Eberly College of Arts and Sciences

C. Eugene Bennett Department of Chemistry

Chemical Hygiene Plan

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http://www.wvu.edu/~chemistry/safety/BarbaraLFoster.html

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Chapter 1. Principles of Laboratory Safety

Section 1. OSHA Laboratory Standard

The Occupational Safety and Health Administration (OSHA) Laboratory Standard, OSHA 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories,* was created to minimize employee and student exposure to hazardous chemicals in the laboratory. The OSHA Laboratory Standard can be viewed on the OSHA Web site:
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106

The OSHA Laboratory Standard definition of a Chemical Hygiene Plan is:
"A 'Chemical Hygiene Plan' means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace..."

The C. Eugene Bennett Department of Chemistry Chemical Hygiene Plan (CHP) was developed to meet the requirements of the OSHA Laboratory Standard. The Chemical Hygiene Plan establishes general rules for the safe handling, storage, and disposal of hazardous chemicals and sets forth prudent work practices that are designed to protect the employee from exposure to chemical hazards and unsafe work practices in the laboratory. To protect its students and employees from hazardous materials and unsafe work practices, the Department of Chemistry has established safety rules and regulations for undergraduates in the academic laboratories, undergraduates in the research laboratories, employees in the Prep Rooms, and researchers in the Chemistry Research Laboratory Building.

Section 2. Health Hazards

According to OSHA, a hazardous chemical is a chemical for which there is statistically significant evidence, based on at least one study conducted in accordance with established scientific principles, that acute or chronic health effects may occur in exposed persons. Acute exposure is defined as short durations of exposure to high concentrations of hazardous materials in the work place. Chronic exposure is defined as continuous exposure over a long period of time to low concentrations of hazardous materials in the work place.

Many of the chemicals and solutions that are routinely used in academic laboratories can present a significant health hazard when handled improperly. The Swiss physician and alchemist Theophrastus Phillippus Aureolus Bombastus von Hohenheim (1493-1541), who took the name Paracelsus later in life in homage to Celsus, a Roman physician, is known as "The Father of Toxicology." Paracelsus is famous for his quote, "What is it that is not poison? All things are poison and nothing is without poison. It is the dose alone that makes a thing not a poison."

Engineering controls (i.e., chemical fume hoods and glove boxes), administrative controls (i.e., safety rules, Chemical Hygiene Plans, and Standard Operating Procedures), and personal protective equipment (PPE) (i.e., gloves, lab coats, and chemical splash goggles) are designed to protect laboratory workers from exposure to hazardous materials. Routes of exposure to hazardous materials include contact with skin and eyes, inhalation, ingestion, and injection.

Health hazards in the laboratory include toxic, flammable, corrosive, and carcinogenic chemical substances. The effect of an exposure to a hazardous material can be acute or chronic, depending upon the hazardous material and the length of time that one was exposed to the hazardous material. Acute health effects can appear rapidly after only one exposure and can result in rashes, dizziness, coughing, and burns. Chronic health effects may take months or years before they are diagnosed. Symptoms of chronic exposure can include joint paint, neurological disorders, and tumors.

A chemical allergy is an adverse reaction (i.e., rash or hives) to a chemical. Some persons have developed chemical sensitivities to certain chemicals or types of chemicals, including ammonia, iodine, bromine, and sulfur. Such reactions are usually the result of a previous sensitization to that particular chemical, or one that is similar in nature.

The protein in soft, flexible latex rubber gloves can cause mild or severe, life-threatening latex allergic reactions in some persons.

Section 3. Physical Hazards

Examples of physical hazards in the laboratory include gas cylinders, cryogenic liquids, electrical equipment, lasers, magnetic fields, and reactions that involve high pressure or vacuum lines.

Another type of physical hazard is the presence of spilled liquids or broken glassware on the floor or in the work space. Good housekeeping practices serve to eliminate these physical hazards. Laboratory workers must follow all departmental safety rules and policies to avoid injuries associated with physical hazards.

Section 4. Material Safety Data Sheets

Important information about handling a chemical can be found on the label of the chemical container and in the Material Safety Data Sheet (MSDS). An MSDS is designed to provide laboratory and emergency personnel with the proper procedures for handling, storage, and disposal of a particular hazardous material. A Material Safety Data Sheet is a document that contains relevant information about a material, as referenced by OSHA 29 CFR, *Occupational Safety and Health Standards: Hazard Communication*, Part 1910.1200.
For consistency purposes, a 16-section standard format has been established by ANSI (ANSI Z400.1-1998):

1. **Product Identification**
   Provides information about the chemical and the supplier, including:
   - Synonyms
   - Chemical Abstracts Service (CAS) number
   - Molecular weight
   - Chemical formula
2. **Composition/Information on Ingredients**
3. **Hazards Identification**
   - Emergency overview
   - Health, Flammability, and Instability rating
   - Protective equipment
   - Storage color code
   - Potential health effect

4. First Aid Measures
- •Inhalation
- •Ingestion
- •Skin contact
- •Eye contact

5. Fire Fighting Measures
- •Fire
- •Explosion
- •Fire extinguishing media
- •Special information

6. Accidental Release Measures

Actions that should be taken in the event of an accidental release of the material.

7. Handling and Storage

Information on how to safely handle and store the material.

8. Exposure Controls and Personal Protection
- •Airborne exposure limits
- •Ventilation system requirements
- •Personal respirator requirements
- •Skin protection
- •Eye protection

9. Physical and Chemical Properties
- •Appearance
- •Odor
- •Solubility
- •Specific gravity
- •pH
- •Boiling point
- •Melting point
- •Vapor density
- •Vapor pressure
- •Evaporation rate

10. Stability and Reactivity
- •Hazardous decomposition products
- •Hazardous polymerization
- •Incompatibilities
- •Conditions to avoid

11. Toxicological Information
- •LD50 information
- •Cancer lists

12. Ecological Information
- •Environmental fate
- •Environmental toxicity

13. Disposal Considerations

Recommended disposal methods

14. Transport Information

Shipping classification

15. Regulatory Information

Federal, State, and International regulations

16. Other Information
- •NFPA ratings

•Label hazard warnings
•Label precautions
•Label first aid information
•Product use
•Revision information
•Disclaimer

A comprehensive file of Material Safety Data Sheets (MSDS) must be kept on file in the laboratory or be readily accessible to all employees during all work shifts. MSDS can be made available to employees via the Internet. A helpful MSDS Web site is http://www2.hazard.com/msds/index.php

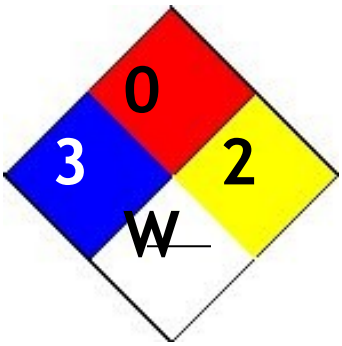
Laboratory workers should always READ and HEED the label and the Material Safety Data Sheet before using a chemical for the first time. Know the types of PPE that you will be required to wear when handling the chemical. Ensure that the ventilation in the laboratory will be adequate for your needs. Be familiar with the departmental Chemical Hygiene Plan and Emergency Action Plan in the event of a chemical spill, fire, or explosion.

Section 5. NFPA Classification System

In the event of a fire or an explosion in a laboratory, the National Fire Protection Association (NFPA) universal hazard diamond is designed to provide information to emergency responders regarding the chemical contents of a laboratory. The hazard diamond provides information on the degree of danger for health hazards, fire hazards, and instability hazards.

The NFPA hazard diamond is commonly displayed on chemical labels, secondary container labeling in the academic laboratories, and on the MSDS. Additionally, it is posted on the laboratory door or other highly visible location. When posted on the laboratory door, the numerical ratings refer to the contents of the entire laboratory, not to a specific chemical within the laboratory.

NFPA CLASSIFICATION SYSTEM
Source: NFPA 704 (2001)
BLUE - HEALTH HAZARD
4=Can be lethal
3=Can cause serious or permanent injury
2=Can cause temporary injury
1=Can cause significant irritation
0=Offers no hazard



RED - FLAMMABILITY HAZARD
4=Will rapidly vaporize and burn
3=Can be ignited under almost all ambient temperature conditions
2=Must be moderately heated or exposed to high ambient temperatures
1=Must be preheated before ignition
0=Materials that will not burn

YELLOW - INSTABLITY HAZARD

4=Readily capable of detonation or explosive decomposition at normal temperatures and pressures
3-Capable of detonation or explosive decomposition but must be heated
2=Readily undergoes violent chemical change at elevated temperatures and pressures
1=Normally stable, but can become unstable at elevated temperatures and pressures
0=Normally stable, even under fire conditions

WHITE - SPECIAL HAZARD

OX=Materials that possess oxidizing properties
~~W~~=Materials that react violently or explosively with water

Chapter 2. Chemical Hygiene Responsibilities

Section 1. President of the Institution

The President of West Virginia University is ultimately responsible for the implementation, enforcement, and support of the West Virginia University Chemical Hygiene Plan (CHP) and laboratory safety program.

Section 2. Department of Environmental Health and Safety

1. Provides general and specific laboratory safety training to employees upon request.
2. Provides technical assistance to laboratory employees regarding chemical handling, storage, use, and disposal.
3. Conducts exposure assessments upon request. Maintains environmental monitoring and employee exposure records. Submits monitoring results to the Chemical Hygiene Officer and the Dean/Director within five working days of receipt.
4. Audits the Chemical Hygiene Plan, chemical inventory, and MSDS records in each department on an annual basis.
5. Conducts annual testing of chemical fume hoods and posts the testing results on each chemical fume hood in the department.
6. Provides annual laboratory inspections to ensure compliance with the WVU Chemical Hygiene Plan.
7. Provides technical assistance regarding personal protective equipment and safety equipment.
8. Provides technical assistance to employees to ensure code compliance.

Section 3. Dean of the Eberly College of Arts and Sciences

1. Assumes responsibility for departments engaged in the laboratory use of hazardous chemicals and appoints one or more Chemical Hygiene Officer(s) (CHO) for each department or unit. Provides the Chemical Hygiene Officers with the support necessary to implement and maintain their Chemical Hygiene Programs.
2. Ensures that each department remains in compliance with the departmental and WVU CHP.
3. Provides budgetary arrangements to ensure the health and safety of the employees of the college.

Section 4. Eberly College Safety Coordinator

1. Serves as the Dean's liaison with college chairs, directors, faculty, staff, and students regarding safety and health issues.
2. Oversees the development of and subsequent revisions of departmental Chemical Hygiene Plans, chemical inventories, emergency plans, and chemical waste disposal plans.
3. Conducts laboratory inspections and submits detailed inspection reports to the Department Chair and the Dean of the Eberly College. Conducts follow-up inspections, as appropriate.
4. Serves as the Eberly College liaison with the Department of Environmental Health and Safety to ensure that all departments are in compliance with federal, state, local, and university policies regarding chemical storage and waste disposal.
5. Writes, designs, oversees production, and serves as the editor of Eberly College safety documents.
6. Keeps current of legal requirements concerning regulated substances.

Section 5. Chemical Hygiene Officer (CHO)

1. Establishes and maintains a departmental CHP that will serve to promote a safe and healthy environment in which to teach, learn, and conduct research.
2. Revises departmental safety rules and regulations and the Chemical Hygiene Plan, as needed. Revisions of safety documents are reviewed by the department chair, who provides comments to the Chemical Hygiene Officer.
3. Serves on the Departmental Safety Committee
4. Obtains funding for safety-related purchases or training, as appropriate.
5. Monitors procurement, use, storage, and disposal of chemicals.
6. Conducts regular inspections of the laboratories and prep rooms. Submits detailed laboratory inspection reports to the department chair and to the dean of the Eberly College.
7. Maintains inspection, personnel training, and inventory records.
8. Assists laboratory supervisors in developing and maintaining adequate facilities.
9. Keeps current of legal requirements concerning regulated substances.
10. Seeks ways to improve the chemical hygiene program.
11. Notifies employees of the availability of medical attention under the following circumstances:
    - Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
    - Where exposure monitoring reveals an exposure level routinely above the action level for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements.
    - Whenever a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure occurs, the employee may have a medical consultation to ascertain if a medical examination is warranted.
12. If medical attention is necessary, the CHO provides the attending physician the identity of the hazardous substance to which the employee may have been exposed; a description of the conditions under which the exposure occurred; and the signs and symptoms that the employee may be experiencing.
13. The CHO will notify affected employees in writing of any monitoring results either individually or by posting results in an appropriate location accessible to employees. This information shall be distributed within five working days upon receipt of the results from the Department of Environmental Health and Safety.
14. Attends annual CHO training that is conducted by the institution.
15. Encourages laboratory employees to attend specialized training that is provided by the institution (i.e., first-aid training, fire extinguisher training, and gas cylinder training).

Section 6. Department Chairperson

1. Assumes responsibility for personnel engaged in the laboratory use of hazardous chemicals.
2. Provides the Chemical Hygiene Officer with the support necessary to implement and maintain the Chemical Hygiene Plan.
3. After receipt of laboratory inspection report from the Chemical Hygiene Officer, meets with laboratory supervisors to discuss cited violations and to ensure timely actions to protect laboratory workers and facilities and to ensure that the department remains in compliance with all applicable federal, state, university, local, and departmental codes and regulations.

4. Provides budgetary arrangements to ensure the health and safety of the departmental employees, visitors, and students.
5. Serves as Chair of the Departmental Safety Committee. Appoints a faculty member and a graduate student member to serve on the Departmental Safety Committee.

Section 7. Departmental Safety Committee

1. Review accident reports and make appropriate recommendations to the Department Chairperson regarding proposed changes in the laboratory procedures.
2. Perform laboratory inspections in Clark Hall and the Chemistry Research Laboratory Building on an annual basis, or as needed. Prepare a detailed inspection report to be submitted to each faculty member/laboratory supervisor.

Section 8. Laboratory Supervisor

1. Ensures that laboratory workers comply with the departmental CHP and do not operate equipment or handle hazardous chemicals without proper training and authorization.
2. Always wears personal protective equipment that is compatible to the degree of hazard of the chemical.
3. Follows all pertinent safety rules when working in the laboratory to set an example for his or her supervisees.
4. Reviews laboratory procedures for potential safety problems before assigning to other laboratory workers.
5. Ensures that visitors follow the laboratory rules and assumes responsibility for the laboratory visitors.
7. Ensures that personal protective equipment is available and properly used by each laboratory employee and visitor.
8. Maintains and implements safe laboratory practices.
9. Monitors the facilities and the chemical fume hoods to ensure that they are maintained and function properly. Contacts the appropriate person, as designated by the Department Chairperson, to report problems with the facilities or the chemical fume hoods.

Section 9. Laboratory Worker

1. Reads, understands, and follows all safety rules and regulations that apply to the work area.
2. Plans and conducts each operation, laboratory class, or research project in accordance with the departmental and institutional CHP.
3. Promotes good housekeeping practices in the laboratory or work area.
4. Communicates appropriate portions of the CHP to students in the work area.
5. Notifies the supervisor of any hazardous conditions or unsafe work practices in the work area.
6. Uses personal protective equipment as appropriate for each procedure that involves hazardous chemicals.
7. Immediately reports any job-related illness or injury to the supervisor.

Chapter 3. Personal Apparel and Personal Protective Equipment (PPE)

Section 1. Personal Apparel

1. Laboratory workers must wear clothing that provides protection from chemical spills in the laboratory. You should wear clothing that sufficiently covers your upper and lower body, including long pants (or long skirt) and the equivalent of a t-shirt. Shorts and short skirts are inappropriate apparel in the laboratory.
2. Wear shoes at all times in the laboratory. Do not wear perforated, open-toed, open-backed, or high-heeled shoes, clogs, or sandals.
3. For your protection, jewelry (i.e., rings, bracelets, necklaces, and watches) should not be worn in the laboratory. Chemicals can seep under the jewelry and cause injuries to the skin. Jewelry can become caught in machinery and can conduct electricity. Chemicals can ruin jewelry and change its composition (i.e., when mercury comes into contact with gold).
4. Hair longer than shoulder length and loose sleeves must be confined in the laboratory.

Section 2. Personal Protective Equipment (PPE)

1. Always review new procedures and refer to the MSDS to determine the degree of PPE that is required for each chemical that will be used in the laboratory.
2. Wear chemical splash goggles that conform to ANSI Z87.1-2003, *Occupational and Educational Personal Eye and Face Protection Devices*, at all times (and over eyeglasses) when working in the laboratory.

Chemical splash goggles protect the face and eyes in the event of a chemical splash.

Approved for use in chemistry laboratories.

Safety glasses do not protect the face and eyes from chemical splashes.

Not approved for use in chemistry laboratories.

Impact goggles are designed for use in a woodworking shop.

Not approved for use in chemistry laboratories.

3. A face shield (in addition to chemical splash goggles) should be used when there exists a possibility of fire, explosion, or implosion.
4. Protective safety glasses with UV-absorbing lenses should be worn when working with radiation of wavelengths shorter than 250 nm.
5. Gloves that are appropriate to the degree of hazard (according to the MSDS) must be worn at all times. Inspect gloves for defects before wearing. Remove gloves before handling pens, notebooks, doorknobs, radios, computer keyboards, and telephones. Remove gloves before exiting the laboratory.
6. Lab coats or aprons must be worn at all times in the laboratory.
7. All photographs that are taken in a laboratory setting in Clark Hall or the CRL must depict laboratory workers who are wearing proper personal protective equipment (i.e., goggles, gloves, and laboratory coat). Notify the Chemical Hygiene Officer prior to the event when photographs of laboratory workers are scheduled to be taken for publication purposes.

Chapter 4. Facilities – Clark Hall of Chemistry (CH) and the Chemistry Research Laboratory Building (CRL)

Section 1. Laboratory Design

1. The laboratory facility will have an appropriate ventilation system to avoid intake of contaminated air.
2. The stockrooms and storerooms must be well ventilated.
3. The laboratory will include proper storage cabinets and storage areas for chemicals.
4. The laboratory will have available properly functioning chemical fume hoods and laboratory sinks.
5. Other safety equipment in the laboratory will include fire extinguishers, safety showers, fire blankets, and eyewash stations.
6. Experimental work should be appropriate to facilities available.
7. Modifications to the laboratory facility cannot be undertaken without consultation with the department Chair, the Chemical Hygiene Officer, and personnel from the Department of Environmental Health and Safety.

Section 2. Laboratory Ventilation

1. Laboratory procedures involving hazardous chemicals must not be started if there is a possibility that the ventilation system cannot handle the gas or vapor emissions from the procedure.
2. General ventilation provides a source of breathing air and a source for make-up air for local ventilation devices. The laboratory ventilation should have a performance level of 10-20 room changes per hour. An inadequate ventilation system can cause an increased risk by creating a false sense of security in the laboratory. Laboratory air must not be recirculated within the building.
3. There should be 2.5 linear feet of hood space for each worker who spends the majority of his or her time working with hazardous chemicals.
4. Hood face velocity should be 60-120 linear feet per minute.
5. All chemical fume hoods will be tested on an annual basis by personnel from the Department of Environmental Health and Safety and inspection results will be posted on the fume hood.
6. To ensure their safety and health, all personnel must properly use and maintain the chemical fume hoods.
   - When using the hood, the sash opening should be kept at a minimum to ensure the efficiency of the operation.
   - All chemicals and equipment should be placed at least six inches from the hood face to ensure proper air flow.
   - Use the hood when there is a possibility of release of toxic chemical vapors, dusts, or gases.
   - Use the hood when working with any volatile substance.
   - Keep hoods closed when not in use.
   - Do not store chemicals or equipment in the hood.
   - Workers should be discouraged from walking in front of a hood that is in use. Such behavior disrupts the air flow in front of the hood.
   - Keep your head and body outside of the hood face and listen for changes in the air flow.

- Do not rely on the hood for protection against explosions. Plan your experiments wisely.
- Keep the sash glass clean and to not obstruct the view of the hood with posters, decals, or other items.

Section 3. Building Security

1. All doors in Clark Hall of Chemistry and the Chemistry Research Laboratory Building must be closed and locked when workers or students are not present.
2. If you are working in a laboratory or office and leave for any reason or any length of time, you must close and lock the door.
3. Do not loan your building keys to anyone else.
4. Immediately report the loss or theft of your keys to the Chemical Hygiene Officer.
5. Do not permit unauthorized persons to enter laboratories or offices in the chemistry buildings.
6. Do not prop open doors or leave doors ajar to allow unauthorized access to the chemistry facilities.
7. If an employee should discover that criminal activity has occurred in either building, he or she should immediately notify the Chemical Hygiene Officer.
8. Employees will be notified via email, meetings with the Chairperson or Chemical Hygiene Officer, or departmental meetings of any criminal action that occurred in the chemistry facilities.

Chapter 5. General Protocols

Section 1. How to Avoid Routine Exposure to Hazardous Chemicals

1. Thoroughly review all proposed laboratory procedures to determine the potential health and safety hazards before beginning work in the laboratory. Refer to the MSDS for guidance on chemical storage, handling, and disposal. Avoid underestimation of risk when handling hazardous materials.
2. Minimize all chemical exposure. Avoid ingestion, injection, inhalation, eye contact, and skin contact with hazardous materials.
3. Observe the PEL (Permissible Exposure Limit) and TLV (Threshold Limit Value) of each hazardous material in the laboratory. These limits are listed in the MSDS.
4. The choice of chemicals to be used in the laboratory should be appropriate to the facilities and should not exceed the capacity of the exhaust system.
5. Do not smell or taste chemicals. When instructed to smell a chemical, gently waft the vapors toward your nose. Do not directly inhale the vapors.
6. Vent apparatuses which may discharge chemicals (vacuum pumps, distillation columns, etc) into local exhaust or hoods.
7. Inspect gloves and glove boxes before use.
8. Do not allow release of toxic substances into cold rooms since these rooms recirculate the air.
9. Always wash exposed areas of skin after chemical usage and before exiting the laboratory.
10. Never wear gloves or lab coats outside of the laboratory or into areas where food is stored and consumed. Laboratory workers should wash laboratory apparel separately from personal clothing.
11. Eating, smoking, using smoke-less tobacco products, drinking, chewing gum, or applying cosmetics in areas where laboratory chemicals are present is prohibited.
12. Food and beverages are not to be stored in chemical storage areas or refrigerators.
13. Do not use glassware or utensils used for laboratory work for any other purpose (i.e., drinking from beakers).
14. Keep chemical containers closed when not in use.

Section 2. General Housekeeping Practices in the Laboratory

1. Access to exits, emergency equipment, and utilities must never be blocked. Coats, bags, and other personal items must be stored in the proper area, not on the benchtops or in the aisle ways.
2. Properly label chemicals and equipment for use and storage. Repair or replace any damaged labels immediately. Secondary containers must be labeled with the chemical name, manufacturer's name, hazard class, and any other special warnings.
3. The floors should be cleaned on a regular basis. Promptly wipe up all liquid spills and ice on the floor.
4. Keep work areas clean and uncluttered. Benchtops and hoods should remain clear of broken glass, spilled chemicals, paper litter, etc.
5. Chemical hazards should be maintained at least two inches from the edge of the bench tops.
6. Hallways and stairways should not be used as storage areas.
7. Do not conduct unattended experiments without the authorization and prior

approval of the Laboratory Supervisor.

8. Do not store materials or chemicals on the floor.
9. Do not block the sink drains. Place rubber matting in the bottom of the sinks to prevent breakage of glassware and avoid injuries.
10. Wear appropriate gloves to clean glassware. Do not pile up dirty glassware in the laboratory. Wash glassware carefully. Dirty water can mask glassware fragments. Handle and store laboratory glassware with care. Promptly discard cracked or chipped glassware.
11. Clean up work areas at the end of the operation or day.
12. Properly dispose of broken glass and sharps (i.e., needles and razor blades). If broken glassware is contaminated with a hazardous substance, the glassware must be treated as a hazardous substance.
13. To avoid accidents, drawers and cabinets must be kept closed.
14. Properly dispose of all waste chemicals. Never pour waste chemicals down the drains.
15. To avoid the presence of noxious fumes arising from the sewer lines, the Laboratory Supervisor should ensure that a liter or more of water is poured down each laboratory floor drain on at least a monthly basis to ensure that the drain trap is functional.
16. Formal housekeeping and laboratory inspections will be conducted on a regular basis by the Chemical Hygiene Officer and/or the Departmental Safety Committee.

Section 3. General Safety Rules

1. Employees are not permitted to deviate from the assigned work schedule without prior authorization from the Laboratory Supervisor. Unauthorized experiments are strictly forbidden.
2. Plan appropriate protective procedures and plan the positioning of all equipment before beginning any operation. Follow the appropriate Standard Operating Procedures (SOP) at all times in the laboratory.
3. Read the MSDS and the label before using a hazardous chemical in the laboratory.
4. Report all injuries, accidents, incidents, and near-misses to the Chemical Hygiene Officer.
5. Know the location and proper use of the safety equipment, (i.e., eyewash station, safety shower, fire extinguisher, first-aid kit, and fire blanket) emergency telephone, and fire alarm in the laboratory in which you are working.

5. Appropriate personal protective equipment must be worn at all times in the laboratory.
6. Appropriate eye protection (chemical splash goggles and/or a face shield) must be worn by all persons (including visitors) where chemicals are used or stored.

8. Wear appropriate gloves when handling toxic materials. Inspect all gloves for holes and defects before using.
9. The use of contact lenses in the laboratory is strongly discouraged. If an employee must wear contact lenses when working with hazardous substances, the employee must notify his or her supervisor so that all special precautions can be taken.
10. Do not wear synthetic finger nails in the laboratory. Synthetic finger nails are made of extremely flammable polymers which burn to completion and are not easily extinguished.
11. Notify your supervisor if you experience any sensitivities to any chemicals.

12. When heating a test tube or other apparatus, never point the apparatus toward yourself or your laboratory colleagues.
13. Always protect your hands when cutting glass tubing. Do not attempt to dry glassware by inserting a glass rod wrapped with paper towels. Always lubricate glassware with soap or glycerin before inserting rods, tubing, or thermometers. Hot glass looks just like cold glass. Be sure that your glassware has cooled before you touch it.
14. Dilute concentrated acids and bases by slowly pouring the acid or base into the water with stirring.
15. Secure all water, gas, air, and electrical connections in a safe manner.
16. Avoid working alone in the laboratory.
17. Do not pipet any substance by mouth in the laboratory; use a pipet aid.
18. Properly dispose of all chemical wastes. Do not pour chemicals down the drains.
19. Report any unsafe conditions to the Laboratory Supervisor or Chemical Hygiene Officer.
20. Children and other unauthorized persons are not permitted in the laboratory.
21. Hair longer than shoulder length and loose sleeves must be confined in the laboratory.

Section 4. Unattended Operations

1. Obtain permission from the supervisor prior to conducting any unattended operations.
2. Leave lights on and post a sign on the door announcing an unattended operation.
3. Return periodically to check on the unattended operation.
4. Provide for the containment of toxic substances in the event of equipment or utility failure.
5. Water hoses must be securely fastened to faucets and apparatus to avoid floods.
6. The laboratory door should be posted with emergency contact names and telephone numbers.

Section 5. Signs and Labels

1. Emergency signs shall be posted on all laboratory and prep room doors. The signs must contain the names and telephone numbers of all emergency contact personnel.
2. Label all secondary containers, including waste receptacles, with the contents, manufacturer's name, appropriate warnings, and hazard class.
3. Provide designated location(s) for safety shower, eye wash, fire extinguisher, first-aid station, fire blanket, and emergency telephone.
4. Post warning signs for areas of special or unusual hazards.

Section 6. Laboratory Equipment

1. Electrical equipment should be maintained only by trained individuals. Properly ground all electrical equipment. Report any electrical failure or suspicious heating of equipment to the Laboratory Supervisor immediately. Periodically inspect electrical equipment. Ensure quick access to electrical equipment shut-offs in the event of an emergency. Ensure that all electrical hand tools are double insulated or grounded.
2. Centrifuges should be anchored securely to the bench top. Close the lid before operating and remain with the centrifuge until full operating speed is attained. If

vibration occurs, stop the centrifuge and check the counter-balance load. Periodically clean the buckets and rotors to avoid contamination.

3. Securely lock down all balances and computers to avoid theft.
4. Take extra precautions when using Dewar flasks; shield or wrap them with tape to contain implosions.
5. Use laboratory equipment for the intended purpose only.
6. Periodically clean and examine all laboratory equipment.
7. Do not block walkways or aisles with extension cords. Periodically inspect extension cords for visible defects.
8. When using lasers, always wear appropriate eye protection and do not look directly at the source of the beam. Do not aim the laser by sighting along the beam. Keep the laser beam at or below chest height. Reflective materials should not be allowed near the beam. Hang warning signs when lasers are in use.
9. When using UV lamps, wear UV-absorbing eye protection, as described in the operating procedures for the instrument. Cover exposed skin.

Section 7. Environmental Monitoring

1. Regular employee exposure monitoring shall be provided upon request.
2. Regular monitoring for airborne substances may be appropriate when testing a new ventilation system or when redesigning laboratory hoods.
3. Regular monitoring may be appropriate if a hazardous substance is stored in the laboratory or if the substance is used routinely (three times a week or more.)

Section 8. Medical Monitoring Program

The institution has established an Employee Medical Monitoring Program. In compliance with OSHA 29 CFR 1920.20, employee records will be maintained for the length of employment plus 30 years. The employee will be monitored:

- if the employee develops signs and symptoms of exposure associated with a hazardous chemical.
- when exposure monitoring routinely exceeds the action level for an OSHA regulated substance.
- in the event of a spill, leak, explosion, or other occurrence resulting in the likelihood of exposure.

Section 9. Record Maintenance

1. Accident report forms will be submitted to the Chemical Hygiene Officer.
2. Medical records are to be retained by the institution.
3. The Chemical Hygiene Officer and EHS will retain copies of all personnel training records.
4. The Chemical Hygiene Officer and EHS will retain an up-to-date copy of the chemical inventory.
5. The Chemical Hygiene Officer will maintain the departmental CHP.

Chapter 6. Chemical Management

Section 1. Introduction

The prudent management of hazardous materials, from their procurement to their disposal, is a critical element of a successful laboratory safety program. Chemical management includes the following processes:

1. Chemical Procurement
2. Chemical Storage
3. Chemical Handling
4. Chemical Inventory
5. Transportation of Chemicals
6. Chemical Waste

Section 2. Chemical Procurement

When preparing to order a chemical for an experiment, there are several questions that one should ask, including:

- Do I really need to order this chemical?
- How much do I really need to order to perform my experiment? (**REMEMBER THAT WHEN ORDERING CHEMICALS, LESS IS ALWAYS BEST**) Order the least amount of chemicals that will be needed to save storage space, money, and disposal costs.
- What personal protective equipment (PPE) is required when handling this chemical? Is the proper PPE available in the laboratory?
- What is the level of training that is required to use this chemical?
- Are there special handling precautions?
- Does the laboratory have the proper storage facilities?
- Does the laboratory chemical fume hood provide proper ventilation?
- Are there special containment considerations in the event of a spill, fire, or flood?
- Will the institution provide disposal of this chemical? Are there additional costs related to the disposal of this chemical?

According to the OSHA Lab Standard, Appendix A, Section D.2.a (Chemical Procurement, Distribution, and Storage; Procurement), "Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved." Additionally, Section D.2.a (Chemical Procurement, Distribution, and Storage; Procurement) states, "No container should be accepted without an adequate identifying label. Preferably, all substances should be received in a central location." Only authorized personnel should purchase chemicals and other hazardous materials, such as gas cylinders. Within the C. Eugene Bennett Department of Chemistry, the Chemical Hygiene Officer reviews all hazardous material requisitions. If you or your group should receive a gratis shipment of chemicals from any source, submit a copy of the bill of lading or packing slip to the Chemical Hygiene Officer. Ultimately, the purchaser of the chemical accepts responsibility for the ownership of the chemical.

All chemical shipments in the Bennett Department of Chemistry are received and processed by the laboratory staff in Room 304 Clark Hall.

Section 3. Chemical Storage

In the event of a chemical spill or fire, incompatible chemicals that are stored in close proximity can mix to produce fires, toxic fumes, and explosions. To protect the laboratory worker, chemicals must be separated and stored according to hazard category and compatibility. Read the MSDS and heed the precautions regarding the storage requirements of the chemicals in your laboratory. A detailed compatibility table is included in *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*. http://www.nap.edu/books/0309052297/html

All chemical containers must be properly labeled. To avoid accidents and potentially costly fines from federal regulatory agencies, all secondary container labels should contain:

- Chemical name
- Hazard warnings
- Name of manufacturer
- Name of researcher in charge
- Date of transfer to the vessel

Promptly date all incoming chemical shipments and rotate stock to ensure use of older chemicals. Peroxide-formers should be dated upon receipt and dated again when the container is opened so that the user can dispose of the material according to the recommendations on the Material Safety Data Sheet. Store peroxide-formers away from heat and light in sealed, airtight containers with tight-fitting, non-metal lids. Test regularly for peroxides and discard before expiration dates.

When storing chemicals on open shelves, always use sturdy shelves that are secured to the wall and contain ¾" lips. To avoid accidents, do not store liquid chemicals over five feet in height on the open shelves. Do not store chemicals within 18 inches of the sprinkler heads in the laboratory. Use secondary containment devices (i.e., chemical-resistant trays) where appropriate. Do not store chemicals in the laboratory fume hood. Do not store chemicals on the floor, aisle ways, hallways, areas of egress, or on the bench top. Store chemicals away from heat and direct sunlight.

Only laboratory-grade explosion-proof refrigerators and freezers may be used to store chemicals that require cool storage in the laboratory. The chemicals that are stored in the refrigerator must be placed in sealed and properly labeled containers. Periodically clean and defrost the refrigerator/freezer to ensure maximum efficiency. Never use domestic refrigerators and freezers to store chemicals since they possess ignition sources and can cause dangerous and costly laboratory fires and explosions. Do not store food or beverages in the laboratory refrigerator. Label all refrigerators that contain radioactive materials with the appropriate symbols and warnings. Conduct regular testing and inspections of the refrigerators to ensure that they are not contaminated with radioactive materials.

Highly toxic chemicals must be stored in a well-ventilated, secure area that is designated for this purpose. Cyanides must be stored in a tightly closed container and securely locked in a cool, dry, cabinet. Access to the cabinet must be restricted. Protect cyanide containers against physical damage and separate them from incompatibles. Follow good hygiene practices and regularly inspect your PPE. Use proper disposal techniques.

Hydrofluoric acid (HF) quantities in the laboratory must be kept at a minimum for the planned usage. Personnel must be trained on the proper techniques to handle HF. Calcium gluconate gel (2.5%) must be present in the laboratory for treatment purposes in the event of an exposure. Standard first-aid treatments for acid burns do not apply to an HF exposure. Rinse with cool water for five minutes only, apply the calcium gluconate gel, and immediately seek medical attention.

Ethanol (200 proof, 100%) that is obtained from the departmental Stockroom must be stored in a securely locked cabinet within the laboratory. Minimize quantities and restrict access.

Flammable liquids should be stored in approved flammable liquid containers and storage cabinets and National Fire Protection Association (NFPA) limits on the quantity of flammables per cabinet, lab space, and building must be observed. Store odiferous materials in ventilated cabinets. Chemical storage cabinets may be used for long-term storage of limited amounts of chemicals.

Rooms that are used specifically for chemical storage and handling (i.e., prep rooms, storerooms, waste collection rooms, and laboratories) are controlled-access areas. Chemical storage rooms should be professionally designed and must provide proper ventilation, two means of access/egress, vents and intakes at both ceiling and floor levels, a diked floor, and automatic water sprinklers (with the exception of water-reactive chemical storage). The chemical storage room must be a spark-free environment and one must use only spark-free tools within the room. Special grounding must be installed to prevent static charge while dispensing solvents.

Section 4. Chemical Handling

Important information about handling chemicals can be found in the Material Safety Data Sheets (MSDS). A comprehensive file of Material Safety Data Sheets (MSDS) must be kept on file in the laboratory or be readily accessible online to all employees during all work shifts. Workers should always READ and HEED the label and the Material Safety Data Sheet before using a chemical for the first time. Know the types of PPE that you will be required to wear when handling the chemical. Ensure that the ventilation in the laboratory will be adequate for your needs. Be familiar with the departmental Chemical Hygiene Plan and Emergency Action Plan in the event of a chemical spill, fire, or explosion.

Section 5. Chemical Inventory

Why do we maintain chemical inventories in our labs? The OSHA Lab Standard, Appendix A, Section D.2.b (*Chemical Procurement, Distribution, and Storage*), states, *"Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity"* and Section D.2.d (*Chemical Procurement, Distribution, and Storage*), states, *"Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom."*

What are the benefits of performing annual chemical inventory updates?
•Ensure that chemicals are stored according to compatibility tables.
•Eliminate unneeded or outdated chemicals.
•Ability to share chemicals in emergency situations.
•Update the NFPA 704 posting on the laboratory door.

•Promote more efficient use of lab space.
•Check expiration dates of peroxide-formers.
•Check the integrity of the shelving and storage cabinets.
•Force lab supervisors to make "Executive Decisions" about dusty bottles of chemicals.
•Repair/replace labels and caps.
•Many research groups plan a "clean the lab" day in concert with the inventory update.
•Ensure compliance with all federal, state, and local record keeping regulations.
•Promote good relations and a sense of trust with the community and your emergency responders.
•Reduce the risk of exposure to hazardous materials and ensure a clean and healthy laboratory environment.

The amounts of hazardous materials should be carefully monitored in the laboratory. A physical chemical inventory should be performed at least annually, or as requested by the Chemical Hygiene Officer. A thorough inventory will eliminate unneeded or outdated chemicals and will ultimately result in more efficient use of laboratory storage space. The chemical inventory should include:

- Chemical name
- Chemical Abstract Service number
- Manufacturer
- Owner
- Room number
- Location of chemical within the room

Safety Issues Related to the Chemical Inventory Process
•Wear appropriate PPE and have extra gloves available.
•Use a chemical cart with side rails and secondary containment.
•Use a laboratory step stool.
•Read the Emergency Action Plan and be familiar with the institution's safety equipment.
•If necessary, conduct a work stand down while you perform the inventory.

Section 6. Transportation of Chemicals

Always use a secondary containment device (i.e., rubber pail) when transporting chemicals from the storeroom to the laboratory or even short distances within the laboratory. Use carts with attached side rails and trays of single piece construction at least two inches deep to contain a spill that may occur. Bottles of liquids should be separated to avoid breakage and spills. Never transport liquid chemicals in basket-type carts. Do not overfill carts. Avoid high traffic areas when moving chemicals within the building. Plan your work to avoid class changing times and other times when students are in the hallways. When possible, use freight elevators when transporting chemicals and do not allow other passengers. If you must use a general traffic elevator, ask other passengers to wait until you have delivered your chemicals.

Always ground the drum and receiving vessel when transferring flammable liquids from a drum to prevent a static charge buildup.

To protect faculty, staff, and students, all planned demonstrations and chemistry magic shows that will be performed by chemistry personnel that are not a part of normal instructional activities must be pre-approved and authorized by the Chemical Hygiene Officer. Faculty who are interested in participating in such activities and plan to use

departmental chemicals and apparatus must submit the following information, in writing and two weeks in advance of the planned event, to the Chemical Hygiene Officer:

*The location of the demonstration
*The date of the event
*The age of the intended audience
*The number of persons who will attend the event
*The degree of audience participation
*The demonstrations that will be performed
*A list of chemicals that will be transported to the demonstration site
*The personal protective equipment that will be worn and by whom

All chemicals that are transported to the demonstration site must be handled in a prudent manner, packaged appropriately, properly labeled, and transported back to Clark Hall for disposal via the university chemical waste disposal system. Under no circumstances should any chemicals that originated at the Department of Chemistry be left at the demonstration site or disposed of at the demonstration site. Prior to the planned event, event organizers should ensure that, in the event of an accident involving chemicals in their personal vehicles, they will be covered under their personal insurance policies. Many insurance policies forbid the transport of any chemicals from the workplace in personal vehicles.

The American Chemical Society (ACS) publication, "National Chemistry Week (NCW) and Community Activities Safety Guidelines" provides an excellent resource for personnel who perform demonstrations and magic shows and can be found at the ACS Web site:
http://www.chemistry.org/portal/resources/ACS/ACSContent/ncw/PDF/safetyguidelines.pdf

Submit all chemicals to be shipped outside the department, either domestically or internationally, to the Academic Laboratory Manager III, Room 302 Clark Hall, telephone (304) 293-3435 x6410. The U.S. Department of Transportation oversees the shipment of hazardous materials and will impose significant fines and citations in the event of non-compliance.

Section 7. Chemical Waste

Chemical waste must be processed according to the policies of the institution. Contact the Academic Laboratory Manager III, Room 302 Clark Hall, to obtain the departmental hazardous waste forms. Hazardous waste will be collected on a regular basis by institutional personnel.

All properly labeled chemical waste must be submitted to the laboratory staff in Room 304 Clark Hall. Do not leave waste in the Prep Room without speaking with a laboratory staff member.

Waste containers should be the minimum size that is required. Leave at least two inches of headspace in the liquid container to avoid a build up of gas which can cause a subsequent explosion.

It is the policy of the Eberly College of Arts and Sciences and the C. Eugene Bennett Department of Chemistry that all waste chemicals must be placed in the appropriate waste containers in the laboratories. Do not pour chemicals down the drains or in the wastebaskets.

Chapter 7. Compressed Gas Safety

Section 1. General

All laboratory workers must know and understand the properties, uses, and safety precautions of the gas before using the gas and/or associated equipment. Consult the supplier and the Material Safety Data Sheets for the particular gases being used. The Laboratory Supervisor should provide proper training and instruction for all personnel handling compressed gases. Chemical splash goggles and leather gloves are recommended for handling compressed gas cylinders.

Section 2. Gas Cylinder Handling

Never drag or slide a gas cylinder, even for short distances. Cylinders should be moved by using a suitable hand cart. Securely fasten the cylinder cap prior to transporting a gas cylinder. Never drop cylinders or permit them to strike each other violently. The valve protection cap must be left in place until the cylinder has been secured against a wall or bench, placed in a cylinder stand, or on a cylinder cart and is ready to be used. Cylinders must be secured at all times. Do not tamper with safety devices in valves or cylinders and never permit oil, grease, or other readily combustible substances to come in contact with cylinders, valves, or regulators for oxidizing gases. Do not remove or deface the product identification labels or decals, or change the cylinder color. Never lift a cylinder by the cap. Promptly return empty or unneeded cylinders to the gas cylinder room on the first floor of Clark Hall.

Section 3. Storage of Gas Cylinders

Cylinders should be stored in an upright position. Cylinders should be assigned to a definite, isolated area for storage and the area posted with the names of the gases stored. Separate cylinders of gases belonging to various categories, taking into account the nature of the gases. Segregate full and empty cylinders. The area should be dry, cool, and well-ventilated, and preferably fire-resistant. Keep cylinders protected from excessive temperatures by storing them away from radiators or other sources of heat. Cylinders must be secured while in storage. Open flames are prohibited in oxidant or flammable gas cylinder storage areas. Cylinders containing oxidizers must be separated from flammable gas storage areas or combustible materials by at least 20 feet (6 meters) or by a noncombustible wall. Store only the amount of flammable or toxic gas required for a specific application. Store cylinders containing flammable gases away from other combustible materials. Cylinders containing flammable gases and mixtures should be properly grounded. Store empty and full cylinders separately and arrange full cylinders so that old stock is used first. Ensure that an adequate supply of water is available for first-aid, fire action, or dilution of corrosive material in the event of a spill.

Section 4. Use of Gas Cylinders

The cylinder decal or label is the only positive way to identify the gas contained in a cylinder. Color coding of cylinders is an identification method used for the convenience of the cylinder supplier only. Do not use cylinders as rollers for moving material or other equipment. Never attempt to mix gases in a cylinder. Never transfer gases from one cylinder to another. Never use oxygen as a substitute for compressed air. No part of a cylinder should be subjected to temperatures above 130°F (54°C). Prevent sparks or flames from welding or cutting torches or any other source from coming in contact with cylinders. Do not permit cylinders to come in contact with electrical apparatus or circuits. Use regulators and pressure relief devices when connecting cylinders to systems of lower

pressure service ratings. Only regulators approved for the specific gas should be used. Open the cylinder valve before adjusting the pressure on the regulator. Always open the cylinder valve slowly. Valves should be closed on cylinders and all pressure released from equipment connected to the cylinder at the end of a task or any time an extended nonuse period is anticipated. If a cylinder protective cap is extremely difficult to remove, do not apply excessive force or pry the cap loose with a bar inserted into the ventilation openings. Attach a label or tag to the cylinder identifying the problem and return the cylinder to the supplier. Wrenches should not be used on valves equipped with an handwheel. If the valve is faulty, attach a label or tag to the cylinder identifying the problem and return the cylinder to the supplier. Use only oxygen-compatible threading compounds such as Teflon tape on valve threads for oxygen service.

Section 5. Gas Regulators

1. General

Most regulators are similar in appearance, however, a principle difference occurs at the inlet connection. Inlet connection standards are established by the Compressed Gas Association (CGA). It is important that the inlet connection of the regulator is properly mated with the supply valve connection, as specified by the established standards for the service intended. Checking proper mating will avoid putting the regulator into the wrong service.

2. Selecting a Regulator

Select a regulator which is suited for the particular gas service. CGA valve outlets are noted for each gas and gas mixture and the CGA inlet for the regulator must correspond. Never use regulators with gases other than those for which they were intended.

3. Using a regulator

Identify the regulator. Check the label and the inlet and outlet gauges. Ascertain that the high pressure gauge is suitable for the pressure of the cylinder or source system. Inspect the regulator for evidence of damage or contamination. If there is evidence of physical damage or foreign material inside the regulator, return it to the supplier. Inspect the cylinder valve for evidence of damage. Attach the regulator to the cylinder and tighten the inlet nut securely. Close the regulator by turning the adjusting knob to the full counterclockwise position. The regulator must be closed before opening the cylinder valve.

4. Safety Check the System

Make sure that the regulator adjusting knob is turned fully counterclockwise. Standing with the cylinder valve between yourself and the regulator, place both hands on the cylinder valve and open it slowly, allowing the pressure to rise gradually in the regulator. When the high pressure gauge indicates maximum pressure, open the cylinder valve fully. Always close the cylinder valve when it is no longer necessary to have it open. Do not leave it open when the equipment is unattended or not in operation.

5. Adjusting the Pressure

Turning the adjusting knob clockwise, establish the required use pressure by referring to the low pressure gauge. Make sure that the cylinder valve is easily accessible. Never exchange the discharge (low pressure) gauge for one of lower

pressure. The gauge may rupture if the adjusting knob is unintentionally turned too far.

6. Precautionary Measures

Check diaphragm regulators for creep (leakage of gas from the high pressure side when the low pressure side is turned off). Provide check valves. Gas from a high pressure system may back up, so backpressure protection is needed to prevent damage to a regulator.

7. Removing the Regulator from Service

Close the cylinder valve. Vent the gases in the regulator and/or system, or isolate the system and vent the gases in the regulator by turning the adjusting knob clockwise to make certain that no pressure is trapped inside the regulator. If the gas is flammable, an oxidant, corrosive, or toxic, take appropriate measures to render it innocuous by employing a suitable disposable system before venting the gas to the atmosphere. After relieving all the gas pressure, turn the adjusting knob counterclockwise as far as possible. All low pressure equipment connected to sources of high pressure should be disconnected entirely or, if not, independently vented to the atmosphere as soon as the operation is completed or shut down for an extended period of time. Disconnect the regulator. If the regulator is to remain out of service, protect the inlet and outlet fittings from dirt, contamination, or mechanical damage. Replace the cylinder valve cap.

Section 6. Basic Emergency Action Procedures Involving Gas Cylinders

1. Pre-Emergency Planning

Be prepared. Dealing with compressed gas emergencies begins with planning. An emergency response plan should be developed for the laboratory. As a minimum, the plan should include:

- Emergency telephone numbers
- Emergency response organizational charts
- Emergency procedures
- Listing of key personnel
- Training schedules and documentation
- Hazardous materials lists (including storage locations, quantities, etc.)
- Emergency response equipment lists
- Facility maps

2. Fire Extinguishing Methods

Before working with any flammable material, first notify the Chemical Hygiene Officer about the type of material being handled and the best method to use in fighting that particular kind of fire. If an emergency should occur in which gas is burning, **stop the flow of gas before extinguishing the fire**. If the fire is extinguished before the gas is turned off, an explosive mixture with air may be formed, which could result in more extensive damage. However, if the fire must be extinguished before an immediate shutoff of the gas supply can be accomplished, use carbon dioxide or dry chemical extinguishers. Cool the surrounding area with water spray to prevent ignition of other combustible materials. The possibility of oxidizing gases, nonflammable toxic gases, or nonflammable corrosive gases being present in the area or being involved in a

fire is another important safety consideration. Develop procedures to eliminate or minimize the hazards associated with these products.

3. Handling of Leaking Cylinders

Most leaks occur at the valve used in the top of the cylinder. Areas that may be involved are:

•Valve threads
•Safety device
•Valve stem
•Valve outlet

If a leak develops, immediately notify the Chemical Hygiene Office and effect emergency action procedures. Never attempt to repair a leak at the valve threads or safety device. Consult the supplier for instructions if the leak is located at the valve stem or valve outlet. **The following general procedures are for leaks of minimum size where the indicated action can be taken without serious exposure to personnel.**

- If a leak develops in a cylinder containing flammables, inerts, or oxidants, ensure that there is adequate ventilation to dissipate the gas. Move the cylinder to an isolated area (away from combustible material if it is a flammable or oxidizing gas) and post signs that describe the hazards and state warnings.
- Some corrosives are also oxidants or flammables, adding to the seriousness of the leak. If the product is corrosive, the leak may increase in size as the gas is released. Move the cylinder to an isolated, well-ventilated area and use suitable means to direct the gas into an appropriate chemical neutralizer. Post signs that describe the hazards and state warnings.
- Follow the same procedure for toxic gases as for corrosive gases. Move the cylinder to an isolated, well-ventilated area and use suitable means to direct the gas into an appropriate chemical neutralizer. Post signs that describe the hazards and state warnings.
- If it is necessary to move a leaking cylinder through populated portions of the building, place a plastic bag, rubber shroud, or similar protection over the top and tape it (preferably with duct tape) to the cylinder to confine the leaking gas.
    - Basic action for large or uncontrollable leaks should include the following steps:
    - Notify the Chemical Hygiene Officer
    - Evacuation of personnel
    - Rescue of injured personnel by crews equipped with adequate protective clothing and breathing apparatus
    - Fire-fighting action
    - Emergency repair
    - Decontamination

Section 7. Cryogenics

The temperature used to distinguish between cryogenics and refrigeration depends on the source to which one is referring. Temperatures as low as -150°C (-238°F) are used as the upper limit for defining a fluid as cryogenic. The most commonly used temperature is -73°C (-100°F).

1. General Safety Precautions

As stated above, the potential hazards in handling all cryogenic liquids stem from their two main properties:

- Because they are all extremely cold, cryogenic liquids and their cold "boil-off" vapor can rapidly freeze human tissue, and can cause many common materials such as carbon steel, plastics, and rubber to become brittle or even fracture under stress. Care must also be given to the method of joining (welding, etc.) the materials. Cryogenic liquids in containers and piping at temperatures at or below the boiling point of liquefied air (-194°C or -318°F) can actually condense the surrounding air to a liquid. The extremely cold cryogenic fluids (liquid hydrogen and liquid helium) can solidify air or other gases.
- All cryogenic liquids produce large volumes of gas when they vaporize. If these liquids are vaporized in a sealed container, they can produce enormous pressures which could rupture the vessel. For this reason, pressurized cryogenic containers are usually protected with multiple devices for pressure relief. Common protective devices are pressure relief valves for primary protection and frangible discs for secondary protection. Vaporization of all liquid cryogenics, except oxygen, in an enclosed work area can create an oxygen-poor atmosphere. Vaporization of liquid hydrogen in an enclosed work area can create a flammable mixture with air.
- Personnel should be thoroughly instructed and trained in the nature of cryogenic hazards and the proper steps to avoid them. This should include emergency procedures, operation of equipment, safety devices, knowledge of the properties of materials used, and personal protective equipment required.
- Equipment and systems should be kept scrupulously clean and contaminating materials (oil, grease, etc.) avoided as these may create a hazardous condition upon contact with cryogenic fluids or gases used in the system.
- Mixing of gases or liquids should be strictly controlled to prevent the formation of flammable or explosive mixtures. As the primary defense against fire or explosion, extreme care should be taken to avoid contamination of a fuel with an oxidant or contamination of an oxidant with a fuel.
- When flammable gases are being used, potential ignition sources must be carefully controlled.

2. Handling

Always handle cryogenic liquids carefully. At their extremely low temperatures, they can produce cryogenic burns on the skin and freeze tissues. When spilled on a surface they tend to cover it completely and therefore cool a large area. The vapors from these liquids are also extremely cold and can produce burns. Use both hands when handling cryogenics. Do not use a cell phone when handling cryogenics or allow yourself to be distracted in any other manner.

Exposure to these cold gases which is too brief to affect the skin of the face or hands can affect delicate tissues, such as those of the eyes. Stand clear of boiling or splashing liquid and its issuing cold gas. Boiling and splashing always occur when charging a warm

container or when inserting objects into the liquid. Always perform these operations slowly to minimize boiling and splashing. Never allow any unprotected part of your body to touch uninsulated pipes or vessels containing cryogenic liquids; the extremely cold material may stick fast and tear the flesh when you attempt to withdraw it. Even nonmetallic materials are dangerous to touch at low temperatures. Use tongs to withdraw objects immersed in a cryogenic liquid. In addition to the hazards of frostbite or flesh sticking to cold materials, objects that are soft or pliable at room temperature, such as rubber or plastics, are easily broken because they become hard and brittle at these extremely low temperatures. Carbon steels become brittle at low temperatures and may easily fracture when stressed.

3. Protective Clothing

Chemical splash goggles must be worn during the transfer process and during normal handling of cryogenic liquids. If severe spraying or splashing may occur, a face shield should be worn for additional protection. Dry leather gloves or fiberglass gloves should always be worn when handling anything that comes in contact with cold liquids or vapor. Gloves should be loose fitting so that they can be removed quickly if cryogenic liquids are spilled into them. Depending on the application, special clothing may be advisable. Wear trousers on the outside of shoes. Personnel working with cryogenic fluids should not wear watches, rings, bracelets, and other jewelry.

4. Containers

Cryogenic liquids are stored, shipped, and handled in several types of containers, depending upon the quantity required by the user. The most common containers for laboratory use are the dewar or the liquid cylinder. Since heat leak is always present, vaporization takes place continuously. Rates of vaporization may be as low as 0.4% and as high as 3% of container content per day, depending upon the design of the container and the volume of the stored product. Customized containers must be designed and constructed to withstand the weights and pressures that will be encountered, and adequately ventilated to permit the escape of evaporated gas. They should also be equipped with rupture disks on both inner and outer vessels to release pressure if the safety relief valves should fail. As there is always some gas present when using liquefied gases, container capacity should be designed to include an allowance for that portion which will be in the gaseous state.

- **Dewars**

  This type of container is considered a nonpressurized container. The unit measure of capacity of the dewar is the liter. Five- to 200-liter dewars are available. Product may be removed by pouring from the smaller dewars. Product should be removed from the 50-liter and large capacity dewars by means of low pressurization and a transfer tube. A dust cap over the outlet of the neck tube prevents atmospheric moisture from plugging the neck tube. These containers cannot be used for liquid helium or liquid hydrogen.

Chapter 8 Biological Safety

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1Section 1. Institutional Biohazards Committee

2The Institutional Biohazards Committee (IBC) at West Virginia University oversees all activities which pose a biohazard. Biosafety approval is required for the following activities:

- Activities involving infectious agents of plants, animals and humans
- The use of serum and/or tissue from humans or non-human primates
- Any work involving wild mammals or their tissue
- Creation of transgenic eucaryotes
- Transfection using adenovirus-derived vectors or other vectors capable of infecting human cells.

3 All inquiries regarding biological safety and IBC approval at West Virginia University should be directed to the Director of Institutional Biosafety, (304) 293-7157.

Section 2. General Procedures

Individuals working with biohazards will:

- Follow the requirements of applicable research protocol, SOP, and this CHP.
- Institute biosafety measures consistent with U.S. Department of Health and Human Services, May 1993, "Biosafety in Microbiological and Biomedical Laboratories, most current edition, Public Health Service, Centers for Disease Control and Prevention and National Institutes of Health, Washington, DC.
- Control access to laboratories and field research areas.
- Follow the applicable exposure control plan when the potential for exposure to bloodborne pathogens and other potentially infectious materials exists.
- Ensure that procured items are purchased from qualified suppliers and that items are inspected or certified upon receipt.

Section 3. Engineering and Work Practice Controls

Drawing blood or collecting urine samples for private reasons (i.e., life insurance policies) is prohibited on WVU property. Engineering and work practice controls designed to eliminate or minimize worker exposure shall be implemented. Engineering controls that are used shall be examined, maintained, and replaced on a regular schedule to ensure their effectiveness. Examples of engineering controls include the use of a sharps disposal container and use of a container specially marked for contaminated first-aid materials. Hand-washing facilities shall be provided on each site. If hand-washing facilities are not available, antiseptic hand cleansers or towelettes must be used immediately, followed by soap and running water as soon as possible. Employees shall wash hands immediately after removing gloves or coming in contact with human or animal blood or other potentially infectious materials.

Employees must not eat, drink, smoke, apply cosmetics, use cell phones, or handle contact lenses in areas of potential exposure. Equipment that may have been contaminated with human or animal blood or other infectious materials shall be examined and decontaminated, if feasible. If equipment cannot be decontaminated, it shall be labeled as a biohazard. Information regarding the biohazard shall be communicated to all handling, shipping, and service personnel.

1Section 4. Personal Protective Equipment (PPE)

Use PPE that does not permit human or animal blood or other potentially infectious materials to reach employees' clothes or body under normal conditions and duration of

use. Provide, maintain, and properly dispose PPE at each work area and place it in a regulated container for disposal. Gloves (i.e., latex and/or puncture-resistant gloves) must be worn when exposure to animal, human, or other potentially infectious materials is expected and when contaminated items or surfaces are being handled.
Do not reuse disposable gloves. Replace if torn or punctured or their ability to function as a barrier has been compromised. Wear surgical masks, in combination with eye protection (i.e., chemical splash goggles) when splashes may contaminate eyes, nose, or mouth.

Section 5. Housekeeping and Labeling

Clean and decontaminate all equipment and environmental surfaces after contact with animal, human, or other potentially infectious materials. Place regulated waste in containers that have lids that can be tightly closed, that are constructed to prevent leaks, and that are labeled with biohazard labels and sealed before moving. Dispose of all contaminated laundry as regulated waste or send to a laundry facility where personnel are experienced in handling infectious waste. Complete information regarding the nature of the waste and potential hazards shall be disclosed to the laundry facility. Label all regulated waste with the "Biohazard" label. Label infectious waste containers with appropriate WVU labels for infectious wastes.

Section 6. Biosafety Employee Information and Training -

Annual training shall be provided for those working with biohazards by lab supervisors and/or university personnel from the Biosafety Office (304) 293-7157. Information and training shall include:

0• An accessible copy of OSHA regulation 29 CFR 1910.1030 and explanation of its contents.
1• A general explanation of the epidemiology and symptoms of bloodborne diseases.
2• An explanation of the modes of transmission of bloodborne pathogens.
3• An explanation of the Exposure Control Plan and the means by which an employee can obtain a copy of the written plan.
4• An explanation of the required methods for recognizing tasks and other activities that may involve exposure to animal, human, and other potentially infectious materials.
5• An explanation of the use and limitations of methods that prevent or reduce exposure, including appropriate engineering controls, work practices, and PPE.
6• An opportunity for posing questions to and receiving answers from the person conducting the training session.

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0Section 7. Useful Biological Safety Web Sites

Biosafety in Microbiological and Biomedical Laboratories (BMBL):
http://www.cdc.gov/od/ohs/biosfty/bmbl4/bmbl4toc.htm

West Virginia University Institutional Biohazards Committee (IBC):
http://www.wvu.edu/~rc/ibc/index.htm

For information on Human Immune Deficiency Virus (HIV), Hepatitis B Virus (HBV), and Hepatitis C Virus (HCV):
http://www.cdc.gov/hiv/pubs/facts.htm

http://www.cdc.gov/ncidod/diseases/hepatitis/index.htm

World Health Organization information:
http://www.who.org/

National Institutes of Health "Guidelines for Research Involving Recombinant DNA Molecules":
http://www4.od.nih.gov/oba/rac/guidelines/guidelines.html

Chapter 9 Radiation Safety

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Section 1. Purpose

The Radiation Safety Office of West Virginia University (WVU) is responsible for all laboratories at WVU and WVU Hospitals, Inc. which use radioactive materials as part of their research. Their goal is to ensure that personnel use radioactive materials and dispose of waste safely and in compliance with federal regulations.

Section 2. WVU Radiation Safety Office

The Radiation Safety Office hours of operation are Monday through Friday, 8:00 a.m. to 4:30 p.m. You can contact the Radiation Safety Office at (304) 293-3413 or via Fax at (304) 293-4529. In the event of an emergency, the Radiation Safety staff member on call can be paged at (304) 987-1586.

Section 3. Useful Radiation Safety Web Sites

WVU Radiation Safety Office Web Site
http://www.hsc.wvu.edu/rsafety/

Nuclear Regulatory Commission:
http://www.nrc.gov/

Center for Devices and Radiological Help:
http://www.fda.gov/cdrh/index.html

U.S. Environmental Protection Agency-Radiation:
http://www.epa.gov/radiation/

Chapter 10 Emergency Preparedness

Section 1. Fire Alarm Policy

When a fire alarm sounds in the facility, you must evacuate the laboratory immediately via the nearest exit. Extinguish all flames and turn off all equipment, as appropriate, before exiting. Faculty and teaching assistants must ensure the orderly and expeditious evacuation of the students from the classrooms and laboratories. Personnel who violate this fire alarm policy will be subject to citations and/or arrest by the responding university and city officials.

Section 2. Emergency Safety Equipment

1. A written emergency action plan should be developed and communicated to all personnel in the unit. The plan should include procedures for evacuation, ventilation failure, first-aid, and incident reporting.
2. Fire extinguishers will be made available in the laboratory and will be tested on a regular basis by Facilities Management personnel. If you activate a fire extinguisher for any reason, immediately report the activity to the Chemical Hygiene Officer so that the fire extinguisher will be replaced in a timely manner.
3. Eye wash stations will be made available and inspected on a regular basis by departmental personnel.
4. Safety showers will be made available and tested routinely by departmental personnel.
5. Fire blankets will be made available in the laboratory, as required. Fire blankets are used to wrap a burn victim to douse the flames. They are also useful to cover a shock victim and for warmth and to provide a privacy shield when treating a victim under a safety shower in the event of a chemical spill.
6. Access to fire alarms and telephones will be made available for emergency use.
7. Maintain clear pathways to fire extinguishers, eye wash stations, fire blankets, first-aid kits, and safety showers.

Section 3. Chemical Spill Policy

Laboratory personnel should be familiar with the chemical, physical, and toxicological properties of each hazardous substance in the laboratory. Consult the label and the Material Safety Data Sheet prior to the initial use of each hazardous substance. Personal protective equipment should be used that is appropriate to the degree of hazard of the chemical in use. Always use the minimal amount of the chemical and use caution when transporting the chemical. In the event of an accidental chemical release or spill, personnel should refer to the following general guidelines. Consult the Chemical Hygiene Officer if you should have any questions regarding the following guidelines.

Low flammability and low toxicity materials that are not volatile (e.g., inorganic acids and caustic bases)

1. Decontaminate any victims with the nearest safety shower, eyewash, or other appropriate action as described in the Material Safety Data Sheet.
2. Immediately notify the Chemical Hygiene Officer.
3. Wear personal protective equipment that is appropriate to the degree of hazard of the spilled substance.
4. Using chemical spill kits that contain an inert absorbent, clean up the affected area if this action can be accomplished without risk of additional injury or contamination to personnel. If the spill is located on the laboratory floor, be aware that some absorbents can create a slipping hazard.

5. Dispose of contaminated materials according to departmental policy.
6. Complete an incident report and submit it to the Chemical Hygiene Officer.

Flammable solvents of low toxicity (e.g., diethyl ether and tetrahydrofuran)

1. Decontaminate any victims with the nearest safety shower, eyewash, or other appropriate action as described in the Material Safety Data Sheet.
2. Alert all other workers in the laboratory and the general vicinity of the spill.
3. Extinguish all flames and turn off any spark-producing equipment. If necessary, turn off the power to the laboratory at the circuit breaker. However, the ventilation system must remain operational.
4. Immediately notify Chemical Hygiene Officer.
5. Wear personal protective equipment that is appropriate to the degree of hazard of the spilled substance.
6. Using spill pillows or spill absorbent and non-sparking tools, soak up the solvent as quickly as possible. Be sure to soak up chemicals that have seeped under equipment and other objects in the laboratory. If the spill is located on the laboratory floor, be aware that some absorbents can create a slipping hazard.
7. Dispose of contaminated materials according to departmental policy.
8. Complete an incident report and submit it to the Chemical Hygiene Officer.

Highly toxic materials (e.g., dimethylmercury and hydrofluoric acid)

1. Alert all other workers in the laboratory and the general vicinity of the spill and immediately evacuate the area.
2. Decontaminate any victims with a safety shower or eyewash in a safe location. Take other appropriate decontamination action as described in the Material Safety Data Sheet.
3. Immediately notify the Chemical Hygiene Officer.
4. Do not attempt to clean up the spill. EHS personnel will evaluate the hazards that are involved with the spill and will take the appropriate actions.
5. Only EHS personnel and appropriate outside industrial hygienists are authorized to decontaminate the area and dispose of the contaminated waste.
6. Complete an incident report and submit it to the Chemical Hygiene Officer.

Section 4. Accident Procedures

1. Immediately notify the Chemical Hygiene Officer. Following the incident, the employee must complete a Supervisor's Injury/Illness Report (included in Appendix C) and submit it to the Chemical Hygiene Officer. Provide a copy of the appropriate MSDS to the attending physician, as needed.

Cuts: If the injured person has experienced a minor cut, flush the wound with tepid running water to remove any possible chemical contaminants. If there is a cut on a gloved hand, remove the glove after thoroughly washing the affected area to avoid contamination of the cut with chemicals. Apply a bandage and advise the victim that he or she should report any signs of infection to a physician. If there is a possibility that the wound is contaminated by broken glass or chemicals, the victim should seek immediate medical attention.

If the injured person has experienced a more serious injury (if sutures will be necessary) call 911 and apply sterile gauze pads to the wound. If necessary, apply direct pressure to the wound to stop the bleeding.

Apply additional pads if the blood soaks through the first sterile pad. If bleeding continues, encourage the victim to lie down and elevate the wound area to a position above the victim's heart. If you are unable to stop the bleeding, remain calm and carefully explain the situation to the dispatcher at 911. The dispatcher will advise you on further action.

Thermal Burns: **Do not apply ointments or ice to the wound.** For first-degree wounds, flush with copious amounts of tepid running water. Apply a moist dressing and bandage loosely.
For second degree (with open blisters) and third degree burns, do not flush with water. Apply a dry dressing and bandage loosely. Immediately seek medical attention.

HF Exposure: Hydrofluoric acid (HF) is an extremely corrosive liquid that can cause severe injury via skin and eye contact, inhalation, and ingestion. HF readily penetrates the skin and causes decalcification of the bones. Laboratory workers should be familiar with first-aid procedures for HF exposure before beginning work with HF. Calcium gluconate gel (2.5% w/w) must be readily accessible in work areas where any potential HF exposure exists. **In the event of contact with HF, first-aid must be started within seconds.** In the event of an HF exposure on skin, immediately flush the exposed area with tepid water, remove contaminated clothing, and call 911. Apply the calcium gluconate gel after 5 minutes of flushing with water. If the calcium gluconate gel is unavailable, continue flushing the exposed areas with water until medical assistance arrives. If HF is splashed in the eyes, immediately flush for 15 minutes, holding the eyelids apart, and call 911. If ingested, call 911 immediately. If the vapor is inhaled, move the victim to fresh air and call 911.

Chemical Burns: Immediately flush the area with tepid running water for 15 minutes.Place the victim in the safety shower, if necessary, before removing any jewelry, contaminated clothing, and shoes. **Do not apply ointments, baking soda, ice, or gauze coverings to the wound.** Seek immediate medical attention.

Eye Contact: Flush eyes with tepid water for 15 minutes and seek immediate medical attention.

Ingestion: **DO NOT WASTE TIME.** Call 911. Do not encourage vomiting except under the advice of a physician. **Call the Poison Control Center immediately and consult the MSDS for the appropriate action.**
POISON CONTROL CENTER: 1-800-222-1222
Save all chemical containers and a small amount of vomitus, if possible, for analysis. Stay with the victim until emergency medical assistance arrives.

Unconsciousness: Call 911. If it is safe for you to enter the area, place the victim on his or her back and cover with a blanket. Do not attempt to remove the victim from the area unless there exists an immediate danger. Clear the

area of any chemical spill or broken glassware. If the victim begins to vomit, turn the head so that the stomach contents are not aspirated into the lungs.

Convulsions: Call 911. If it is safe for you to enter the area, remove anything that might cause harm to the victim. Clear the area of any chemical spills or broken glassware. If the victim begins to vomit, turn the head so that the stomach contents are not aspirated into the lungs. Try to protect the victim from further danger with as little interference as possible.

First Aid for Cold Burns:

Tissue contact with cryogenic liquids produces damage similar to that associated with thermal burns and causes severe deep freezing with extensive destruction of tissue. Flush affected areas with large volumes of tepid water (41-46 °C [105-115°F]) to reduce freezing. If it is not in the area involved, loosen any clothing which may restrict circulation. Do not apply heat. Cover the affected area with a sterile protective dressing or with clean sheets if the area is large, and protect the area from further injury. Seek medical attention promptly. Note that frozen tissues are painless and appear waxy with a pallid yellow color. Tissues become painful and edematous upon thawing and the pale color turns to pink or red as circulation of blood is restored. Tissues which have been frozen show severe, widespread cellular injury and are highly susceptible to infections and additional trauma. Therefore, rapid rewarming of tissues in the field is not recommended if transportation to a medical facility will be delayed.

Appendix A References

1. ANSI Z87.1-2003; American National Standard, *Occupational and Educational Personal Eye and Face Protection Devices*; American Society of Safety Engineers: Des Plaines, IL, 2003.
2. ANSI Z358.1-2004; *Standard for Emergency Eyewash and Shower Equipment*; American National Standards Institute: New York, NY, 2004.
3. National Fire Protection Association, NFPA 30: *Flammable and Combustible Liquids Code*; Quincy, MA, 2000 edition.
4. National Fire Protection Association, NFPA 45: *Standard on Fire Protection for Laboratories Using Chemicals*; Quincy, MA, 2000 edition.
5. National Fire Protection Association, NFPA 704: *Standard System for the Identification of the Hazards of Materials for Emergency Response*; Quincy, MA, 2001 edition.
6. Occupational Safety and Health Administration*, Occupational Exposure to Hazardous Chemicals in Laboratories*; 29 CFR; Part 1910.1450, 1990. http://www.osha.gov
7. *Prudent Practices in the Laboratory, Handling and Disposal of Chemicals*; National Research Council; National Academy Press: Washington, D.C., 1995.
http://www.nap.edu/books/0309052297/html
8. *Safety in Academic Chemistry Laboratories*; 7th edition, American Chemical Society; Washington, D.C., 2003. http://membership.acs.org/c/ccs/pub_3.htm
http://membership.acs.org/c/ccs/pubs/SACL_Spanish.htm
http://membership.acs.org/c/ccs/pubs/SACL_faculty.htm

Appendix B Glossary of Terms

Section 1. Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
BEI	Biological Exposure Indexes
CAA	Clean Air Act
CAS	Chemical Abstracts Service
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
CHEMTREC	Chemical Transportation Emergency Center
CHO	Chemical Hygiene Officer
CHP	Chemical Hygiene Plan
CMA	Chemical Manufacturer's Association
CPSC	Consumer Product Safety Commission
CWA	Clean Water Act
DOE	Department of Energy
DOL	Department of Labor
DOT	Department of Transportation
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FR	Federal Register
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	High Efficiency Particulate Air
HMIS	Hazardous Materials Identification System
IARC	International Agency for Research on Cancer
IDLH	Immediately Dangerous to Life and Health
MSDS	Material Data Safety Sheets
NAS	National Academy of Sciences
NEC	National Electrical Code
NFPA	National Fire Protection Association
NIEHS	National Institute of Environmental Health Sciences
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
NSF	National Science Foundation
NTP	National Toxicology Program
OEL	Occupational Exposure Limit
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PPE	Personal Protective Equipment
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SCUBA	Self-Contained Breathing Apparatus
SOP	Standard Operating Procedures
TLV	Threshold Limit Value

TWA	Time Weighted Average
VOC	Volatile Organic Compounds
WHO	World Health Organization

Section 2. Definitions

Acute Exposure—Short durations of exposure to high concentrations of hazardous materials in the work place.

Allergen—A chemical substance that induces an immediate or delayed adverse reaction by the immune system.

Asphyxiant—A substance that can cause suffocation.

Carcinogen—A substance that causes the development of cancerous growths in humans or is considered capable of causing cancer in humans. A substance is considered a carcinogen if:

1) It has been evaluated by the International Agency for Research on Cancer (IARC) and has been found to be a carcinogen or potential carcinogen;
2) It is listed in the National Toxicology Program's (NTP) *Annual Report on Carcinogens* as a carcinogen or potential carcinogen;
3) It is an OSHA-regulated carcinogen;
4) One study has been published which positively identifies the substance as a carcinogen.

Caustic Material—A material that has a pH greater than 12 and has a corrosive or irritating effect on living tissue at the point of contact.

Chemical Abstracts Service (CAS) Registration Number—A unique number that is assigned to a chemical as a means to identify the material.

Chemical Hygiene Officer—An employee who is qualified, through training, education, and experience, to oversee the implementation of and subsequent reviews of the Chemical Hygiene Plan, per OSHA 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories.*

Chemical Hygiene Plan—A written plan that is designed to protect laboratory workers from occupational exposure to hazardous chemicals, per OSHA 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories.*

Chronic Exposure—Continuous exposure over a long period of time to low concentrations of hazardous materials in the work place.

Chronic Toxicity—Adverse health effects that can be a result of long-term exposure to hazardous materials.

Combustible Material—A substance (solid, liquid, or gas) that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.

Corrosive Material—A substance that has a pH less than 2 or greater than 12 which can cause visible destruction of or irreversible alteration on physical contact with living tissue.

Embryotoxin—A material that is harmful to a developing embryo at a concentration that does not have adverse effects on the pregnant female.

Explosive Material—A material that will exhibit a rapid chemical change when subjected to a suitable ignition source (i.e., detonation, heat, friction, or impact).

Flammable—A term commonly used to describe a gas, solid, vapor, or liquid that easily ignites and rapidly burns.

Flash Point—The lowest temperature at which a flammable liquid produces sufficient vapor to form a readily ignitable mixture with air, either at its surface or in a container.

Hazardous Chemical—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 persons.

Hazard Warning—A label on a chemical container that includes text and/or symbols to convey the hazards of the material.

High Efficiency Particulate Air (HEPA) filter—An air filter that has a 99.97% removal efficiency for 0.03 micron particles.

Immediately Dangerous to Life and Health (IDLH)—The maximum concentration of a hazardous substance from which a worker can escape within 30 minutes without irreversible health effects. IDLH is used to determine respirator selection.

Incompatible Materials—Materials which, when mixed, could result in the formation of toxic gases or hazardous conditions (i.e., an explosion).

Irritant—A substance that produces an inflammatory effect on contact with living tissue.

Lachrymator—A substance that has an irritating or burning effect on skin, eyes, and respiratory tract.

LD_{50}— The single dose (lethal dose) of a substance that will cause the death of 50% of a population of animals. Exposure to the substance is via all routes except inhalation.

Material Safety Data Sheet—A document which contains relevant information about a material, as referenced by OSHA 29 CFR, Part 1910.1200.

Mutagen—A material that produces genetic mutations in chromosomal DNA.

Oxidizing Agent—A substance that may react violently upon contact with reducing materials.

Nonflammable—A material that is not easily ignited; a DOT hazard class for compressed gases that are not classed as flammable gases.

Permissible Exposure Limit (PEL)—The maximum acceptable concentration of a chemical in the work place air. Commonly used exposure limits include TLV-TWA (Threshold Limit Value-Time Weighted Average), STEL (Short-Term Exposure Limit), and C (Ceiling Value).

Personal Protective Equipment (PPE)—Protective equipment (i.e., gloves, chemical splash goggles, laboratory coat or apron, respirators) that is worn by laboratory workers to protect them from direct exposure to hazardous materials.

Physical Hazard—A substance that is a hazard of physical origin (i.e., a burn); a material that is flammable, explosive, water reactive, pyrophoric, or unstable; a combustible liquid, a compressed gas, an organic peroxide, or an oxidizer.

Poison—A substance that may injure or kill an organism, even in relatively low doses.

Pyrophoric Material—Any liquid or solid which will ignite spontaneously in air below 54°C (130°F).

Reactive Material—An explosive material, organic peroxide, pressure-generating material, or water-reactive material that vigorously polymerizes, decomposes, condenses, or becomes self-reactive when subjected to pressure, shock, or temperature changes.

Select Carcinogen—Defined in OSHA 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories,* as a substance that:

1) Is regulated by OSHA as a carcinogen;
2) Is listed by the NTP as "known to be carcinogen";
3) Is listed on IARC lists as Group 1, "carcinogenic to humans"; or
4) Is included on the IARC lists as Group 2A or 2B, "reasonably anticipated to be carcinogen", because it causes statistically significant tumor incidence in animals according to the criteria that are listed in Section 2, Paragraph b.

Stench—Material that emits an extremely offensive odor.

Teratogen—A substance that causes growth abnormalities in embryos.

Threshold Limit Value—The ACGIH term that is used to express the maximum airborne concentration of a substance to which most workers can be exposed during a normal eight-hour work day or normal 40-hour work week with no adverse health effects.

TLV-Ceiling Limit—The exposure concentration of an airborne substance that must not be exceeded at any time.

TLV-Short Term Exposure Limit (STEL)—-The maximum concentration of an airborne substance for a continuous exposure period of 15 minutes, with the following guidelines:

1) There will be a maximum of four 15-minute periods per day.
2) There will be at least 60 minutes between exposure periods.
3) The daily TLV-TWA will not be exceeded.

TLV-Time Weighted Average—The ACGIH term that is used to express the maximum allowable time weighted average concentration of an airborne substance for a normal eight-hour work day or 40-hour work week.

Toxic Material—A poisonous substance which has the ability to cause adverse health effects upon exposure.

Appendix C Supervisor's Injury/Illness Report

For EH&S use only CASE NUMBER :
Hearing Loss: _____ Sharps Injury: _____
Privacy Case: _____ Fatality: _____ Date of Death _____ OSHA Recordable ___ YES ___ NO ___ Reclassified

1. Name of Injured: _____ **2. WVU ID No. (700 xx xxxx):** _____
(Last, Suffix) (First) (Middle) Click here to look up WVU ID
3. Gender: ___ Female ___Male 4. Age_____ **5. Day/Date of Incident** _____ ___/ /_____
6. Time of Incident: ___AM **__**PM __during work __entering work __leaving work __lunch/break
7. Campus Department _____ **8. Assignment #** _____ **9. Job Title**_____

10. Employment Category: (Check one) ___Faculty ___Staff ___Graduate Student ___Student ___Visitor
11. Status: ___Fulltime ___ Part-time ___Temporary
12 Length of Employment: ____years **13 Time in occupation when incident occurred:** ____years

14. Describe Exactly what happened. Include OBJECT or SUBSTANCE that caused harm: (e.g. slipped on wet floor, exposure to cleaning chemicals, cut with carpet knife…*Use the back of this sheet if necessary*).
15 Location of Incident :
(example Engineering Sciences loading dock)

16. Describe the INJURY or ILLNESS and BODY PART(S) affected (e.g. cut on palm of left hand; sprained back.)
17. Was the victim wearing Personal Protective Equipment? (please specify)

18. Was the employee seen by a physician? ___Yes ___No **19. Name of Physician** _____
20. Location of Treatment_____ **21. Was employee in Emergency room?**__Yes __No
22. Was employee hospitalized overnight as a patient? __Yes __No

23.Type of Treatment received: (check type)
_____Set Fracture/broken bone ____Treat Infection _____Stitches/Sutures _____Tetanus Shot _____Surgery _____Prescription ____Physical Therapy (more than once) _____Remove foreign Object from eye
Other
(explain)_____

24. Total lost work days after the day of incident _____ **25. Total days of restricted activity**_____
26. If employee has not returned to work check here _____(*Please fill out "Employee Return-To-Work Notice")*
27. Was Worker Compensation Filed? _____Yes _____No

Employee's Signature _____ **Date**_____

Supervisor's Signature_____**Date**_____

Reviewer's Signature _____ **Date**_____

Eberly College of Arts and Sciences

C. Eugene Bennett
Department of Chemistry

Chemical Hygiene Plan

I have read and understand the Department of Chemistry Chemical Hygiene Plan. I will follow the safety procedures and precautions and incorporate them into my standard operating procedures when working with hazardous materials in the laboratory. If I should have any questions regarding the Chemical Hygiene Plan, I will contact Barbara L. Foster, C. Eugene Bennett Department of Chemistry Chemical Hygiene Officer.

_____ _____

Name (Signature) Date

_____

Name (print)

Return this form to Barbara L. Foster,
Chemical Hygiene Officer, in Room 217 Clark Hall.