-6	IQ (2-Amino-3-methylimidazo[4,5-f]quinoline)	000096-09-3	Styrene-7,8-oxide
000148-82-3	Melphalan	010540-29-1	Tamoxifen
000484-20-8	5-Methoxypsoralen	029767-20-2	Teniposide
000101-14-4	Methylenebis(chloroaniline) (MOCA)	001746-01-6	2,3,7,8-Tetrachlorodibenzo-para-dioxin
000075-09-2	Methylene chloride	000127-18-4	Tetrachloroethylene
000066-27-3	Methyl methanesulfonate	000052-24-4	Thiotepa
000070-25-7	N-Methyl-N´-nitro-N-nitrosoguanidine (MNNG)	000095-53-4	ortho-Toluidine
000684-93-5	N-Methyl-N-nitrosourea	000299-75-2	Treosulfan
	MOPP and other combined chemotherapy including alkylating agents	000079-01-6	Trichloroethylene
000505-60-2	Mustard gas (Sulfur mustard)	000096-18-4	1,2,3-Trichloropropane
000091-59-8	2-Naphthylamine	000126-72-7	Tris(2,3-dibromopropyl) phosphate
	Nickel compounds	000051-79-6	Urethane (see Ethyl carbamate)
000051-75-2	Nitrogen mustard	000593-60-2	Vinyl bromide
016543-55-8, 064091-91-4	N'-Nitrosonornicotine (NNN) and 4-(NNitrosomethylamino)- 1-(3-pyridyl)-1-butanone (NNK)	000075-01-4	Vinyl chloride
000055-18-5	N-Nitrosodiethylamine	000075-02-5	Vinyl fluoride

LIST OF SELECT AGENTS AND OTHER BIOLOGICAL TOXINS MANDATING CHEMICAL PROTOCOL REVIEW

Select Agent Toxins:

Abrin
Botulinum neurotoxins
Clostridium perfringens epsilon toxin
Conotoxins
Diacetoxyscirpenol
Ricin
Saxitoxin
Shiga-like ribosome inactivating proteins
Shigatoxin
Staphylococcal enterotoxins
T-2 toxin
Tetrodotoxin

Other Biological Toxins:

Cholera Toxin
Diphtheria Toxin
Pertussis Toxin

LIST OF PESTICIDES (EPA LISTED) MANDATING CHEMICAL PROTOCOL REVIEW

Compound	CAS No.	Compound	CAS No.
Abate (Temephos)	3383-96-13	Cycloate	1134-23-2
Acifluorfen	62476-59-9	2,4-D acid	94-75-7
Alachlor	15972-60-8	2,4-DB acid	94-82-6
Aldrin	309-00-2	DCPA (Dacthal)	2136-79-0
Ametryn	834-12-8	2,4'-DDD	53-19-0
Amoban	3566-10-7	4,4'-DDD	72-54-8
AOP	--	2,4'-DDE	3424-82-6
Asponb	3244-90-4	4,4'-DDE	72-55-9
Atraton	1610-17-9	2,4'-DDT	789-02-6
Atrazine	1912-24-9	4,4'-DDT	50-29-3
Azinphos-ethyla	2642-71-9	DEF (Butifos)	78-48-8
Azinphos ethyl (Ethyl guthion)	642-71-9	Demeton-O	298-02-3
Azinphos methyl (Guthion)	86-50-0	Demeton-Oc	8065-48-3
a-BHC	319-84-6	Demeton-S	126-75-0
ß-BHC	319-85-7	Demeton-Sc	8065-48-3
?-BHC (Lindane)	58-89-9	Diallate	2303-16-4
d-BHC	319-86-8	Diazinon	333-41-5
Bendiocarb	22781-23-3	1,2-Dibromo-3-chloropropane (DBCP)	96-12-8
Benfluralin	1861-40-1	Dicamba	1918-00-9
Bolstar (Sulprofos)	35400-43-2	Dichlobenil (Casoron)	1194-65-6
Bromacil	314-40-9	3,5-Dichlorobenzoic acid	51-36-5
Bromoxynil (Brominal)	1689-84-5	Dichlorofenthiona	97-17-6
Busan 40	51026-28-9	Dichlorprop	120-36-5
Busan 85	128-03-0	Dichlorvos (DDVP)	62-73-7
Butachlor	23184-66-9	Diclofol (Kelthane)	115-32-2
Butylate	2008-41-5	Diclofop-methyl	51338-27-3
Carbophenothiona	786-19-6	Dicrotophosa	141-66-2
Captafol	2425-06-1	Dieldrin	60-57-1
Captan	133-06-2	Dimethoate	60-51-5
Carboxin	5234-68-5	Dinoseb	88-85-7
cis-Chlordane	5103-71-9	Dioxathion	78-34-2
trans-Chlordane	5103-74-2	Diphenamid	957-51-7
Chlordane -- not otherwise specified (n.o.s.)	57-74-9	Disulfoton (Disyston)	298-04-4
Chlorfenvinphosa	470-90-6	Disulfoton sulfone	2497-06-5
Chlorobenzilate	510-15-6	Disulfoton sulfoxide	2497-07-6
Chlorpropham	101-21-3	Diuron	330-54-1
Chlorpyrifos	2921-88-2	Endosulfan I	959-98-8
Chlorpyrifos methyla	5598-13-0	Endosulfan II	33213-65-9
Chlorthalonil (Daconil)	1897-45-6	Endosulfan sulfate	1031-07-8
Coumaphos	56-72-4	Endrin	72-20-8
Crotoxyphosa	7700-17-6	Endrin aldehyde	7421-93-4

LIST OF PESTICIDES (EPA LISTED) MANDATING CHEMICAL PROTOCOL REVIEW

Compound	CAS No.	Compound	CAS No.
Cyanazine	21725-46-2	Endrin ketone	53494-70-5
EPN	2104-64-5	Nabam	142-59-6
Eptam (EPTC)	759-94-4	Naled	300-76-5
Ethalfluralin (Sonalan)	55283-68-6	Napropamide	15299-99-7
Ethion	563-12-2	Niacide	8011-66-3
Ethoprop	13194-48-4	4-Nitrophenol	100-02-7
Famphura	52-85-7	Norflurazon	27314-13-2
Fenamiphos	22224-92-6	Oxyfluorfen	42874-03-3
Fenarimol	60168-88-9	Parathion, ethyl	56-38-2
Fenitrothion	122-14-5	Parathion, methyl	298-00-0
Fensulfothion	115-90-2	Pebulate	1114-71-2
Fenthion	55-38-9	Pendimethalin	40487-42-1
Ferbam	14484-64-1	Pentachlorophenol (PCP)	87-86-5
Fluridone	59756-60-4	o-Phenylenediamine	95-54-5
Fonophosa	944-22-9	Phorate	298-02-2
Gardona (Tetrachlovinphos)	961-11-5	Phosmet	732-11-6
Heptachlor	76-44-8	Phosphamidon	297-99-4
Heptachlor epoxide	1024-57-3	Phosphamidon	13171-21-6
Hexachlorobenzene	118-74-1	Picloram	1918-02-1
Hexachlorocyclopentadiene	77-47-4	Polyram	9006-42-2
Hexamethyl phosphoramidea (HMPA)	680-31-9	Profluralin	26399-36-0
Hexazinone	51235-04-2	Prometon (Pramitol 5p)	1610-18-0
Imidan (Phosmet)	732-11-6	Prometryn	7287-19-6
Ioxynil	1689-83-4	Pronamide (Kerb)	23950-58-5
Isodrin	465-73-6	Propachlor (Ramrod)	1918-16-7
KN Methyl	137-41-7	Propargite (S-181)	2312-35-8
Leptophos	21609-90-5	Propazine	139-40-2
Malathion	121-75-5	Propetamidophos	31218-83-4
Mancozeb	8018-01-7	Propham	122-42-9
Maneb	12427-38-1	Prosulfocarb	52888-80-9
MCPA acid	94-74-6	Ronnel	299-84-3
MCPP acid	7085-19-0	Silvex (2,4,5-TP)	93-76-5
Merphos	150-50-5	Simazine	122-34-9
Metalaxyl	57837-19-1	Simetryn	1014-70-6
Metham	137-42-8	Sodium dimethyldithiocarbamat	128-04-1
Methiocarb	2032-65-7	Stirophos (Tetrachlorvinphos, Gardona)	22248-79-9
Methoxychlor	72-43-5	Sulfotepp	3689-24-5
Methyl chlorpyrifos	5598-13-0	Sulprofos (Bolstar)	35400-43-2
Methyl paraoxon	311-45-5	2,4,5-T acid	94-82-6
Methyl paraoxon	950-35-6	2,4,5-TB	93-80-1

LIST OF PESTICIDES (EPA LISTED) MANDATING CHEMICAL PROTOCOL REVIEW

Compound	CAS No.	Compound	CAS No.
Methyl parathion	298-00-0	Tebuthiuron	34014-18-1
Metolachlor	51218-45-2	Terbacil	5902-51-2
Metribuzin	21087-64-9	Terbufosa	13071-79-9
Mevinphos	7786-34-7	Terbutryn (Igran)	886-50-0
MGK-264	113-48-4	2,3,4,5-Tetrachlorophenol	4901-51-3
Mirex	2385-85-5	2,3,4,6-Tetrachlorophenol	58-90-2
Molinate	2212-67-1	Tetraethyl pyrophosphate (TEPP)d	107-49-3
Monocrotophos	6923-22-4	Thionazina,b (Zinophos)	297-97-2
Thiram	137-26-8	Triclopyr (Garlon)	55335-06-3
Tokuthionb (Prothiofos)	34643-46-4	Tricyclazole	41814-78-2
Toxaphene	8001-35-2	Trifluralin (Treflan)	1582-09-8
Triademefon	43121-43-3	Tri-o-cresyl phosphatea,d (TOCP)	78-30-8
Triallate	2303-17-5	Vernolate	1929-77-7
Trichlorfona	52-68-6	ZAC	--
Trichloronateb	327-98-0	Zineb	12122-67-7
2,4,5-Trichlorophenol	95-95-4	Ziram	137-30-4
2,4,6-Trichlorophenol	88-06-2		

LIST OF PYROPHORIC CHEMICALS MANDATING CHEMICAL PROTOCOL REVIEW

Grignard Reagents: RMgX (R=alkyl, X=halogen)
Metal alkyls and aryls: Alkyl lithium compounds; tert-butyl lithium
Metal carbonyls: Lithium carbonyl, nickel tetracarbonyl
Metal powders (finely divided): Cobalt, iron, zinc, zirconium
Metal hydrides: Sodium hydride
Nonmetal hydrides: Diethylarsine, diethylphosphine
Non-metal alkyls: R_3B, R_3P, R_3As; tetramethyl silane, tributyl phosphine
Phosphorus
Potassium
Sodium
Gases: Silane, dichlorosilane, diborane, phosphine, arsine

LIST OF EXPLOSIVE CHEMICALS (BATF) MANDATING CHEMICAL PROTOCOL REVIEW

A	Cyclotrimethylenetrinitramine [RDX].
Acetylides of heavy metals.	**D**
Aluminum ophorite explosive.	DATB [diaminotrinitrobenzene].
Amatex.	DDNP [diazodinitrophenol].
Amatol.	DEGDN [diethyleneglycol dinitrate].
Ammonal.	Dimethylol dimethyl methane dinitrate composition.
Ammonium nitrate explosive mixtures (cap sensitive).	Dinitroethyleneurea.
Ammonium nitrate explosive mixtures (non-cap sensitive).	Dinitroglycerine [glycerol dinitrate].
Ammonium perchlorate	Dinitrophenol.
Ammonium picrate [picrate of ammonia, Explosive D].	Dinitrophenolates.
Ammonium salt lattice with isomorphously substituted inorganic salts.	Dinitrophenyl hydrazine.
ANFO [ammonium nitrate-fuel oil].	Dinitroresorcinol.
Azide explosives.	Dinitrotoluene-sodium nitrate explosive mixtures.
B	DIPAM [dipicramide; diaminohexanitrobiphenyl].
Baranol.	Dipicryl sulfone.
Baratol.	Dipicrylamine.
BEAF [1, 2-bis (2, 2-difluoro-2-nitroacetoxyethane)].	Display fireworks.
Blasting powder.	DNPA [2,2-dinitropropyl acrylate].
BTNEC [bis (trinitroethyl) carbonate].	DNPD [dinitropentano nitrile].
BTNEN [bis (trinitroethyl) nitramine].	**E**
BTTN [1,2,4 butanetriol trinitrate].	EDDN [ethylene diamine dinitrate].
Butyl tetryl.	EDNA [ethylenedinitramine].
C	Ednatol.
Calcium nitrate explosive mixture.	EDNP [ethyl 4,4-dinitropentanoate].
Cellulose hexanitrate explosive mixture.	EGDN [ethylene glycol dinitrate].
Copper acetylide.	Erythritol tetranitrate explosives.
Cyanuric triazide.	Ethyl-tetryl.
Cyclonite [RDX].	**F**
Cyclotetramethylenetetranitramine [HMX].	Flash powder.
Cyclotol.	Fulminate of mercury.

LIST OF EXPLOSIVE CHEMICALS (BATF) MANDATING CHEMICAL PROTOCOL REVIEW

Fulminate of silver.	**M**
Fulminating gold.	Magnesium ophorite explosives.
Fulminating mercury.	Mannitol hexanitrate.
Fulminating platinum.	MDNP [methyl 4,4-dinitropentanoate].
Fulminating silver.	MEAN [monoethanolamine nitrate].
G	Mercuric fulminate.
Gelatinized nitrocellulose.	Mercury oxalate.
Gem-dinitro aliphatic explosive mixtures.	Mercury tartrate.
Guanyl nitrosamino guanyl tetrazene.	Metriol trinitrate.
Guanyl nitrosamino guanylidene hydrazine.	Minol-2 [40% TNT, 40% ammonium nitrate, 20% aluminum].
Guncotton.	MMAN [monomethylamine nitrate]; methylamine nitrate.
H	Mononitrotoluene-nitroglycerin mixture.
Hexanite.	**N**
Hexanitrodiphenylamine.	NIBTN [nitroisobutametriol trinitrate].
Hexanitrostilbene.	Nitrated carbohydrate explosive.
Hexogen [RDX].	Nitrated glucoside explosive.
Hexogene or octogene and a nitrated N-methylaniline.	Nitrated polyhydric alcohol explosives.
Hexolites.	Nitric acid explosive mixtures.
HMTD [hexamethylenetriperoxidediamine].	Nitro aromatic explosive mixtures.
HMX [cyclo-1,3,5,7-tetramethylene 2,4,6,8-tetranitramine; Octogen].	Nitrogelatin explosive.
Hydrazinium nitrate/hydrazine/aluminum explosive system.	Nitrogen trichloride.
Hydrazoic acid.	Nitrogen tri-iodide.
K	Nitroglycerine [NG, RNG, nitro, glyceryl trinitrate, trinitroglycerine].
KDNBF [potassium dinitrobenzo-furoxane].	
L	Nitroglycide.
Lead azide.	Nitroglycol [ethylene glycol dinitrate, EGDN].
Lead mannite.	Nitroguanidine explosives.
Lead mononitroresorcinate.	Nitronium perchlorate propellant mixtures.
Lead picrate.	Nitrourea.
Lead salts, explosive.	**O**
Lead styphnate [styphnate of Pb, Pb trinitroresorcinate].	Octogen [HMX].
Liquid nitrated polyol and trimethylolethane.	Octol [75 percent HMX, 25 percent TNT].

LIST OF EXPLOSIVE CHEMICALS (BATF) MANDATING CHEMICAL PROTOCOL REVIEW

P	Silver tetrazene
PBX [plastic bonded explosives].	Sodatol.
Pentolite.	Sodium amatol.
Perchlorate explosive mixtures.	Sodium azide explosive mixture.
Peroxide forming chemicals	Sodium dinitro-ortho-cresolate.
PETN [nitropentaerythrite, pentaerythrite tetranitrate, pentaerythritol	Sodium nitrate explosive mixtures.
tetranitrate].	Sodium nitrate-potassium nitrate explosive mixture.
Picramic acid and its salts.	Sodium picramate.
Picramide.	Styphnic acid explosives.
Picrate explosives.	**T**
Picratol.	Tacot [tetranitro-2,3,5,6-dibenzo- 1,3a,4,6a tetrazapentalene].
Picric acid	TATB [triaminotrinitrobenzene].
Picryl chloride.	TATP [triacetonetriperoxide].
Picryl fluoride.	TEGDN [triethylene glycol dinitrate].
PLX [95% nitromethane, 5% ethylenediamine].	Tetranitrocarbazole.
Polynitro aliphatic compounds.	Tetrazene [tetracene, tetrazine, 1(5-tetrazolyl)-4-guanyl tetrazene
Polyolpolynitrate-nitrocellulose explosive gels.	hydrate].
Potassium chlorate and lead sulfocyanate explosive.	Tetryl [2,4,6 tetranitro-N-methylaniline].
Potassium nitrate explosive mixtures.	Tetrytol.
Potassium nitroaminotetrazole.	TMETN [trimethylolethane trinitrate].
Pyrotechnic compositions.	TNEF [trinitroethyl formal].
PYX [2,6-bis(picrylamino)]-3,5-dinitropyridine.	TNEOC [trinitroethylorthocarbonate].
R	TNEOF [trinitroethylorthoformate].
RDX [cyclonite, hexogen, T4, cyclo-1,3,5,-trimethylene- 2,4,6,-trinitramine; hexahydro-1,3,5-trinitro-S-triazine].	TNT [trinitrotoluene, trotyl, trilite, triton].
S	Torpex.
Salts of organic amino sulfonic acid explosive mixture.	Tridite.
Silver acetylide.	Trimethylol ethyl methane trinitrate composition.
Silver azide.	Trimethylolthane trinitrate-nitrocellulose.
Silver fulminate.	Trimonite.
Silver oxalate explosive mixtures.	Trinitroanisole.
Silver styphnate.	Trinitrobenzene.
Silver tartrate explosive mixtures.	Trinitrobenzoic acid.

LIST OF EXPLOSIVE CHEMICALS (BATF) MANDATING CHEMICAL PROTOCOL REVIEW

Trinitrocresol.	Tritonal.
Trinitro-meta-cresol.	**U**
Trinitronaphthalene.	Urea nitrate.
Trinitrophenetol.	**X**
Trinitrophloroglucinol.	Xanthamonas hydrophilic colloid explosive mixture.
Trinitroresorcinol.	

LIST OF US DOT COMPRESSED POISON GASES (49 CFR 172.101) MANDATING CHEMICAL PROTOCOL REVIEW

Arsine	Hydrogen iodide
Boron trichloride	Hydrogen selenide
Boron trifluoride	Hydrogen sulfide
Bromine chloride	Methyl bromide
Carbon monoxide	Methyl mercaptan
Carbonyl fluoride	Methylchlorosilane
Carbonyl sulfide	Nitrosyl chloride
Chlorine	Perchloryl fluoride
Chlorine pentafluoride	Phosgene
Cyanogen	Phosphine
Cyanogen chloride	Phosphorus pentafluoride
Diborane	Selenium hexafluoride
Dichlorosilane	Silicon tetrafluoride
Dinitrogen tetroxide	Stibine
Ethylene oxide	Sulfur dioxide
Fluorine	Sulfur tetrafluoride
Germane	Sulfuryl fluoride
Hexaethyl tetraphosphate	Tellurium hexafluoride
Hexafluoroacetone	Trifluoroacetyl chloride
Hydrogen bromide	Trifluorochloroethylene
Hydrogen chloride	Tungsten hexafluoride

LIST OF ANTINEOPLASTIC AGENTS MANDATING CHEMICAL PROTOCOL REVIEW

Drug	**Drug**	**Drug**
Aldesleukin	Floxuridine	Nilutamide
Alemtuzumab	Fludarabine	Oxaliplatin
Altretamine	Fluorouracil	Paclitaxel
Amsacrine	Flutamide	Pegaspargase
Anastrozole	Fulvestrant	Pentostatin
Arsenic trioxide	Gemcitabine	Perphosphamide
Asparaginase	Gemtuzumab ozogamicin	Pipobroman
Azacitidine	Goserelin	Piritrexim isethionate
Bexarotene	Hydroxyurea	Plicamycin
Bicalutamide	Ibritumomab tiuxetan	Prednimustine
Bleomycin	Idarubicin	Procarbazine
Busulfan	Ifosfamide	Raltitrexed
Capecitabine	Imatinib mesylate	Streptozocin
Carboplatin	Interferon alfa-2a	Tamoxifen
Carmustine	Interferon alfa-2b	Temozolomide
Chlorambucil	Interferon alfa-n1	Teniposide
Cisplatin	Interferon alfa-n3	Testolactone
Cladribine	Irinotecan HCl	Thioguanine
Cyclophosphamide	Leflunomide	Thiotepa
Cytarabine	Letrozole	Topotecan
Dacarbazine	Leuprolide acetate	Toremifene citrate
Dactinomycin	Lomustine	Tositumomab
Daunorubicin HCl	Mechlorethamine	Triptorelin
Denileukin	Megestrol	Uracil mustard
Docetaxel	Melphalan	Valrubicin
Doxorubicin	Mercaptopurine	Vinblastine sulfate
Epirubicin	Methotrexate	Vincristine sulfate
Estramustine phosphate sodium	Mitomycin	Vindesine
Etoposide	Mitotane	Vinorelbine tartrate

University of Houston Clear Lake

APPENDIX 6: RESEARCH SAFETY COMMITTEE FORMS

High Risk Chemical Review Form

Section 1 - Applicant Data

Date: **RSC Protocol Number:**

Project Name:

Principal Investigator: **Department:**

Building/Room Number: **Office Phone:**

Other Committee Approvals:

Section 2 - Identification of Chemical Agent

Chemical Agents:

Use Quantity:

Number of Procedures:

Storage Quantities and Location:

Location Where Work is to be Conducted (Building/Room Number):

Laboratory Phone Number:

Section 3 - Personnel Involved in Study and Experience Working with Chemical Agents / Experience with the specific agent under review

1. **Experience**: /
2. **Experience:** /
3. **Experience:** /

Section 4 - Experimental Description (Include procedural aspects regarding chemical usage):

Methods:

Section 5 – Chemical / Industrial Hygiene Related Information

Physical Properties:

Classification:

Toxicology:

Routes of Exposure:

Other Precautions:

Exposure Limits:

Monitoring Requirements:

Section 6 - Hazard Controls

Engineering/Administrative Controls:

Personal Protective Equipment:

Section 7- Hazardous Waste Disposal

Identify method of waste disposal:

Hazardous waste code:

Has source substitution been investigated?

Can chemical be neutralized during experiment?

Section 8 - Fulfillment of UHCL Chemical Hygiene Plan Requirements

Hazard Communication Training:

Personnel: Date/Status:

Last Laboratory Safety Survey Date:

Findings:

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MEMORANDUM OF UNDERSTANDING AND AGREEMENT FOR USE OF CHEMICAL AGENTS

Title of Research:

Number: RSC 00-000

PI Name:. **Dept:**

Lab Room No(s): **Phone:**

Chemical Name: **CAS Number:**

Usage Amount: **Storage Amount:**

The referenced chemical has been determined to require a Research Safety Committee Protocol Review based on the following: (check one) :

_____ **Chemicals are listed on the "Mandatory Protocol Review Chemical List"**

_____ **Chemical is hazardous because of its toxicological, usage, and storage quantities**

Attach the completed "High Risk Chemical Review Form"

_____ **The referenced chemical has been exempted from the full review process, and a Fact Sheet has been provided with information on hazards and safety practices that must be followed**

I agree to comply with current regulations and university policies pertaining to the use, storage, transfer and shipment of chemical agents. I will also abide by all of the provisions of UHCL Chemical Hygiene Plan, the recommendations of the Research Safety Committee, and follow the instructions on the Fact Sheet supplied for a specific chemical that is exempt from the full committee review process.

_____ _____
P.I. signature Date

The UHCL Research Safety Committee has reviewed the above proposal and has verified the classification indicated by the Principal Investigator.

_____ _____
Chemical Hygiene Officer Date

The Research Safety Committee has been provided a summary of the described work and approves the described use of chemical(s) listed. The activities described in this protocol will be reviewed annually.

_____ _____ _____
Chair, Research Safety Committee Date

Graduate Student Permission to Work Independently After Hours

This form should be filled out by the PI requesting permission for a graduate student to work independently after normal business hours (normal business hours are defined as being between 8:00 a.m. and 6:00 p.m.).

This form must be *turned in* to the Chair of the Research Safety Committee (RSC Chair) or the Chemical Hygiene Officer (CHO) *at least 14 days for review and include an SOP for the project.* Laboratory activities that could place the student in a potentially hazardous situation will be denied. In denied cases, the PI should work with the RSC Chair or the CHO to modify the project to reduce the hazards, obtain a partner, or complete it during normal business hours.

Name(s) of student(s) seeking permission to work in the laboratory after regular working hours:

_____

_____

Experiment/Reason student(s) may need to come after hours (give specific lab activities to be performed)

_____

_____

Location (room number) _____

As a faculty member, I certify that the above laboratory activity is safe for a student to perform independently and poses no possible danger to the student.

_____ _____
Faculty Signature **Date**

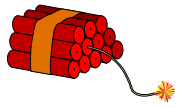
As a student, I agree to comply with all the established safety guidelines outlined in the NS Laboratory Safety Manual and any additional safety instructions from my faculty member.

_____ _____
Student(s) Signature **Date**

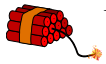
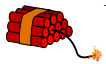
_____ _____
RSC Chair or Dean's Signature (approval) **Date**
(circle to indicate RSC Chair or Dean's signature)

University of Houston Clear Lake

APPENDIX 7: CHEMICAL SEGREGATION & INCOMPATIBILITIES GUIDELINES

Class of Chemical	Examples	Recommended Storage Method	Incompatible Materials	Possible Reaction If Mixed
Corrosive Acids 	**Mineral Acids** – Chromic Acid Hydrogen Chloride Hydrochloric Acid Nitric Acid Perchloric Acid Phosphoric Acid Sulfuric Acid	Separate cabinet or storage area away from potential water sources, i.e. under sink	Flammable Liquids Flammable Solids Bases Oxidizers Poisons	Heat   Gas Generation  Violent Reaction
Corrosive Bases/Caustics 	Ammonium Hydroxide Sodium Hydroxide Sodium Bicarbonate	Separate cabinet or storage area away from potential water sources, i.e. under sink	Flammable Liquids Flammable Solids Acids Oxidizers Poisons	 Heat  Gas Generation  Violent Reaction
Explosives 	Ammonium Nitrate Nitro Urea, Picric Acid Trinitroaniline Trinitrobenzene Trinitrobenzoic Acid Trinitrotoluene Urea Nitrate	Secure location away from other chemicals	Flammable Liquids Oxidizers Poisons Acids Bases	Explosion Hazard 

Class of Chemical	Examples	Recommended Storage Method	Incompatible Materials	Possible Reaction If Mixed
Flammable Liquids 	Acetone Benzene Diethyl Ether Methanol Ethanol Toluene Glacial Acetic Acid	Grounded flammable storage cabinet of flammable storage refrigerator	Acids Bases Oxidizers Poisons	 Fire Hazard Heat   Violent Reaction
Flammable Solids 	Phosphorus Magnesium	Separate dry cool area	Acids Bases Oxidizers Poisons	 Fire Hazard Heat   Violent Reaction
Oxidizers 	Sodium Hypochlorite Benzoyl Peroxide Potassium Permanganate Potassium Chlorate Potassium Dichromate Peroxides Perchlorates Chlorates Nitrates	Spill tray that is separate from flammable and combustible materials	Reducing Agents Flammables Combustibles Corrosives	 Fire Hazard Toxic Gas Generation 
Poisons 	Cyanides Cadmium Mercury Osmium Acrylamide DMSO	Vented, cool, dry area in unbreakable chemically resistant secondary containers	Flammable Liquids Acids Bases Oxidizers Corrosives	Generation of Toxic & Flammable Gas   Violent Reaction

Class of Chemical	Examples	Recommended Storage Method	Incompatible Materials	Possible Reaction If Mixed
Water Reactive Chemicals 	Sodium Metal Potassium Metal Lithium Metal Lithium Aluminum Hydride	Dry, cool location away from potential spray from fire sprinklers and other water sources, i.e. under sink	Aqueous Solutions Oxidizers	Heat   Violent Reaction
Flammable Compressed Gases 	Methane Acetylene Propane Hydrogen	Cool, dry area away from oxidizing gases while securely attached to wall or bench	Oxidizing & Toxic Compressed Gases Oxidizing Solids	Fire Hazard   Explosion Hazard
Oxidizing Compressed Gases 	Oxygen Chlorine Bromine	Cool, dry area away from flammable gases while securely attached to wall or bench	Flammable Gases	Fire Hazard   Explosion Hazard
Poisonous Compressed Gases 	Carbon Monoxide Hydrogen Sulfide	Cool, dry area away from flammable gases or liquids while securely attached to wall or bench	Flammable Gases Oxidizing Gases	Release of Toxic Gas   Violent Reaction

Partial Incompatibility Listing

Compound/Class	Avoid Storage Near or Contact With:
Acids	
Acetic Acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene, glycogen, perchloric acid, peroxides, permanganate
Hydrofluoric Acid	Ammonia (aqueous or anhydrous), do not store in glass container
Nitric Acid (conc.)	Acetic acid, aniline, chromic acid, acetone, alcohol, or other flammable liquids, hydrocyanic acid, hydrogen sulfide, or other flammable gases, nitratable substances: copper, brass or any heavy metals (or will generate nitrogen dioxide/nitrous fumes) or organic products such as wood and paper
Sulfuric Acid	Light metals (lithium, sodium, potassium), chlorates, perchlorates, permanganates
Bases	
Ammonia	Mercury, chlorine, bromine, iodine, hydrofluoric acid, calcium hypochlorite
Calcium oxide	Water
Alkaline metals	Sodium, potassium, magnesium, calcium, aluminum, carbon dioxide, carbon tetrachloride or other chlorinated hydrocarbons, halogens, water
Bromine	Ammonia, acetylene, butadiene, methane, propane, butane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Carbon, activated	Calcium hypochlorite, oxidizing agents
Chlorine	Ammonia, acetylene, butadiene, methane, propane, butane, or other petroleum gases, hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Copper	Acetylene, hydrogen peroxide, nitric acid
Fluorine	Isolate from everything
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, ammonia, fulminic acid (produced in nitric acid ethanol mixtures)
Oxygen	Oils, grease, hydrogen, other flammable gases, liquids, or solids

Bases, continued	
Phosphorous (white)	Air, oxygen, caustic alkalis as reducing agents (or will generate phosphine)
Potassium	Carbon tetrachloride, carbon dioxide, water
Silver	Acetylene, oxalic acid, tartaric acid, fulminic acid (produced in nitric acid-ethanol mixtures), and ammonium compounds
Organics	
Acetone	Concentrated nitric acid and sulfuric acid mixtures
Acetylene	Fluorine, chlorine, bromine, copper, silver, mercury
Aniline	Nitric acid, hydrogen peroxide
Flammable Liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Hydrocarbons (propane, butane, etc.)	Fluoride, chlorine, bromine, chromic acid, sodium peroxide
Nitroparaffins	Inorganic bases, amines
Oxalic Acid	Silver, mercury
Oxidizers	
Chlorates	Ammonia salts, acids, metal powders, sulfur, finely divided organics, or combustible materials
Chromic Acid (trioxide)	Acetic acid, naphthalene, camphor, glycerol, turpentine, alcohol or flammable liquids
Ammonium Nitrate	Acids, metal powders, flammable liquids, chlorates, nitrates, sulfur, finely divided organic or combustible materials
Chlorine Dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Cumene Hydroperoxide	Organic or inorganic acids

Oxidizers, continued	
Hydrogen Peroxide	Copper, chromium, iron, most other metals or salts, alcohols, acetone, or other flammable liquids, aniline, nitromethane, or other organic or combustible materials
Hypochlorites	Acids (will generate chlorine or hypochlorous acid)
Nitrates	Sulfuric acid (will generate nitrogen dioxide)
Perchloric Acid	Acetic acid, bismuth and its alloys, alcohol, paper, wood, grease, oils
Peroxides (Organics)	Organic or inorganic acids, also avoid friction and store cold
Potassium Chlorate	Acids, especially sulfuric acid
Potassium Permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Sodium Peroxide	Any oxidizable substance such as methanol, ethanol, glycerol, ethylene glycol, glacial acetic acid, acetic anhydride, benzaldehyde, furfural, methyl acetate, ethyl acetate, carbon disulfide
Alkaline metals	Sodium, potassium, magnesium, calcium, aluminum, carbon dioxide, carbon tetrachloride or other chlorinated hydrocarbons, halogens, water
Calcium oxide	Water
Cyanides	Acids (will generate hydrogen cyanide)
Phosphorous (white)	Air, oxygen, caustic alkalis as reducing agents (will generate phosphine)
Potassium	Carbon tetrachloride, carbon dioxide, water
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium Peroxide	Any oxidizable substance such as methanol, ethanol, glycerol, ethylene glycol, glacial acetic acid, acetic anhydride, benzaldehyde, furfural, methyl acetate, ethyl acetate, carbon disulfide
Sulfides	Acids (will generate hydrogen sulfide)

Reducing Agents	
Hydrazine	Hydrogen peroxide, nitric acid, other oxidants
Nitrites	Acids (will generate nitrous fumes)
Sodium Nitrite	Ammonium nitrate and other ammonium salts
Toxics/Poisons	
Arsenicals	Reducing agents (will generate arsine)
Azides	Acids (will generate hydrogen azide)
Cyanides	Acids (will generate hydrogen cyanide)
Hydrocyanic Acid	Nitric Acid, alkalis
Hydrogen Sulfide	Fuming nitric acid, oxidizing gases
Selenides	Reducing agents (will generate hydrogen selenide)
Sulfides	Acids (will generate hydrogen sulfide)
Tellurides	Reducing agents (will generate hydrogen telluride)

APPENDIX 8: HAZARD COMMUNICATION PROGRAM At THE UNIVERSITY OF HOUSTON – CLEAR LAKE

Introduction

To ensure that information about the dangers of hazardous chemicals used at the University of Houston – Clear Lake (UHCL) is known by all affected employees, the following Hazard Communication Program has been established. The purpose of this program is to implement the Texas Hazard Communication Act, Chapter 502 of the Health and Safety Code as well as the Federal Hazard Communication Standard 1910.1200

The Federal OSHA Hazard Communication Standard was updated on March 26, 2012, to conform to the United Nations (UN) Globally Harmonized System of Classification and Labeling of Chemicals (GHS). To incorporate the changes made to the Federal OSHA Hazard Communication Standard, UHCL has added these components into this program to establish consistency and safety for the entire university. This program applies to all work operations at UHCL where employees may be exposed to hazardous chemicals under normal working conditions and during emergencies. This written program is available for review on our website or in writing by contacting EHS at 281-283-2106.

Under this program, employees are educated on: workplace chemical lists; labeling of containers; Safety Data Sheets (SDS); education and training requirements; complaints, investigations, injuries, and reporting procedures; treatment; university policies, as well as any additional state or federal requirements directly related to this program.

APPLICABILITY

The primary function of UHCL is teaching and research. Chemicals in laboratories are under the direct supervision of faculty members/principal investigators (technically qualified individuals), labels on incoming containers of chemicals are not to be removed or defaced, UHCL complies with Sections 502.006 and 502.009 with respect to laboratory employees, and no laboratories are used to produce hazardous chemicals in bulk for commercial purposes. Laboratories that want to ship samples of hazardous chemicals must contact EHS for assistance with chemical shipping. Under no circumstances are personnel other than DOT-certified EHS Department employees allowed to ship hazardous materials.

Texas Health & Safety Code: Sec. 502.004

(f) This chapter does not apply to:

(1) any hazardous waste, as that term is defined by the federal Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended, when subject to regulation issued under that Act by the Environmental Protection Agency.

(2) a chemical in a laboratory under the direct supervision or guidance of a technically qualified individual if:

(A) labels on incoming containers of chemicals are not removed or defaced;

(B) the employer complies with Sections 502.006 and 502.009 with respect to laboratory employees; and

(C) the laboratory is not used to produce hazardous chemicals in bulk for commercial purposes.

WORKPLACE CHEMICAL LIST

In accordance with the Texas Community Right-To-Know Act, a Texas Tier II Report is completed by Environmental Health & Safety annually by March 1st of each year to report chemicals that meet or exceed reporting thresholds at UHCL. Copies of this report are sent to the TCEQ's STEERS reporting website, the local fire department, and the local emergency planning committee. Copies of this report are kept by EHS. At this time, diesel fuel, gasoline, hydraulic oil, transformer oil, motor oil, and sulfuric acid are the only chemicals maintained in excess of the reporting threshold quantities. The Tier II report gives the locations of the storage tanks and other storage locations. This list is updated annually, dated, signed, and copies are kept indefinitely. Employees are made aware of this hazard through training.

Texas Health & Safety Code: Sec. 502.005

(a) For the purpose of worker right-to-know, an employer shall compile and maintain a workplace chemical list that contains the following information for each hazardous chemical normally present in the workplace or temporary workplace in excess of 55 gallons or 500 pounds or in excess of an amount that the board determines by rule for highly toxic or dangerous chemicals:

(1) the identity used on the SDS and container label; and

(2) the work area in which hazardous chemicals are normally present.

(b) The employer shall update the workplace chemical list as necessary but at least by December

31st of each year. Each workplace chemical list shall be dated and signed by the person responsible for compiling the information.

(c) The workplace chemical list may be prepared for the workplace as a whole or for each work area or temporary workplace and must be readily available to employees and their representatives. All employees shall be made aware of the workplace chemical list before working with or in a work area containing hazardous chemicals.

(d) An employer shall maintain a workplace chemical list for at least 30 years. The employer shall send complete records to the director if the employer ceases to operate.

ANNUAL CHEMICAL INVENTORY

To comply with the EPA's Emergency Planning and Community Right-to-Know regulations and the OSHA Laboratory Standard, principal investigators are required to submit a chemical inventory identifying the exact location (building and room) and quantity of all hazardous chemicals in their laboratories. To facilitate the submission of the inventory, a template, and all supporting documentation is available from EHS. EHS will verify the annual chemical inventory submission during the lab's annual laboratory safety survey.

SAFETY DATA SHEETS (SDSs)

SDSs for the chemicals are provided by manufacturers and distributors to UHCL with each initial shipment and with the first shipment after an SDS is updated. Depending on the company, the SDS is included inside the package containing the chemical, which should go directly to the principal investigator's laboratory personnel.

SDSs are readily available for review by all employees at UHCL. In addition to the paper copies available as described above, employees may access SDSs via computer internet 24 hours a day. In addition, an employee may directly request an SDS from EHS by calling 281-283-2106.

Texas Health & Safety Code: Sec. 502.006

(e) *A chemical manufacturer or distributor shall provide appropriate Safety Data Sheets to employers who acquire hazardous chemicals in this state with each initial shipment and with the first shipment after an SDS is updated.* ***The SDSs must conform to the most current requirements of the OSHA standard.***

(f) An employer shall maintain a legible copy of a current SDS for each hazardous chemical purchased. If the employer does not have a current SDS for a hazardous chemical when the chemical is received at the workplace, the employer shall request an SDS in writing from the manufacturer or distributor in a timely manner or shall otherwise obtain a current SDS. The manufacturer or distributor shall respond with an appropriate SDS in a timely manner.

(g) Safety Data Sheets shall be readily available, on request, for review by employees or designated representatives at each workplace.

(h) A copy of an SDS maintained by an employer under this section shall be provided to the director upon request.

LABELS

Labels on chemicals received at UHCL are not intentionally removed or defaced. Secondary containers are relabeled with the chemical name and appropriate hazard classification. As part of the Environmental Health & Safety's routine surveillance program, principal investigators/laboratory personnel are reminded not to label secondary containers using a chemical symbol in place of the chemical name found on the SDS. In addition, principal investigators/laboratory personnel are encouraged to label all containers with chemicals even if the chemical is intended for immediate use by the employee who performs the transfer.

Texas Health & Safety Code: Sec. 502.007

(a) A label on an existing container of a hazardous chemical may not be removed or defaced unless it is illegible, inaccurate, or does not conform to the OSHA standard or other applicable labeling requirements. Primary containers must be relabeled with at least the identity appearing on the SDS, the pertinent physical and health hazards, including the organs that would be affected, and the manufacturer's name and address. Except as provided by Subsection (b), secondary containers must be relabeled with at least the identity appearing on the SDS and appropriate hazard warnings.

(b) An employee may not be required to work with a hazardous chemical from an unlabeled container except for a portable container intended for the immediate use of the employee who performs the transfer.

EMPLOYEE EDUCATION PROGRAM

The UHCL Research Safety Committee requires annual General Lab Safety training for all individuals working in laboratories. This training will provide a brief refresher on the critical elements of laboratory

safety. Principle investigators and laboratory personnel working in or overseeing a laboratory are required to complete Advanced Lab Safety training in addition to General Lab Safety training. Principal Investigators will be responsible for verifying that all laboratory personnel have completed the training as required by the UHCL Research Safety Committee, EHS, and the University. Environmental Health and Safety will verify the training is complete during the lab's annual laboratory safety survey.

Principal investigators are responsible for any hands-on training for specific hazards in their laboratory and the SOPs are developed and followed by their subordinates. Principal investigators are required to work with Environmental Health and Safety to ensure training is completed for all laboratory attendants. Environmental Health & Safety can assist with Standard Operational Procedures and finding advanced training. Environmental Health and Safety can be contacted via phone at 281-281-2106.

We appreciate your continued participation in maintaining a safe working environment. Please contact the Office of Environmental Health and Safety for any questions at 281-281-2106.

The training program emphasizes these items:

Information on interpreting labels and SDSs and the relationship between those two methods of hazard communication; the location by work area, acute and chronic effects, and safe handling of hazardous chemicals known to be present in the employee's work area and to which the employees may be exposed; the proper use of protective equipment and first aid treatment to be used with respect to the hazardous chemicals to which the employees may be exposed; and general safety instructions on handling, cleanup procedures, and disposal of hazardous chemicals.

Employees are instructed that information is available on the specific hazards of individual chemicals through their supervisor and on the SDSs. Employees are also told how they may access chemical safety information 24 hours a day. Protective equipment and first aid treatment information are also classified by categories of hazardous chemicals.

Whenever the potential for exposure to hazardous chemicals in the employee's work area increases significantly or when new information concerning the hazards of a chemical is received, additional training will be provided. Principal investigators are responsible for providing additional training due to changes in the workplace and are expected to update their SOP and inform EHS of these changes and any additional training conducted. Principal investigators are also required to re-submit their High Risk Chemical Review if there are any changes in the Federal Regulations regarding the chemicals being used. EHS will make every effort to notify principal investigators in the event of any changes in regulations and resulting changes in training required.

Training class/session rosters are maintained for the type of training given to the employees, including the date, employees who attended, the subjects covered, and the names of the instructors. Those records are maintained for at least five years by UHCL and will be used to create a training database. Laboratory

employee training status is assessed annually during routine safety surveys and employees are asked to attend refresher training if necessary.

EHS staff responding to chemical spills are required to attend an initial 40-hour Hazardous Materials Emergency Response Training in accordance with 29 CFR 1910.120, with an annual 8-hour refresher course.

UHCL has developed, implemented, and maintained a written hazard communication program for the workplace that describes how the criteria in the Texas Hazard Communication Act, Chapter 502, of the Health and Safety Code are being met.

Texas Health & Safety Code: Sec.502.009

(a) An employer shall provide an education and training program for employees who use or handle hazardous chemicals.

(b) An employer shall develop, implement, and maintain at the workplace a written hazard communication program for the workplace that describes how the criteria specified in this chapter will be met.

(c) An education and training program must include, as appropriate:

(1) information on interpreting labels and SDSs and the relationship between those two methods of hazard communication;

(2) the location by work area, acute and chronic effects, and safe handling of hazardous chemicals known to be present in the employee's work area and to which the employees may be exposed;

(3) the proper use of protective equipment and first aid treatment to be used with respect to the hazardous chemicals to which the employees may be exposed; and

(4) general safety instructions on the handling, cleanup procedures, and disposal of hazardous chemicals.

(d) Training may be conducted by categories of chemicals. An employer must advise employees that information is available on the specific hazards of individual chemicals through the SDSs. Protective equipment and first aid treatment may be categories of hazardous chemicals.

(e) An employer shall provide additional instruction to an employee when the potential for exposure to hazardous chemicals in the employee's work area increases significantly or when

the employer receives new and significant information concerning the hazards of a chemical in the employee's work area. The addition of new chemicals alone does not necessarily require additional training.

(f) An employer shall provide training to a new or newly assigned employee before the employee works with or in a work area containing a hazardous chemical.

(g) An employer shall keep a written hazard communication program and a record of each training session given to employees, including the date, a roster of the employees who attended, the subjects covered in the training session, and the names of the instructors. Those records shall be maintained for at least five years by the employer. The department shall have access to those records and may interview employees during inspections.

(h) Emergency service organizations shall provide, to their members or employees who may encounter hazardous chemicals during an emergency, information on recognizing, evaluating, and controlling exposure to the chemicals.

REPORTING FATALITIES AND INJURIES

UHCL will report any accidents described in Sec. 502.012 above within 48 hours to the Texas Department of State Health Services. Additional reports will be submitted if necessary.

Texas Health & Safety Code: Sec.502.012

(a) Within 48 hours after the occurrence of an employee accident that directly or indirectly involves chemical exposure, or that involves asphyxiation, and that is fatal to one or more employees, or results in the hospitalization of five or more employees, the employer of any of the employees so injured or killed shall report the accident either orally or in writing to the department.

(b) The report to the department shall relate the circumstances of the accident, the number of fatalities, and the extent of any injuries. If it is necessary to complete the investigation of an incident, the department may require additional reports in writing as necessary.

EMPLOYEE NOTICE; RIGHTS OF EMPLOYEES

The Texas Department of State Health Service "Notice to Employees" is posted in all laboratories at UHCL and additional locations where it is easily visible to employees. Employees who may be exposed to hazardous chemicals as part of their normal work routine will be informed of the possible exposure and will have access to the workplace chemical list and SDSs. Employees have access to training and

24-hour access to SDSs, as described earlier. Principal investigators are primarily responsible for providing personal protective equipment to their employees according to state and federal regulations. Contact EHS for assistance if required.

Texas Health & Safety Code: Sec.502.017

(a) An employer shall post and maintain adequate notice, at locations where notices are normally posted, informing employees of their rights under this chapter. If the director does not prepare the notice under Section 502.008, the employer shall prepare the notice.

(b) Employees who may be exposed to hazardous chemicals shall be informed of the exposure and shall have access to the workplace chemical list and SDSs for the hazardous chemicals. Employees, on request, shall be provided a copy of a specific SDS with any trade secret information deleted. In addition, employees shall receive training concerning the hazards of the chemicals and measures they can take to protect themselves from those hazards. Employees shall be provided with appropriate personal protective equipment. These rights are guaranteed.

APPENDIX 9: NANOPARTICLES SAFETY GUIDE

I. Purpose

This document has been written to offer health and safety guidance to faculty, staff, students, and visitors working with nanotechnology at The University of Houston – Clear Lake. The purpose of the Nanomaterials Safety Program is to provide a framework for anticipating, recognizing, evaluating, and controlling the potential hazards associated with nanotechnology; however, the Program is not intended to provide stand-alone guidance and should be used in conjunction with the UHCL Chemical Hygiene Plan and consultation with the Department of Environmental Health and Safety. All work involving nanotechnology requires approval from the Research Safety Committee before work with nanotechnology is initiated. A site-specific risk assessment will be conducted by EHS to determine the potential hazards of working with nanotechnology. In addition, it is the responsibility of each principal investigator to ensure that laboratory-specific safety plans and standard operating procedures are developed for each laboratory where nanomaterials are used and stored.

II. Introduction

Nanotechnology involves the manipulation of matter at nanometer scales to produce new materials, structures, and devices. Nano-objects are materials that have at least one dimension (e.g., length, width, height, and/or diameter) that is between 1 and 100 nanometers. (CDC/NIOSH, 2009) A nanometer, or nm, is 1×10^{-9} meters or one-millionth of a millimeter. The term *nanoparticles* typically refer to materials in which all three dimensions are in the nanoscale. In this document, the term *nanoparticles* or *nanomaterials* will refer to purposefully created, engineered particles with at least one dimension between 1 and 100 nanometers. (CDC/NIOSH, 2009) Nanoparticles may be dry particles, suspended in a gas (as a nanoaerosol), suspended in a liquid (as a nanocolloid or nanohydrosol), or embedded in a matrix (as a nanocomposite). Nanoparticles also exist in several structures, such as nanotubes, nanoplates, and nanofibers. (CDC/NIOSH, 2009)

The term *ultrafine particle* has traditionally been used to describe airborne particles smaller than 100 nm in diameter that are byproducts of industry or nature. Ultra-fine particles tend to be generated through processes such as combustion and vaporization. The particles are produced in large quantities from industrial activities such as thermal spraying and welding and from domestic combustion activities like gas cooking. Ultra-fine particles are also found in the atmosphere, where they originate from combustion sources like forest fires and volcanic activity and atmospheric gas-to-particle conversion processes, such as photo-chemically driven nucleation. (CDC/NIOSH, 2009)

Research with nanomaterials has shown that the physiochemical characteristics of particles can influence their effects in biological systems. Some of these characteristics include:

- **Charge;**
- **Chemical reactivity;**
- **Degree of agglomeration;**
- **Shape;**
- **Size;**
- **Solubility;**
- **Surface area; and**
- **Surface composition**

There are many unknowns as to whether the unique properties of engineered nanomaterials pose health concerns. The potential health risk following exposure to a substance is generally associated with the following (CDC/NIOSH, 2009):

- Magnitude and duration of the exposure;
- Persistence of the material in the body;
- Inherent toxicity of the material; and
- Susceptibility or health status of the person.

Unfortunately, there is limited data regarding the health risks related to nanomaterials. As such, this document is to provide EHS-accepted recommendations for practicing prudent health and safety measures when working with nanomaterials.

III. Regulations

At this time, there are no federal regulations that specifically address the health and safety implications of nanotechnology. There are also no national or international consensus standards on measurement techniques for nanomaterials in the workplace. However, as with conventional chemicals, research with nanomaterials must be conducted in a manner that is safe and responsible. All chemicals, including nanomaterials, must be transported, stored, used, and disposed of in accordance with all federal, state, and local requirements.

The Occupational Safety and Health Administration (OSHA) requires employers to maintain a safe and healthful workplace, "free from recognized hazards likely to cause death or serious physical harm." (29 USC 654) According to OSHA, laboratory personnel must be informed of the risks associated with workplace hazards. This is generally accomplished through training programs, Safety Data Sheets, and labeling and signage.

The Resource Conservation and Recovery Act of 1976 (RCRA) regulates the transportation, treatment, disposal, and cleanup of hazardous waste. Nanomaterials that meet the definition of a "hazardous waste" in RCRA are subject to this rule.

Nanomaterials that are defined as "chemical substances" under the Toxic Substances Control Act (TSCA) and which are not on the TSCA Inventory must be reported to U.S. Environmental Protection Agency (EPA). A Pre-manufacture Notice must be submitted to the EPA by anyone intending to manufacture or import a chemical substance that is not on the TSCA Inventory of Chemical Substances.

The Federal Insecticide, Fungicide, and Rodenticide Act requires that the EPA approve all new pesticide products, as well as new uses and changes in the composition of existing pesticide products, before the products may be sold or distributed in commerce. To evaluate an application for registration, the EPA requires the applicant to provide a complete characterization of the composition of the product, proposed labeling that describes the intended use of the product, and the results of extensive health and safety testing.

It should be also noted that the U.S. Food and Drug Administration currently regulates a wide range of products including those that utilize nanotechnology or contain nanomaterials (e.g., a drug delivery device).

IV. Hazard Assessments

Before beginning work with nanomaterials, a hazard assessment should be performed by EHS personnel. The purpose of the assessment will be to identify appropriate work procedures, controls, and personal protective equipment to ensure worker safety. The assessment will evaluate several factors, including but not limited to the physical and chemical properties of the nanomaterial, the process by which the material will be generated and/or used, and existing engineering controls (e.g., fume hood, glove box). In some instances, the safety personnel may recommend collecting occupational exposure measurements (e.g., sampling). This will be performed to further understand potential hazards or to identify specific processes or equipment requiring additional engineering controls. Additionally, any protocol involving the use to nanoparticles is subject to approval by the UHCL Research Safety Committee.

V. Exposure Routes

The most common route of exposure to a nanomaterial is through inhalation (see Table 1). The deposition of discrete nanomaterials in the respiratory tract is determined by the particle's aerodynamic or thermodynamic diameter. Particles that are capable of being deposited in the gas exchange region of the lungs are considered respirable particles.
Discrete nanomaterials are deposited in the lungs to a greater extent than larger respirable particles. Deposition increases with exertion (due to an increase in breathing rate and change from nasal to mouth breathing). It also increases among persons with existing lung diseases or conditions. Based on animal studies, discrete nanomaterials may enter the bloodstream from the lungs and translocate to other organs.

Ingestion is another route whereby nanomaterials may enter the body. Ingestion can occur from unintentional hand-to-mouth transfer of materials. This can occur with traditional materials and it is scientifically reasonable to assume that it could happen during the handling of materials that contain nanomaterials. Ingestion may also accompany inhalation exposure because particles that are cleared from the respiratory tract via the mucociliary escalator may be swallowed. A few studies suggest that nanomaterials may enter the body through the skin during exposure. At this time, it is not known if skin penetration of nanomaterials would result in adverse health effects. There is also little information about the health effects of injecting nanomaterials into living organisms.

Potential Sources of Occupational Exposure to Nanomaterials for Various Synthesis Methods

Process Synthesis	*Particle Formation*	*Exposure Source or Worker Activity*	*Primary Exposure Route***
Gas Phase	In Air	Direct leakage from the reactor, especially if the reactor is operated at positive pressure	Inhalation
		Product recovery from bag filters in reactors.	Inhalation/Dermal
		Processing and packaging of dry powder.	Inhalation/Dermal
		Equipment cleaning/maintenance (including reactor evacuation and spent filters).	Dermal (and inhalation during reactor evacuation)
Vapor Deposition	On Substrate	Product recovery from reactor/dry contamination of workplace.	Inhalation
		Processing and packaging of dry powder.	Inhalation/Dermal

		Equipment cleaning/maintenance (including reactor evacuation).	Dermal (and inhalation during reactor evacuation)
Colloidal	Liquid Suspension	If liquid suspension is processed into a powder, potential exposure during spray drying to create a powder, and the processing and packaging of the dry powder.	Inhalation/Dermal
		Equipment cleaning/maintenance.	Dermal
Attrition	Liquid Suspension	If liquid suspension is processed into a powder, potential exposure during spray drying to create a powder, and the processing and packaging of the dry powder.	Dermal
		Equipment cleaning/maintenance.	Dermal
** Note: Ingestion would be a secondary route of exposure from all sources/activities from deposition of nanomaterials on food or subsequently swallowed (primary exposure route inhalation) and from hand-to-mouth contact (primary exposure route dermal).			

Table 1 – Sources of Exposure to Nanomaterials through Occupational Activities (Aiken et al. 2004)

VI. Factors Affecting Exposure

Every attempt should be made to prevent or minimize exposure to nanomaterials. Factors affecting exposure to nanomaterials include the amount of material being used and whether it can be easily dispersed or form airborne sprays or droplets. The degree of containment and duration of use will also influence exposure. In the case of airborne material, particle or droplet size will determine whether the material can enter the respiratory tract and where it is most likely to deposit. Inhaled particles smaller than 10 micrometers in diameter have some probability of penetrating and being deposited in the gas-exchange (i.e., alveolar) region of the lungs, but there is at least a 50% probability that particles smaller than 4 micrometers in diameter will reach the gas-exchange region.

At present there is insufficient information to predict all of the situations and workplace scenarios that are likely to lead to exposure to nanomaterials. However, some workplace factors will increase the potential for exposure, including (CDC/NIOSH, 2009):

- Working with nanomaterials in liquid media without adequate protection (e.g. gloves) will increase the risk of skin exposure.
- Working with nanomaterials in liquid media during pouring or mixing operations, or where a high degree of agitation is involved, will lead to an increased likelihood of inhalable and respirable droplets being formed.
- Generating nanomaterials in the gas phase in non-enclosed systems will increase the chances of aerosol release to the workplace.
- Handling nanopowders will lead to the possibility of aerosolization.
- Maintenance on equipment and processes used to produce or fabricate nanomaterials will pose a potential exposure risk to workers performing these tasks.

- Cleaning of dust collection systems used to capture nanomaterials will pose a potential for both skin and inhalation exposure.

VII. Engineering Controls

To provide a safe work environment for faculty, staff, students, and visitors, engineering controls must be maintained wherever nanomaterials are used or stored. At a minimum, engineering controls should include local exhaust ventilation, localized filtration, and personal protective equipment. Respiratory protection is required when working with nanomaterials when local exhaust ventilation and filtration is not available.

The following engineering controls should be used in conjunction with the aforementioned policy when handling nanomaterials (CDC/NIOSH, 2009; VCU, 2007):

- Use of a chemical fume hood is recommended for all tasks with the potential of aerosolizing nanomaterials in either liquid or powder form.
- A well-designed local exhaust ventilation system with a local high-efficiency particulate air (HEPA) filter shall be used to effectively remove nanomaterials.
- Animals shall be appropriately restrained and/or sedated before administering injections and other dosing methods.
- If heavy usage of aerosolized nanoparticles is in use, a proper decontamination, or buffer, area shall be utilized to ensure the nanomaterials are not transported outside of the working area.
- Frequent hand washing, especially before eating, smoking, applying cosmetics, or leaving the work area shall be employed.
- Laboratories and other spaces where nanomaterials are used or stored must be equipped with an eyewash station that meets American National Standards Institute (ANSI) and Occupational Safety and Health Administration (OSHA) requirements.

VIII. Administrative Controls

Although traditional permissible exposure limits (PEL) exist for many of the substances that nanomaterials are made from, the PEL for a nanomaterial of these substances is not yet clear. Thus, it is important to incorporate the following administrative controls into all laboratory operations:

- The laboratory's safety plan shall be modified to include health and safety considerations of nanomaterials used in the laboratory.
- Principal investigators shall develop and implement standard operating procedures (SOPs) in the preparation and administration of nanomaterials (with minimal exposure).
- Protocols involving the *in vivo* use of nanomaterials must be reviewed and approved by the IACUC.
- Laboratory personnel must receive the appropriate training, including specific nanomaterial-related health and safety risks, standard operating procedures, and steps to be taken in the event of an exposure incident, before working with nanomaterials.
- Laboratory personnel must be instructed to use extreme caution when performing injections involving nanomaterials since accidental needle stick presents an exposure threat.
- Exposures involving nanomaterials or any other acutely hazardous material must be reported to EHS as soon as possible.

IX. Work Practices

The incorporation of good work practices can help to minimize exposure to nanomaterials. Examples of good work practices include the following (CDC/NIOSH, 2009):

- Projects or applications with the potential for producing nanomaterial aerosols must be conducted within an approved chemical fume hood or ducted biological safety cabinet.
- Needles used for nanomaterial injection must be disposed of in an approved sharps containers immediately following use. Needles used for nanomaterial injection should never be bent, sheared, or recapped.
- Bench paper utilized during the preparation of nanomaterial stock should be lined with an impervious backing to limit the potential for contamination of work surfaces in the event of a minor spill.
- Work areas should be cleaned at the end of each work shift (at a minimum) using either a HEPA-filtered vacuum cleaner or wet wiping methods. Dry sweeping or pressurized air should not be used to clean work areas. Benchtops, chemical fume hood interiors, biological safety cabinet interiors, equipment, and laboratory surfaces with potential for nanomaterial contamination should be routinely cleaned. Cleanup should be conducted in a manner that prevents worker contact with waste. The disposal of all waste material should comply with all applicable federal, state, and local regulations.
- The storage and consumption of food or beverages in workplaces must be prevented where nanomaterials are handled, processed, or stored, since exposure may occur via ingestion. Wash hands carefully before eating, drinking, applying cosmetics, smoking, or using the restroom.
- Facilities for showering and changing clothes should be provided to prevent the inadvertent contamination of other areas (including take-home) caused by the transfer of nanomaterials on clothing and skin.

X. Personal Protective Equipment

Typical chemistry laboratory apparel should be worn when working with nanomaterials in accordance with the Chemical Hygiene Plan. Always wear appropriate clothing (e.g., pants, shirts, shoes) and personal protective equipment, including safety glasses, laboratory coats, and gloves, when working with nanomaterials. Open sandals, shorts, and skirts are prohibited. Laboratory personnel involved in any task with a potential to nanomaterials must wear the following personal protective equipment:

- **Protective gloves:** Glove selection is best determined by a risk assessment and the chemicals used for the procedure. Nitrile or rubber gloves, which cover hands and wrists completely through overlapping sleeves of lab coats when working with nanomaterials, may provide adequate protection. Wearing two sets of gloves (“double gloving”) is advised whenever performing tasks involving nanomaterials and other hazardous substances. Laboratory personnel should thoroughly wash hands with soap and water before and immediately upon removal of gloves.

- **Eye protection**: Safety glasses or goggles are considered to be the appropriate level of eye protection for working with nanomaterials. EHS recommends wearing a full-face shield when conducting tasks posing potential for any generation of aerosol and/or droplets.

- **Protective clothing:** Laboratory coats or disposable gowns that provide complete coverage of skin must be worn when working with nanomaterials. Clothing contaminated with nanomaterials should be removed immediately. Do not take contaminated work clothes home – contaminated clothing may require disposal as hazardous waste.

- **Respiratory protection:** If engineering controls are not adequate or are not available, and a potential aerosol exposure exists, respiratory protection is required. When working with nanomaterials, one of the following types of respirators must be worn:
  - Filtering face piece (N-95 or greater)
  - Elastomeric half- or full-face piece with N-100, R-100, or P-100 filters; or
  - Powered air-purifying respirator with N-100, R-100, or P-100 filters.

Anyone required to utilize respiratory protection for use with nanoparticle research must contact EHS at 281-281-2106 to be included in UHCL Respiratory Protection Plan.

XI. Spill Cleanup

Anyone attempting to manage any spill involving hazardous agents must be wearing the appropriate personal protective equipment. OSHA advises typically standard approaches to cleaning nanomaterial powder and liquid spills including the use of HEPA-filtered vacuum cleaners, wetting powders down, using dampened cloths to wipe up powders, and applying absorbent materials or liquid traps. (CDC/NIOSH, 2009) Energetic cleaning methods such as dry sweeping or the use of compressed air should be avoided or only be used with precautions that assure that particles suspended by the cleaning action are trapped by HEPA filters. If vacuum cleaning is employed, care should be taken that HEPA filters are installed properly, and bags and filters changed according to the manufacturer's recommendations. At a minimum, the following procedures must be followed when managing an accidental spill of nanomaterials (CDC/NIOSH, 2009):

- Small spills (typically involving less than 5 mg of material) of nanomaterials containing powder should be wet-wiped with cloth/gauze that is dampened with soapy water. Affected surfaces should be thoroughly wet-wiped three times over with an appropriate cleaning agent and with a clean, damp cloth used for each wipe-down. Following completion, all cloth and other spill clean-up materials with a potential for nanomaterial contamination must be disposed of as hazardous waste.
- Small spills (typically involving less 5 ml of material) of nanomaterial-containing solutions should be covered and absorbed with absorbent material. Areas affected by liquid spills should be triple-cleaned with soap and water following the removal of absorbent paper.
- For larger spills of nanomaterials, contact the Office of Environmental Health and Safety at 281-281-2106.

As with any spill or clean-up of contaminated surfaces, handling and disposal of the waste material should follow existing Federal, State, or local regulations.

XII. Waste Disposal

Nanomaterials are potentially hazardous materials. Surplus stocks and other waste materials containing greater than trace contamination must be disposed of through the UHCL EHS Department. In addition, all contaminated sharps waste materials must be placed in proper sharps containers and disposed of as biohazardous waste.

XIII. Glossary

Agglomerate – A group of particles held together by relatively weak forces, including van der Waals forces, electrostatic forces, and surface tension.

Aggregate – A heterogeneous particle in which the various components are held together by relatively strong forces, and thus not easily broken apart.
Buckyballs - Spherical fullerenes composed entirely of carbon (C60).
Fullerenes - Molecules composed entirely of carbon, usually in the form of a hollow sphere, ellipsoid, or tube.
Graphene - A one-atom-thick sheet of graphite.
Nanoscience – The study of phenomena and manipulation of materials at atomic, molecular and micromolecular scales, where properties differ significantly from those at a larger scale.
Nanoaerosol – A collection of nanomaterials suspended in a gas.
Nanocolloid – A nanomaterial suspended in a gel or other semi-solid substance.
Nanocomposite – A solid material composed of two or more nanomaterials having different physical characteristics.
Nanoparticle – A substance with dimensions less than 100 nanometers in size.
Nanohydrosol – A nanomaterial suspended in a solution.
Nanotechnology – The understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications.
Nanotubes - A sheet of graphene rolled up into a seamless cylinder with diameter on the order of a nanometer.
Nanowires - A wire of dimensions on the order of a nanometer.
Nucleation - The first step in the process by which gases are converted to small liquid droplets.
Physiochemical – The underlying molecular organization of life that is manifested as chemical and energy transformations.
Pyrolysis - Chemical change brought about by the action of heat.
Quantum Dots – A nanomaterial that confines the motion of conduction band electrons, valence band holes, or excitons (pairs of conduction band electrons and valence band holes) in all three spatial directions.
Single-Walled Carbon Nanotube – A single sheet graphene wrapped into a tube approximately 1.5 nanometers in diameter.
Thermites – A mixture of aluminum powder and a metal oxide (as iron oxide) that when ignited evolves a great deal of heat and is used in welding and in incendiary bombs.
Translocation – The act, process, or an instance of changing location or position.
Transmission Electron Microscopy (TEM) – A microscopy technique whereby a beam of electrons is transmitted through an ultra-thin specimen, interacting with the specimen as it passes through, and produces an image formed from the interaction of the electrons transmitted through the specimen which is then magnified and focused onto an imaging device.
Ultra-Fine Particles - Airborne particles with an aerodynamic diameter of 0.1 m (100 nm) or less.

XIV. References

Aitken, R.J., Creely, K.S., Tran, C.L. *Nanoparticles: An Occupational Hygiene Review*. Research Report 274. Prepared by the Institute of Occupational Medicine for the Health and Safety Executive, North Riccarton, Edinburgh, England. 2004.

Approaches to Safe Nanotechnology. Department of Health and Human Services, Center for Disease Control, National Institute for Occupational Safety and Health. 2009.

Nanotechnology and Nanoparticles – Safe Working Practices Information. Virginia Commonwealth University. Office of Environmental Health and Safety. 2007

Occupational Safety and Health Act of 1970 (29 U.S.C. 654). Section 5(a) (1).

APPENDIX 10: COMPRESSED GAS AND CRYOGENIC SAFETY

Purpose:

This document provides guidance for University of Houston -Clear Lake personnel who work with and store compressed gases.

REGULATORY STATUTE:

OSHA - 29 CFR 1910.101 - 105
CGA - CGA Pamphlets G-1, 4, 4.1, 5, 6, 8.1, P-1, 2, V-1, SB-2

Compressed Gas Safety Practices Program

1. Written Program.
2. Initial Training.
3. Refresher Training.
4. Safe Handling Procedures for Compressed Gases.
5. General Safety Rules for Specific Types of Gases.
6. Visual Inspection of Compressed Gas Cylinders.
7. General Safety Rules for Use of Compressed Gas.
8. Compressed Gas Storage Locations.

Compressed Gas and Liquified Cryogen Safety Practices Program

1. Written Program.

UHCL will review and evaluate this standard practice instruction on an annual basis, or when changes occur to regulations that govern this program, that prompt revision of this document, or when facility operational changes occur that require a revision of this document. Effective implementation of this program requires support from all levels of management within UHCL. This written program will be communicated to all personnel that are affected by it. It encompasses the total workplace, regardless of number of workers employed or the number of work shifts. It is designed to establish clear goals and objectives.

2. Initial Training.

Initial training should be provided before the job assignment. Training shall be provided to ensure that the purpose and function of the compressed gas safety program are understood by employees and that the knowledge and skills required for the safe application, and usage, of compressed gases are acquired by employees. The training shall include the following:

2.1 Applicable hazards. Each authorized employee shall receive training in the recognition of applicable hazards associated with compressed gases, and the methods and means necessary for safe operation.

2.2 Purpose and use. Each affected employee shall be instructed in the purpose and use of the compressed gas they will come in contact

2.3 Awareness level training. All other employees whose work operations are or may be in an area where compressed gas may be utilized shall be instructed about the emergency procedure and about the prohibition(s) relating to compressed gases used in their work area.

2.4 Warning labels. All employees whose work operations are or may be in an area where compressed gas may be utilized shall be instructed in the recognition and use of warning labels.

2.5 Storage requirements. Storing and handling requirements will be covered in accordance with this guidance document.

2.6 Handling requirements. Handling requirements will be covered in accordance with this guidance document.

2.7 Moving requirements. Moving requirements will be covered in accordance with this guidance document.

2.8 Connecting and disconnecting requirements. Connecting and disconnecting requirements will be covered in accordance with this guidance document.

2.9 Health hazards regarding specific gases. Health hazard regarding specific gases will be covered in accordance with this guidance document.

2.10 General safety precautions. General safety precautions will be covered in accordance with this guidance document.

2.11 Certification. The supervisor shall certify that employee training has been accomplished.

3. Refresher Training.

Refresher will be conducted on a(n) annual basis. Retraining shall be provided for all authorized and affected employees whenever there is a change in their job assignments, a change in the type of gas used, equipment or processes that present a new hazard, or when there is a change in operating procedures.

3.1 Additional retraining shall also be conducted whenever a periodic inspection reveals, or whenever this employer has reason to believe, that there are deviations from or inadequacies in the employee's knowledge or use of the compressed gas safety procedures.

3.2 The retraining shall reestablish employee proficiency and introduce new or revised control methods and procedures, as necessary.

3.3 Certification. The supervisor shall certify that employee training has been accomplished.

4. Safe handling procedures for compressed gases.

4.1 Filling. Under no circumstances will UHCL personnel fill any compressed gas cylinders/containers. Cylinders/containers will be filled by the supplier of the cylinder only.

4.2 Content Identification

4.2.1 Warning labels. All employees whose work operations are or may be in an area where compressed gas may be utilized shall be instructed in the recognition and use of warning labels. Warning labels are essentially warning devices and must be legible at all times. The following will be addressed as a minimum:

4.2.1.1 Removal. When a warning label is attached to a compressed gas cylinder, it is not to be removed without the authorization of the person

responsible for it, and it is never to be bypassed, ignored, or otherwise defeated.

4.2.1.2 Legibility. To be effective, warning labels must be legible and understandable by all authorized employees, affected employees, and other employees whose work operations are or may be in the area. Non-legible or missing labels will be reported to Environmental Health and Safety (281-281-2106) immediately.

4.2.1.3 Durability. Labels and their means of attachment must be made of materials that will withstand the environmental conditions encountered in the workplace.

4.2.1.4 Labels may evoke a false sense of security, and their meaning needs to be understood as part of the overall compressed gas safety program.

4.2.1.5 Labels must be securely attached to cylinders so that they cannot be inadvertently or accidentally detached during use.

4.2.2 Labeling. Each container will bear the proper label for the compressed gas contained.

4.3 Maintenance.

4.3.1 Authorization. Cylinders and the associated cylinder valves used by UHCL will be maintained only by the vendor or their authorized representative. No maintenance is to be done on any cylinder or its associated cylinder valve by any UHCL employee. Any cylinder and/or cylinder valve found defective is to be immediately returned to the responsible vendor. Any employee who has questions about this should contact EHS (281-281-2106) for further information.

4.3.2 Changing prescribed markings. The prescribed markings, supplier/owner markings, or symbols stamped into containers will not be removed or changed unless in accordance with pertinent regulations.

4.3.3 Changing content markings. No employee will deface or remove any markings, labels, decals, tags, or stencil marks applied by our supplier and used for the identification of content. Like markings may be affixed if the original becomes illegible or detached.

4.3.4 Pressure Relief Devices. No employee will change, modify, tamper with, obstruct, or repair pressure relief devices in cylinder valves or cylinders.

4.4 Painting.

4.4.1 Cylinders will not be painted. If a container shows signs of corrosion it will be removed from service and returned to the supplier.

4.4.2 Cylinder color. All employees should be aware that containers may only be painted by the supplier for recognition and segregation. Should UHCL change suppliers' of compressed gas the color coding may also change. Always double-check to ensure you have the correct cylinder for the intended use. Never rely solely on the cylinder color for identification.

4.5 Contamination or improper contents. Any container found suspected to be contaminated or having its contents suspect will be immediately removed from service and reported to Environmental Health and Safety (281-281-2106). The supplier will be immediately notified and requested to remove the affected cylinder from the site.

4.6 Leaking or defective containers.

4.6.1 Leaking Containers. Supervisors will ensure all employees under their control understand the following. Any employee discovering a leaking container should attempt to take the following actions:

- Notify workers in the immediate area of the leak.
- If the container could contain hazardous material (or if you're not sure), evacuate personnel in the area to fresh air (preferably up-wind or side-wind relative to the source).
- Report the following as soon as possible to Environmental Health and Safety (281-281-2106):
-- Contents.
-- Location.
-- Number of employees in immediate area.
-- Circumstances of the release.
-- Condition of container.
-- Other pertinent information as required.

4.6.2 Defective Containers. Supervisors will ensure all employees under their control understand the following. Any employee discovering a defective or corroded container should attempt to take the following actions:

- Notify the supervisor of the department where the container was discovered.
- If the container could contain hazardous material (or if you're not sure), evacuate personnel in the area to fresh air (preferably up-wind or side-wind relative to the source).
- Supervisor. Report the following as soon as possible to EHS (281-281-2106):
    -- Contents.
    -- Location.
    -- Number of employees in immediate area.

-- Circumstances.
-- Condition of container.
-- Other pertinent information as required.

4.7 Container usage requirements.

4.7.1 Content Identification. Where UHCL employees are responsible for handling and connecting the container for use the operation will not proceed unless the contents can be verified by legible markings and labels.

4.7.2 Container caps, valve outlet caps, and plugs.

4.7.2.1 Container caps. Where removable caps are provided by the gas supplier for valve protection, UHCL employees shall keep such caps on containers at all times except when containers are connected to dispensing equipment.

4.7.2.2 Valve outlet caps and plugs. Where valve outlet caps and plugs are provided by the supplier, employees will keep such devices on the containers and valve outlets at all times except when containers are connected to dispensing equipment.

4.7.3 Misuse. No cylinder will be used for anything other than its intended purpose. Cylinders will not be used as rollers, supports, or for any purpose other than to contain the content as received. No employee will allow an unsafe condition such as this to occur. If an unsafe condition is found, the employee is to notify his/her supervisor and/or EHS (281-283-2106 or 281-283-2104) immediately.

4.7.4 Cylinders not in use (configuration). When cylinders are not being used the valves will remain closed and the cylinder capped at all times except when operational constraints apply.

4.8 Movement of compressed gas cylinders.

4.8.1 Trucks. Cylinders will not be rolled, dragged, or slid. A suitable hand truck, fork truck, roll platform, or similar device will be used to move cylinders.

4.8.2 Rough handling. Cylinders will not be dropped or permitted to strike violently against each other or other surfaces.

4.8.3 Lifting requirements.

4.8.3.1 Cylinder caps. Cylinder caps will not be used for lifting cylinders except for the use of hand trucks which grip the container cap for lifting

onto the hand truck. In any case, the cylinder will not be lifted higher than six inches above the operating surface.

4.8.3.2 Magnetic lifting devices. Magnetic lifting devices are prohibited from use with compressed gas cylinders.

4.8.3.3 Ropes, chains, or slings. Ropes, chains, or slings are prohibited from use with compressed gas cylinders unless lugs or lifting attachments are provided by the manufacturer.

4.8.3.4 Cradles or platforms. Where approved lifting attachments have been provided by the manufacturer, cradles or platforms are authorized for use.

4.9 Cylinder Storage Requirements.

4.9.1 Posting requirements.

4.9.1.1 No Smoking. No Smoking signs will be posted in the storage area.

4.9.1.2 Type gas. Signs designating the type of gas stored in the area will be posted.

4.9.2 Grouping Requirements. Where different types of gases are stored in the same general area the following apply.

4.9.2.1 Like gases. Gases will stored with like gases and segregated from dissimilar gases.

4.9.2.2 Full and empty containers. Full and empty containers will not be intermingled. Separate storage areas will be delineated for each.

4.9.3 Stock rotation. Stock will be rotated so that the oldest material will be the first to be used. The storage layout will be such that old stock can be removed first with minimum handling of other containers.

4.9.4 Storage rooms. Storage rooms used by UHCL will be well-ventilated and dry. Room temperature will not exceed 125 degrees F. Storage in subsurface location will be avoided.

4.9.5 Separation from combustibles. Cylinders will not be stored near readily ignitable substances such as gasoline or waste, or near combustibles in bulk, including oil.

4.9.6 External corrosion requirements. Cylinders will not be exposed to continuous dampness and should not be stored near salt or other corrosive chemicals or fumes. Corrosion may damage the cylinders and may cause the valve protection caps to stick.

4.9.7 Mechanical damage requirements. Cylinders shall be protected from any object that will produce a harmful cut or other abrasion on the surface of the metal. Cylinders will not be stored near elevators, gangways, unprotected platform edges or in locations where heavy moving objects may strike or fall on them.

4.9.8 Storage and use requirements.

4.9.8.1 Store upright. All compressed gas cylinders in service or in storage will be stored standing upright where they are not likely to be knocked over.

4.9.8.2 Restrain. All compressed gas cylinders in use will be restrained above the midpoint to prevent accidental fall-over of the container.

4.9.8.3 Gas cylinders with a water volume up to 305 cu.in. (5.0 L) may be stored in a horizontal position.

4.9.8.4 Cylinder valve end up. Liquefied gas cylinders and dewers, except those designed for use in a horizontal position on tow motors, etc., will be stored and used valve end up. Acetylene cylinders will be stored and used valve end up. Storage of the acetylene cylinder valve end up will minimize the possibility of solvent being discharged. Note: Valve end-up includes conditions where the cylinder axis is inclined as much as 45 degrees from the vertical.

4.9.9 Outdoor storage. Cylinders may be stored in the open but will be stored on a clean dry surface to prevent corrosion to the bottom of the container.

4.9.9.1 Sunlight. Cylinders may be stored in direct sunlight, except in localities where extreme temperatures prevail (above 125 degrees F.). If our supplier recommends storage in the shade for a particular gas, this recommendation will be observed.

4.9.10 Public area. Cylinders used or stored in public areas will be protected to prevent tampering.

4.9.11 Interference with egress. Cylinders when stored inside will not be located near exits, stairways, or in areas normally used or intended for the safe exit of employees.

4.10 Connecting cylinders and withdrawing content.

4.10.1 Trained personnel. Compressed gases will be handled and used only by properly trained employees. Employees must have had initial training in order to handle and use compressed gases.

4.10.2 Content identification. Employees will verify that a label exists and review the label before beginning operations with compressed gas. Unmarked cylinders will not be used. Such containers will be reported to Environmental Health and Safety (281-281-2106). The container color will never be relied on for the identification of a cylinder.

4.10.3 Cylinder caps. Caps will be retained and not removed until the cylinder is placed in service.

4.10.4 Secure cylinders. UHCL will ensure that compressed gases will be secured above the midpoint to prevent them from being knocked over.

4.10.5 Pressure regulator. A suitable pressure regulating device will be used where gas is admitted to a system of lower pressure rating than the supply pressure, and where, due to the gas capacity of the supply source, the system rating may be exceeded.

4.10.6 Pressure relief device. A suitable pressure relief device will be used to protect a system using a compressed has where the system has a pressure rating less than the compressed gas supply source and where, due to the gas capacity of the supply source, the system pressure rating may be exceeded.

4.10.7 Connection requirements. Connections that do not fit will not be forced. Threads on regulator connections or other auxiliary equipment will match those on container valve outlets. **DO NOT CHANGE OUT THREADS**. Different connectors are utilized to prevent the inadvertent mixing of incompatible gases.

4.10.8 Manifold. Where compressed gas cylinders are connected to a manifold, the manifold, and its related equipment will be of proper design for the product(s) they are to contain at the appropriate temperatures, pressures, and flows.

4.10.9 Equipment compatibility. Regulators, gauges, hoses, and other appliances provided for use with a particular gas or group of gases, such as regulators for oxygen use only, will not be used on containers containing gases having different chemical properties. Check with EHS for any concerns in this area (281-283-2106).

4.10.10 Cylinder valve requirements.

4.10.10.1 Cylinder valves will be opened slowly and pointed away from personnel and sources of ignition.

4.10.10.2 For valves having no handwheel the wrench provided by, or recommended by the supplier will be used.

4.10.10.3 On a valve utilizing a handwheel wrenches will not be used.

4.10.10.4 Valves will never be forced open or closed. If valves become frozen for whatever reason, the supplier will be contacted to provide instructions.

4.10.11 Dusting clothing, and cleaning work areas. Compressed will not used to dust off clothing or clean work areas of debris. This may cause serious injury to the eyes or body and/or create a fire hazard.

4.10.12 Residual empty cylinder pressure. When withdrawing a non-liquified compressed gas from a container, the internal pressure should not be reduced to below 20 psig to preclude the backflow of atmospheric air or other contaminants into the container. The cylinder valve should be closed tightly to retain this residual pressure.

4.10.13 Check valves. Compressed gases will not be used where the cylinder may be contaminated by the backflow of process materials unless protected by suitable traps or check valves.

4.10.14 Gas tightness. Connections to piping, regulators, and other appliances will be kept tight to prevent leakage. Where the hose is used, it shall be kept in good condition. All connections shall be tested with Snoop to ensure there is no leakage of gas.

4.10.15 Removing pressure regulator. Before a regulator is removed from a cylinder, the container valve shall be closed and the regulator drained of gas pressure.

5. General safety rules for specific types of gases.

5.1 Flammable gases.

5.1.1 Adjoining exposures. Provisions will be made to protect flammable gases from hazardous exposure to and against hazardous exposure from adjoining buildings, equipment, property, and concentrations of people.

5.1.2 Heating Requirements. Where storage areas are heated, the source will be by steam, hot water, or other indirect means. Heating by flames or fire is prohibited.

5.1.3 Electrical Equipment Requirements. Will conform to the provisions of NFPA 70, National Electrical Code, article 501, for Class 1 Division 2 locations.

5.1.4 Sources of ignition will be forbidden.

5.1.5 Storage buildings will be well-ventilated.

5.1.6 Combustibles and ignition sources. Flammable gas cylinders stored inside of buildings with other occupancies will be kept at least 20 feet from combustibles or ignition sources.

5.1.7 Capacity Limitations. Flammable gas cylinders stored inside industrial buildings on UHCL property except those in use or those attached for use are limited to a total gas capacity of 2500 cubic feet of acetylene or non-liquified flammable gas, or a total cylinder content water capacity of 735 pounds for liquefied petroleum gas or stabilized methylacetylene-propadiene.

5.1.8 Fire Protection Requirements.

5.1.8.1 Fire extinguishers. Adequate portable fire extinguishers of carbon dioxide or dry chemical types will be made available for fire emergencies at UHCL storage locations.

5.1.8.2 No smoking signs. Signs will be posted around the storage area of buildings or at the entrance to storage rooms.

5.1.8.3 Leak testing. A flame or other ignition source will **not** be used for the detection of flammable gas leaks. Use either a flammable gas leak detector, SNOOP, or other suitable solution.

5.1.9 Non-sparking Tools. All tools used when working with flammable gases must be non-sparking tools.

5.2 Hydrogen – is an extremely dangerous gas which is flammable, burns with an invisible flame and has a flammability range of 4% to 75%. In addition to this, it has a reverse Jules-Thompson Coefficient which causes depressurizing (leaking) hydrogen to heat up and catch on fire. All of the requirements from section 5.1 apply to any use of hydrogen. In addition, there are restrictions on the quantities that can be used in a lab based on the lab's location in the building, how the cylinders are to be contained and the piping systems for their use. These requirements are per NFPA 55, NFPA 2, CGA 5.5, and ASME B31-12. Spark free tools, and gas leak detection is also expected with each use.

5.2.1 Use of Flammable Gas Cabinet. Any use of hydrogen from a cylinder larger than a lecture bottle requires the cylinder to be located in a ventilated gas cabinet

which is tied into the lab exhaust system per NFPA 2. Lecture bottles may be used in working hoods.

5.2.2 Use of Hydrogen Gas Detector. Any use of hydrogen from a cylinder larger than a lecture bottle requires the use of a hydrogen gas detector per NFPA 2.

5.2.3 Use of Automatic Shutoff Valve. Any use of hydrogen from a cylinder larger than a lecture bottle requires the use of an automatic shutoff valve which is tied into the fire alarm per NFPA 2..

5.2.4 Location Limitations. Hydrogen cylinders on the third floor of any building are not to exceed 40 cubic feet in capacity. Total volume of Hydrogen cylinders on the third floor may not exceed 100 cubic feet per NFPA 55.

5.2.5 Inspections. Hydrogen cylinder containment systems (gas cabinet, hydrogen sensor, automatic shutoff valve) are required to be tested annually by a qualified technician per NFPA 2.

5.3 Oxygen (Including oxidizing gases)

5.3.1 Cleanliness. Prior to initial use, all equipment used on oxygen lines must be cleaned and certified for use on oxygen systems. This is mandatory for all lines where oxygen content exceeds 21%. Oxygen cylinders, valves, regulators, hose, and other oxygen apparatus will be kept free at all times from oil or grease and will not be handled with oily hands, oily gloves, or greasy equipment.

5.3.2 Separation of oxygen from combustibles. Oxygen cylinders in storage will be separated from flammable cylinders or combustible materials (especially oil and grease) a minimum distance of 20 feet or by a noncombustible barrier at least 5 feet high having a fire-resistance rating of at least one-half hour.

5.3.3 Oxygen-rich atmospheres. The oxygen content in work areas (other than hyperbaric chambers) **MUST NOT** exceed 23 percent by volume. Failure to follow this will result in fires and/or explosions.

5.3.4 Compatibility of materials. Any materials used by UHCL that come into contact with oxygen in valves, piping, fittings, regulators, and utilization equipment must be suitable for use with oxygen, and at the pressures and conditions involved at the specific use point of material. The handling and use of oxygen above 3000 psi may involve greater fire potential, and adequate safety systems analysis needs to be made.

5.3.5 Non-sparking Tools. All tools used when working with enriched oxygen (23% to 100%) must be non-sparking tools.

5.4 Acid and alkaline gases.

5.4.1 Personal Protective Equipment. Supervisors will ensure that precautions are taken to avoid contacting skin or eyes with acid or alkaline gases. Chemical goggles or face shields, rubber (or other suitable chemically protective material) gloves, and aprons will be worn. Long sleeves and trousers will be worn. Open-toed shoes or sneakers are prohibited.

5.4.2 Respiratory equipment. Employees handling and using acid and alkaline gases will have gas masks or self-contained breathing apparatus (SCBA) immediately available for use. SCBA must be used when the concentration of the gas could be higher than the mask canister rating, and or where the oxygen content of the atmosphere could be below 19 percent by volume.

5.4.3 Emergency showers and eyewash fountains. Supervisors will ensure that areas, where acid or alkaline gases are used, are equipped with an emergency shower and eyewash fountain.

5.4.4 Quantity on site. Because of their hazardous nature, supervisors will limit the quantity of this type of gas to the minimum requirements.

5.4.5 Ventilation. Acid and alkaline gases will only be used in well-ventilated areas.

5.5 Highly toxic gases.

5.5.1 Respiratory equipment. Employees handling and using highly toxic gases will have gas masks or self-contained breathing apparatus (SCBA) immediately available for use. SCBA must be used when the concentration of the gas could be higher than the mask canister rating, and or where the oxygen content of the atmosphere could be below 19 percent by volume.

5.5.2 Storage locations. Storage of highly toxic gases will be:

5.5.2.1 Outdoors, or in a separate noncombustible building without other occupancy, or in a separate room without other occupancy.

5.5.2.2 Of noncombustible construction with a fire-resistance rating of at least one hour.

5.5.2.3 Well ventilated to preclude the development of hazardous concentrations.

5.5.2.4 Protected against tampering.

5.5.3 Ventilation. Highly toxic gases will be used only in forced ventilated areas (gas cabinets or some other specially designed containment system) or in hoods with forced ventilation, or outdoors. Hazard analysis will be conducted on equipment emitting high concentrations. The gas will be discharged into appropriate scrubbing equipment which will remove or neutralize the toxic effects before entering the effluent gas stream.

5.5.4 Toxicity. Supervisors will ensure the following. Before using a highly toxic gas, employees must read and understand all warning labels and Safety Data Sheet (SDS) information. All employees working in the immediate area where these gases are handled will be instructed as to the toxicity of the gases and methods of protection against harmful exposure. Employees will not be exposed to concentrations greater than those determined to be safe levels by OSHA 29 CFR 1910.1000 and the threshold limit values guidance by the ACGIH.

5.5.5 Quantity on site. Because of their hazardous nature, supervisors will limit the quantity of this type of gas to the minimum requirements.

5.6 Cryogenic liquefied gases. Cryogenic liquids are gases that are handled in liquid form at relatively low pressure and extremely low temperatures, usually below -238 degrees F. Because of their low temperature, cryogenic liquids are handled in multi-wall, vacuum-insulated containers, tank trucks, tank cars, and storage tanks to minimize evaporation and venting of the gas. Some cryogenic liquids in small quantities are also handled in open, low-pressure thermos type containers in laboratory work.

5.6.1 Personal Protective Equipment. Cryogenic liquids and cold gases can cause frostbite injury upon contact with the body. When handling cryogenic liquids supervisors will ensure that employees use suitable eye protection, such as a face shield, safety glasses, or safety goggles, hand protection, such as insulated loose-fitting gloves, and proper clothing to prevent other bodily exposure.

5.6.2 Ventilation. Cryogenic liquid containers will only be stored and handled in well-ventilated areas to prevent excessive concentrations of the gas. Containers are equipped with pressure relief devices that permit the venting of gas intentionally.

5.6.3 Container Handling. Cryogenic liquid containers will be handled and stored in an upright position. The containers must **not** be dropped, tipped over, or rolled on their sides. A four-wheeled handling truck will be used to move cryogenic liquid containers over 20 gallons capacity.

5.6.4 Containers. Containers designed for specific gas storage will not be used for any other type of gas.

5.6.5 Pressure relief devices. Containers entering this facility will be provided with DOT-approved devices to prevent excessive buildup of pressure from

warming gas. Where cryogenic liquids or cold gas may be trapped between valves, piping will be equipped with appropriate pressure relief devices.

5.6.6 Transfer of cryogenic liquids. Only transfer lines designed for cryogenic liquids will be used. Transfer of cryogenic liquids will be performed slowly enough to minimize excess evaporation and stress due to rapid cooling and contraction of warm containers and equipment.

5.6.7 Liquid oxygen. Liquid oxygen containers, piping, and equipment will be kept clean and free of grease, oil, and organic materials. Ignition sources, flammable materials, organic greases, and oils are **not** permitted in areas where liquid oxygen is stored or transferred.

5.6.8 Liquid hydrogen. Ignition sources are **not** permitted in areas where liquid hydrogen is stored or transferred. Liquid hydrogen must be stored and transferred under positive pressure to prevent the infiltration and solidification of air or other gases.

5.6.9 Liquid helium and liquid neon. Liquid helium and liquid neon must be stored and transferred under positive pressure to prevent the infiltration and solidification of air or other gases.

5.6.10 Liquefied natural gas. Ignitions sources are **not** permitted in areas where liquefied natural gas is stored or transferred. Liquefied natural gas must be stored and transferred under positive pressure to prevent the infiltration of air or other gases.

5.6.11 Inert gases. In areas where inert gases are used or stored, employees will have self-contained breathing apparatus (SCBA) immediately available for use. SCBA must be used in the event the oxygen in the room is displaced by the inert gas creating an oxygen-deficient atmosphere where the oxygen content of the atmosphere could be below 19 percent by volume.

6. Visual inspection of compressed gas cylinders.

Employees of UHCL will use the following for general inspection of compressed gas cylinders. Our supplier has the first responsibility for the inspection of cylinders used by UHCL in accordance with CGA and NFPA guidelines. Only the following inspection criteria will be followed by employees of UHCL:

General Visual Inspection Criteria For Compressed Gas Cylinders

Inspect for:	**Possible result**:

- Dents	Weakening of cylinder wall
- Cuts, gouges or digs	Decrease in wall thickness
- Corrosion	Decrease in wall thickness
- Pitting	Decrease in wall thickness
- Crevice corrosion	Weakening of cylinder wall
- Bulges	Weakening of cylinder wall
- Neck defects	Leak or cylinder explosion
- ARC/Torch burns	Weakening of cylinder wall
- Valve ease-of-movement	Corrosion leading to leak
- Valve thread serviceability	Leak during operation
- Leakage at valve neck	Leak during storage
- Leakage at rupture disk	Leak during storage/catastrophic disk failure

6.1 Suspect cylinders. Cylinders that are suspected to be deficient in any manner will be removed from service. The supplier will then be notified and a representative of the supplier will be asked to inspect the cylinder. UHCL employees discovering a cylinder suspected to be deficient in any manner should notify EHS immediately (281-283-2106).

7. General safety rules for use of compressed gas.

7.1 Pre-operation safety rules.

- Read the Safety Data Sheet before use.
- Inspect cylinder for damage before use.
- Inspect cylinder for leaks before use.
- Ensure "In use" label is present.
- Ensure all labels/warnings are readable.
- Place upright on stable dry surface.
- Ensure cylinder is restrained above mid-point.
- Keep heat, flame, and electrical sources from gas.
- Operate in accordance with established procedures.

7.2 Post-operation safety rules.

- Ensure "empty" or like label is present.
- Remove from operation using established procedures.
- Close valve completely and cap cylinder.
- Transport cylinder using hand truck.

7.3 Full cylinder storage rules.

- Read the Safety Data Sheet before use.
- Do not smoke.
- Mark cylinder with date of storage.

- Ensure stock is properly rotated.
- Use oldest stock first.
- Inspect cylinder for damage before storage.
- Inspect cylinder for leaks before storage.
- Store with like kind of gas.
- Ensure all labels are readable.
- Ensure valve assembly is tightly capped.
- Ensure cylinder is restrained above midpoint.
- Store upright on stable dry surface.
- Keep electrical devices away from gas.
- Keep combustible materials away from gas.
- Keep heat and flame away from gas.

7.4 Empty cylinder storage rules.

- Read the Safety Data Sheet before use.
- Do not smoke.
- Label cylinder "empty" before storage.
- Ensure valve assembly closed tightly.
- Ensure valve assembly capped tightly.
- Inspect cylinder for damage before storage.
- Store with like kind of gas cylinders.
- Ensure all labels are readable.
- Ensure cylinder is restrained above midpoint.
- Store upright on stable dry surface.
- Keep electrical devices away from gas.
- Keep combustible materials away from gas.
- Keep heat and flame away from gas.

8. Compressed gas storage locations.

Location	Type Gas	Average Quantity Stored	Last Hazard Eval.

APPENDIX 11: STANDARD OPERATING PROCEDURES TEMPLATE

University of Houston Clear Lake

(Insert name of chemical/process/experiment here)

Standard Operating Procedure

Rev Date: 08/01/2024

This standard operating procedure (SOP) outlines required methods to be used by researchers during this outlined experiment or process. These practices and procedures are intended to provide a safe working environment, promote a culture of forward-thinking risk mitigation, and to promote compliance with federal, state, and local regulations.

APPLICABILITY

This SOP is for processes, experiments, or manipulations that pose moderate risks and that call for protective steps beyond those dictated by accepted laboratory standards. They are intended to limit the potential for injury, equipment damage, or environmental impact

This SOP is not applicable to….

RESPONSIBILITIES (Add to list as appropriate)

PI/Supervisor:

- Implement the guidance outlined in this document within departmental/institute operations.
- Provide training to laboratory personnel regarding the specific hazards involved in working with (enter name of chemical/process/experiment here) to include work area decontamination, and emergency procedures prior to conducting any work.
- Provide laboratory personnel with a copy of this SOP and a copy of the SDS(s) provided by the manufacturer.
- Ensure that laboratory personnel have completed appropriate laboratory safety training and/or refresher training as required.
- Ensure all personnel are trained on the proper use/operation of any equipment used during the experiment or process.
- Require the use of proper lab attire (lab coats, gloves, eye protection, and other PPE as required).

Researchers (Graduate Students/Postdocs/Research Staff)

- Implement and follow minimum working protection found in this document.
- Complete appropriate laboratory safety training.
- Wear appropriate personal protective equipment that includes but may not be limited to a lab coat, gloves and eye protection in the laboratory.
- Report all near misses, incidents, and unsafe acts or conditions to the principal investigator and EHS. Any injuries must also be reported to Human Resources. Reporting forms may be found at the following link: https://www.uhcl.edu/about/administrative-offices/environmental-health-safety/forms.

Undergraduate Students

- Follow minimum working protection found in this document.
- Complete appropriate laboratory safety training.
- Wear appropriate personal protective equipment that includes but may not be limited to a lab coat, gloves and eye protection in the laboratory.

PROCEDURE

Fill in all highlighted areas with appropriate information

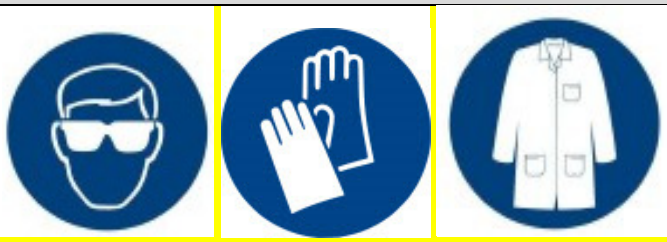
INSERT TITLE OF EXPERIMENT OR PROCESS

This is where you can type out a description of the experiment or process you will perform. Just give an overall view. You will be walking through the experiment or process step by step below.		
Preparer: Insert Name	**Location:** Bayou/STEM/Arbor	
Authorized Personnel with Contact Information		
Position	**Name**	**Number/Email**
Principle Investigator/Supervisor	Insert Name	555-555-5555/someone@uhcl.edu
Student/Technician/Operator	Insert Name	555-555-5555/someone@uhcl.edu
Others to be notified (e.g., other workers in the same laboratory, or other members of the research group)	Insert Name	555-555-5555/someone@uhcl.edu

HAZARDS, CONTROLS, CONDITIONS, & REQUIREMENTS

Potential Hazards	
  Copy and paste relevant pictograms. (Examples in attachment 1)	
Planned Chemicals Involved	**Hazards**
Insert chemical name(s)	List relevant hazards for chemical. (Examples in attachment 1)
Planned Equipment Involved	**Hazards**
Insert equipment name	List relevant hazards for equipment. (Examples in attachment 1)

Hazard Controls	
Engineering	**Work Practice**
Examples include: • Fume hood or glove box • Special ventilation • HEPA-filtered vacuum lines • Non-reactive containers • Pressure relief devices • Temperature control • Pressure control • Bench paper, pads, plastic-backed paper • Special signage • Safe sharp devices • Guards • Connect to ground	Examples include: • Designated areas • Procedures for requesting emergency assistance • Emergency phone numbers • Locations of fire alarms, fire extinguishers, fire blankets, eye washes, showers, etc. • Emergency responders • Workers on shifts • Training on all experimental techniques and experiments • Restricting access; locks • Housekeeping • Lockout/tagout a procedure plan • After-hour procedures • Preventive maintenance

Required PPE

Copy and paste relevant pictograms with descriptions as needed. (Examples in attachment 2)

Experiment Operational Ranges and Conditions					
Pressure:	Insert info	**Temperature:**	Insert info	**Volume:**	Insert info
Flammability Range:	Insert info	**Other:**	Insert info as necessary		

Special Handling & Storage Requirements
Insert handling and storage information here

Spill & Incident Procedure
Insert spill and incident procedure here

Waste Handling & Disposal
Most spent, unused, and expired chemicals/materials are considered hazardous wastes which must be properly disposed of. **DO NOT dispose of chemical wastes by pouring them down a sink or drain, or discarding them in the regular trash containers. All hazardous and non-hazardous wastes must be properly packaged in compatible containers and removed to the designated waste storage area for the affected lab (Room AA for Bayou Building labs, Room 3125 for STEM Building labs). Contact EHS at 281-283-2104 or 281-283-2106 for any assistance required**.

Training Requirements
• Complete EHS online Laboratory Safety training is available online. Contact EHS at 281-283-2106 for access. • Review SOP with knowledgeable person. • Complete training on operation of specialized equipment prior to use (e.g., ultracentrifuge, hydrogenation apparatus). • Other EHS training requirements (e.g., Nanoparticle Safety, Radiation Safety, Hazardous Waste Management, etc.) as appropriate.

PROCEDURE

Step #	Directions
1	Insert procedural steps for experiment or process. Add to table as needed.
2	
3	
4	
5	
6	
7	

VERIFICATION & REVIEW

Current Date	Date of SOP Expiration
00/00/0000	00/00/0000
PI Name	**PI Signature**
Insert Name	
Safety Reviewer Name	**Safety Reviewer Signature**
Insert Name	

LIST OF REFERENCES

Include Safety Data Sheets, Globally Harmonized System, any outside personnel consulted in preparation of document, peer reviewers, etc.

SOP Training Certification

I have read and understand the above SOP. I have taken all appropriate EHS training. I have received prior approval from my supervisor to perform this procedure. I agree to contact my supervisor if I plan to modify this procedure.

NAME	SIGNATURE	UHCL EMPLOYEE ID	DATE

Principal Investigator Revision Date

PROCEDURE MODIFICATIONS/REVISIONS

Current Date	Modifications or Revisions	Name
00/00/0000	Insert summary of changes made	Insert name of person making and/or approving changes
00/00/0000	Original document	Insert name of person making initial procedure

Attachment 1 -- Remove after use

Pictograms and Hazards

Chemical Hazards		
	• Carcinogen • Mutagenicity • Reproductive Toxicity	• Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity
	• Flammables • Pyrophorics • Self-Heating	• Emits Flammable Gas • Self-Reactives • Organic Peroxides
	• Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful)	• Narcotic Effects • Respiratory Tract Irritant
	• Gases Under Pressure	
	• Skin Corrosion/Burns • Eye Damage • Corrosive to Metals	
	• Explosives • Self-Reactives • Organic Peroxides	
	• Oxidizers	

	• Aquatic Toxicity
	• Acute Toxicity (fatal or toxic)
Physical Hazards	
	• Noise
	• Moving Parts
	• Projectiles
	• Slip/Fall
	• Electrical
	• Low Temperature

	• Hot Substance • Hot Surface
	• Glass Hazard
	• Pressure Release

Attachment 2 – Remove after use

Pictograms and Descriptions

Personal Protective Equipment	
	Hard Hat
	Eye Protection • Safety Glasses • Safety Goggles
	Face Shield
	Hearing Protection • Ear Plugs • Ear Muffs • Canal Caps

	Filtering Facepiece Respirator • N/R/P95 • N/R/P99 • N/R/P100
	Tight Fitting Respirator • Half Face • Full Face
	Welding Hood
	High Visibility Clothing
	Lab Coat
	Additional Apron • Acid splash, liquid resistant • Dust, grease
	Clothing protection • Long sleeve shirt and pants • Leather • Fire Resistant • Chemical Resistant
	Gloves • Vinyl • Nitrile • Cotton • Cut Resistant • Heat Protective • Rubber • Cold Protective • Anti-vibration

Foot Protection

- Closed Toe
- Slip Resistant
- Conductive
- Safety Toe