LABORATORY SAFETY AND MANAGEMENT

A Handbook for Teaching Assistants

Barbara L. Foster

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A Message from the Safety Director

Welcome to the C. Eugene Bennett Department of Chemistry at West Virginia University. Congratulations on your appointment with our department.

In the Eberly College of Arts and Sciences, safety is our first priority in the academic and research laboratories. We realize that we are preparing our students for their careers in laboratory settings in the health sciences, industry, government, and academia. I encourage each of you to actively teach our students about laboratory safety.

A successful safety program involves the daily commitment of everyone in the department to ensure a safe and healthy environment in which to teach and learn. As a Teaching Assistant, you have the responsibility of fulfilling the laboratory teaching mission of the department. You must also ensure that your students follow all departmental safety rules and regulations while they participate in the laboratory sessions. We must promote a culture of safety in the academic laboratories so that our students will remember the safe laboratory practices that they learn in our department and incorporate them into their professional lives. By promoting safety now, we will have a significant impact on all of the people who will share the future work environments of our graduates.

Please contact me if you should have any questions regarding this handbook or if you would like to discuss any matters relating to laboratory safety. Your contributions to the department's teaching mission are valued and appreciated.

Sincerely,

Barbara L. Foster

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CHAPTER 1

Principles of Laboratory Safety

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 is included in Appendix B of this book.

The OSHA Laboratory Standard definition of a Chemical Hygiene Plan is: "A 'Chemical Hygiene Plan' is 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."[1]

The Eberly College of Arts and Sciences Laboratory Safety Plan (ECAS LSP) was developed to meet the requirements of the OSHA Laboratory Standard.[2] This document 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.

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 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. It should be noted that some persons have developed chemical sensitivities to certain chemicals or types of chemicals. If a student informs you of a particular chemical sensitivity, immediately contact the faculty member in charge of the laboratory to discuss the student's participation in the laboratory. If a student is allergic to latex, the student must immediately inform the faculty member. A latex allergy can lead to a life-threatening medical situation.

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. Students must follow all departmental safety rules and policies to avoid injuries associated with physical hazards.

Safety Data Sheets

Important information about handling a chemical can be found on the label of the chemical container and in the Safety Data Sheet (SDS). The SDS is designed to provide laboratory and emergency personnel with the proper procedures for handling, storage, and disposal of a particular hazardous material. A 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.[3]

For consistency purposes, a 16-section standard format has been established by ANSI [4]:

1. Product Identification
   Provides information about the chemical and the supplier, including:
   - Synonyms
   - Chemical Abstracts Service (CAS) number
   - Molecular weight
   - Chemical formula

2. Composition
   - Ingredients

3. Hazards Identification
   - Emergency overview
   - Health, Flammability, and Instability rating
   - Protective equipment
   - Storage color code

4. First Aid Measures
   - Inhalation
   - Ingestion
   - Skin contact
   - Eye contact
   - Notes to physician

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

Laboratory workers should always READ and HEED the label and the 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 your departmental Emergency Action Plan in the event of a chemical spill, fire, or explosion.

Personal Apparel and Personal Protective Equipment (PPE) in the Laboratory

The Teaching Assistant must wear clothing that covers the legs (long pants or a long skirt), the equivalent of a tee-shirt, shoes that completely cover the feet (not sandals), a lab coat or apron, and approved departmental eye protection. The department will provide a lab coat and eye protection. Long hair must be pulled back. Do not wear dangling jewelry.

The student must wear clothing that covers the legs (long pants or a long skirt), the equivalent of a tee-shirt, shoes that completely cover the feet (not sandals), a lab coat or apron, and approved chemical splash goggles. Long hair must be pulled back and students should not wear dangling jewelry.

Look at your students during every laboratory session to ensure that they are wearing approved chemical splash goggles.[5] Students are not permitted to wear safety glasses. If a student is wearing safety glasses or any other type of unauthorized eye protection, do not allow the student to continue working in the laboratory. The student must leave the laboratory to retrieve or purchase their chemical splash goggles.

Safety Rules for Undergraduate Students

The safety rules for undergraduate laboratories are included in Appendix C, page 52, of this book. Teaching Assistants must become familiar with these rules and enforce the safety rules at all times in the laboratory. Walk around the laboratory room and check on your students to make sure that they are wearing appropriate personal apparel and approved PPE, following the instructions in the lab manual, and working safely in the laboratory. It is the Teaching Assistant's responsibility to ensure that students follow the safety rules at all times in the laboratory.

Laboratory Housekeeping

Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards states, "A definite correlation exists between orderliness and the level of safety in the laboratory."[6] Furthermore, the Handbook of Chemical Health and Safety states, "Most safety experts will agree that the principal cause of laboratory accidents is poor housekeeping."[7] The Teaching Assistant must encourage good housekeeping habits in the laboratory and follow these guidelines:

- Access to aisles, emergency equipment, utilities, and exits should be kept clear.
- Coats, bags, and other personal items should be stored in the appropriate areas, not on the bench tops or on the floor.
- Bench tops and sinks should be clean and free of clutter, broken glass, spilled chemicals, and paper litter.
- Chemical hazards should be maintained at least two inches from the edge of the bench top.
- Students must label all secondary chemical containers.
- There should be no food or drink in the laboratory.
- Drawers and cabinets should be kept closed when not in use.
- Equipment and apparatus should be properly stored when not in use.
- Hoods should be clean and contain only the chemicals that are being used for the work-in-progress.
- Floors should be clean and dry. Promptly wipe up any water spills. Do not store chemicals or other materials on the floor.
- Glass disposal boxes are provided in every laboratory room for the disposal of broken glassware. These boxes are purchased by the department exclusively for the disposal of glass items. Call the Prep Room staff using the intercom if you require assistance to clear an area of broken glass. Do not allow your students to place non-glass items in the glass disposal boxes. Chipped or broken 25mL and 50mL burets and graduated cylinders should be returned to the Stockroom and should not be placed in the glass disposal boxes. Broken thermometers should be reported to the Prep Room staff immediately using the intercom. The Prep Room staff will promptly clean up the spill and dispose of the thermometer. Do not place broken thermometers in the glass disposal boxes. Call the Prep Room on the intercom if the glass disposal box is full and the laboratory staff will provide a new box.
- To avoid costly floods, check to ensure that all hose connections are properly clamped.
- Check for defective or frayed electrical cords on equipment.
- Properly dispose of all chemical wastes.

Using the gloves and sponges that are provided, the Teaching Assistant must clean the bench tops, hoods, and instrument room before the leaving the laboratory. Do not leave a dirty lab. If you find a dirty laboratory when you arrive to teach, complete a "Room Condition Report" (example on page 55) and submit it to the Safety Director. Always set a good example in the laboratory. Follow the safety rules and enforce the safety rules during each laboratory session.

CHAPTER 2

Laboratory Procedures

Check In Procedures

On the day of laboratory Check In, the Teaching Assistant should report to the Stockroom at least fifteen minutes prior to the start of the laboratory session to obtain the necessary packet of forms and a key to open the drawers that have been assigned to his or her students. The key must be returned to the Stockroom Supervisor at the end of the Check In laboratory session. The packet of forms will include the following documents.

1. Check In Sheets (examples on pages 63-72)
2. Desk Condition Reports (example on page 56)
3. Check In Procedures Form for Students (example on page 54)
4. Safety Rules (included in this book on pages 52-53)
5. Contact Lens Documents (example on page 57)

Locks

Each student should find the combination to his or her lock inside the laboratory drawer. The student should test the combination to ensure that it is correct. If the combination is not correct for the lock, the student should record the six-digit number that is on the back of the lock (i.e., 701001 V69) on the Desk Condition Report. The Teaching Assistant must verify that this number corresponds to the number on the back of that student's lock. This verification is designed to avoid confusion and to eliminate the possibility of theft of equipment from nearby drawers. The students are responsible for unlocking their drawers at the beginning of each laboratory session and locking their drawers at the end of each laboratory session.

Check In Sheets, Desk Condition Reports, and Check In Procedures Forms

There will be a Check In Sheet, a Desk Condition Report, and a Check In Procedures Form for each student in your laboratory. The Check In Sheet and Desk Condition Report will be collected by the Teaching Assistant at the end of the Check In laboratory session. Please follow these instructions after distributing the forms to your students.

1. Inform the students that they must complete all informational sections of the Check In Sheet and the Desk Condition Report. It is very important that they fill in all of the spaces provided (i.e., telephone number, lock number).
2. Each student should then follow the instructions on the Check In Procedures Form and begin a physical inventory of the equipment in his or her drawer. Instruct the students to remove all items from the drawers and place the items on the tops of the desks.
3. The student should carefully inspect each item. If an item is in good condition, the student should initial that item on his or her Check In Sheet and place the item back into the drawer. If an item is missing or unsuitable for use, the student should list the item on the Desk Condition Report.
4. When the student has completed the inventory of equipment, the Teaching Assistant must check to confirm that missing items are missing and that broken items are broken. The Teaching Assistant mustthen sign the Desk Condition Report and allow the student to obtain replacement items from the Stockroom, if necessary.
5. When the student has initialed all of the items on the Check In Sheet, the Teaching Assistant must sign this sheet.
6. Upon completion of the Check In procedures, the student must lock the drawer and return the Desk Condition Report and the Check In Sheet to the Teaching Assistant.
7. The Teaching Assistant must collect the Check In Sheet and Desk Condition Report from each student and return these forms to the Stockroom Supervisor at the end of the laboratory session.

Safety Rules and Contact Lens Document

Each student must read and sign the Safety Rules for Undergraduate Students in Chemistry Laboratories (included in this book on pages 52-53) and the Use of Contact Lenses in Chemistry Laboratory document (example on page 57). The Teaching Assistant must sign the documents as a witness for each student and submit the signed documents to the Stockroom Supervisor. Do not allow the students to leave without signing these documents and do not allow them to take these documents out of the laboratory room.

- Do not allow the students to take their Check In forms with them when they leave the laboratory.
- Submit all completed Check In materials to the Stockroom Supervisor at the end of the laboratory session.
- Remind the students that if they drop the course they must check out of their laboratory desks at the next scheduled laboratory session.

Food, beverages, water bottles, chewing gum, smoking and smokeless tobacco are not permitted in the laboratory at any time.

Teaching Assistant Duties During Laboratory

At the Beginning of the Laboratory Session

1. You should arrive at Clark Hall at least fifteen minutes prior to the scheduled start of each laboratory session so that you are available to meet with the faculty member in charge of your laboratory.
2. Obtain your test tube rack or unknowns, if appropriate, from the Prep Room (Room 304 Clark Hall). Take the test tube racks directly to the laboratory room. Do not take the test tube racks into the Main Office, restrooms, or any other nonchemical area of Clark Hall.
3. Check to ensure that all needed reagents and supplies are available in your laboratory. If something is missing, notify the Prep Room on the intercom. Do not send a student to the Prep Room for supplies.
4. Turn the fume hood switch located on the wall by the door to the "BENCH" and "IN USE" settings.
5. Return graded unknown reports to the students.
6. Complete a Room Condition Report (example on page 55) if you found the condition of the laboratory room to be unsatisfactory when you arrived (i.e., benchtops, balance rooms, or hoods were not clean).

During the Laboratory Session

1. The Teaching Assistant must set a good example in the academic laboratory. Always wear appropriate apparel, a laboratory apron or lab coat, and approved safety goggles. Follow all safety rules and regulations. Food and drink are not permitted in the laboratory. Do not chew gum in the lab.
2. You are expected to be present and functioning as a Teaching Assistant at all times during the scheduled laboratory session.
3. It is the Teaching Assistant's responsibility to ensure that the students are wearing their approved safety goggles (not safety glasses), laboratory aprons or lab coats, and proper personal apparel at all times in the laboratory.
4. Ensure that your students follow all departmental safety rules and regulations.
5. Instruct students to turn off their cell phones and personal audio devices and put them away during the lab session. Book bags, jackets, purses, handbags, and other personal items should be stored in the proper area in the laboratory. Do not allow your students to place personal items on the benchtops or in the aisles.
6. Proctor all quizzes that are given during the laboratory session. Turn the individual hoods in the general chemistry labs to discourage any dishonest behavior. Move around the room when students are taking quizzes. Do not remain seated at the front bench. As a safety precaution, always check to ensure that your students have moved the hoods back to the proper operating position after the quiz.
7. Each student is expected to do individual work unless special permission is given by the Instructor.
8. Closely monitor your students' progress. See that each student is properly performing the experiment of the day. Circulate around the room and provide individual assistance. Check to see that your students record all experimental observations in their laboratory manuals.
9. Closely supervise the waste disposal in your laboratory. Students must dispose of liquid and solid wastes in the proper containers. Do not allow your students to place gloves or towels in the solid waste containers.
10. Supervise student activities in the balance rooms to avoid equipment damage.
11. Collect all unknown report sheets and arrange them in order of increasing desk number.
12. The Teaching Assistant should always be aware of personal safety when instructing students. Teaching Assistants can be burned with hot glassware and sustain chemical burns in the teaching laboratories. If a student approaches you with glassware, assume that it is hot and do not touch. Hot glassware looks just like cool glassware.
13. Children are not permitted in the laboratory. If a student brings a child to lab, you must tell the student that departmental policy prohibits the presence of children in the lab. The student must immediately remove the child from the laboratory room. Do not conduct the laboratory session while the child is in the room.

At the End of the Laboratory Session

1. Encourage your students to begin clean up at least fifteen minutes prior to the scheduled end of the laboratory session. Due to Clark Hall laboratory schedules, all students must exit the laboratory room at the end of the scheduled session. Encourage your students to thoroughly wash their hands with soap and water (not hand sanitizer) before they leave the laboratory.
2. All common equipment must be returned to the common equipment containers. Do not allow the students to store the common equipment in their student drawers.
3. Check the sinks to ensure that they contain no debris or solid matter.
4. Turn off all faucets in the room.
5. Check to see that all student drawers are locked.
6. It is the Teaching Assistant's responsibility to thoroughly clean the laboratory before you leave for the day. Clean the balance rooms, side shelves, hoods, front bench, and student benches using the gloves and sponges provided.
7. Place the caps on the reagent bottles and waste containers.
8. Close and lock all windows.
9. Turn off the gas and ventilation switches located by the door.
10. Return the test tube rack to the Prep Room.
11. Submit all student report sheets to the Prep Room Supervisor.
12. You are the last person to leave the laboratory room. Do not under any circumstances leave students unattended in the laboratory.

Check Out Procedures

On Check Out day, the Teaching Assistant must report to the Stockroom Supervisor at least fifteen minutes prior to the start of the laboratory session to obtain the following items.

1. The Check In Sheets that were completed by the students at the beginning of the semester (examples on pages 63-72).
2. Forms to be completed by the Teaching Assistant for each student who is not present for Check Out (example on page 58).
3. An empty box for all locks and tags.
4. A key to open the new locks that will be provided to the Teaching Assistant by the Stockroom Supervisor during the laboratory session. This key must be returned to the Stockroom Supervisor at the end of the Check Out laboratory session.

Each Teaching Assistant should use the following procedures when checking students out of the laboratory.

1. The students should remove the locks from their desks. If a student is not present for Check Out, do not unlock his or her drawer until you are prepared to perform Check Out procedures on the drawer. Place the combination tags on the locks and place the locks in the box on the front bench in your laboratory room. This box will be collected by Stockroom personnel and you will receive a box of new locks to place on the drawers during the laboratory session.
2. The student should take all of the items from the drawer and arrange them on the top of the laboratory desk in the order in which they appear on the Check In Sheet.
3. The student must replace chipped or cracked glassware with suitable items from the Stockroom using a Breakage Report. The Teaching Assistant must ensure that the broken or chipped items are placed in the glass disposal boxes. Chipped or broken 25mL and 50mL burets and graduated pipets must be returned to the Stockroom and should not be placed in the glass diposal boxes.
4. The Teaching Assistant must inspect each piece of equipment as it appears on the Check In Sheet. If the item is suitable, the student should place the item back into the drawer. The Teaching Assistant must then initial that item on the Check In Sheet.
5. When all items have been initialed by the Teaching Assistant and have been returned to the drawer, the Teaching Assistant should then immediately place the combination for a new lock inside the drawer and lock the drawer with the new lock.
6. The Teaching Assistant must sign all Check In Sheets and return them to the Stockroom Supervisor at the end of the Check Out session.
7. If a student is not present for Check Out, the Teaching Assistant must complete the appropriate form (example on page 58). Do not perform Check Out procedures on laboratory desks that were not assigned to your students. You are responsible only for the desks that were assigned to your students on Check In day. If a student in your laboratory room has been excused from Check Out by the Instruc-tor, you will perform Check Out on that student's desk. Return these forms to the Stockroom Supervisor at the end of the laboratory session.

8. Students should submit all surplus items that they find in their drawers to the Teaching Assistant. Ensure that all surplus items from student drawers are returned to the Stockroom.
9. Check the Common Equipment containers before you leave the laboratory and ensure that the Common Equipment containers contain all necessary items.

Intercom System in Clark Hall

Intercom Procedures

- Be polite and courteous.
- Clearly state your need (i.e., accident/injury, more chemicals or solutions needed, need an empty waste container, need more filter paper).
- Be patient. There are 20 academic labs in the Bennett Department of Chemistry that can accommodatea total of approximately 400 students at any given time. The lab staff will respond to your request in a timely manner.
- Do not send students to the Prep Room or Stockroom for supplies or chemicals.
- The Teaching Assistant does not leave the laboratory.

Breakage Reports

The Bennett Department of Chemistry Stockroom personnel maintain careful records of glassware and equipment breakage and replacement. The Teaching Assistant should issue a Breakage Report at any time during the semester if a student requires replacements for glassware or equipment or a lock combination. The student must complete every space provided on the Breakage Report. The Stockroom will not accept incomplete reports due to record-keeping responsibilities. The Teaching Assistant should carefully check the Breakage Report and verify that the student requires the glassware listed on the report. It is very important that the student list the exact size of the item to be replaced (i.e., 125 mL Erlenmeyer flask). Teaching Assistants can obtain blank Breakage Reports from the Stockroom Supervisor. The Teaching Assistant should maintain a supply of these reports throughout the semester. Do not leave these reports on the front bench of the laboratory. Never send a student to the Stockroom to obtain blank Breakage Reports during the laboratory session. The Stockroom Supervisor will not issue these reports to students. If a student requires the combination to his or her lock, the Teaching Assistant must verify that the number written on the Breakage Report corresponds to the number on the back of the student's lock.

Lost and Found Items

All personal belongings left by students in the laboratory room should be taken to the Bennett Department of Chemistry Main Office, Room 217 Clark Hall. Instruct your students on the first day of laboratory that they should report to Room 217 to retrieve lost items.

Teaching Assistant Prep Labs

The department provides prep laboratories for all first year Teaching Assistants to facilitate your transition from student to teacher. Your attendance is mandatory at these sessions and you will be notified of the date and time of the weekly laboratory sessions at the beginning of each semester. During the prep labs, Teaching Assistants perform the laboratory experiment that their students will be performing the following week. Teaching Assistants learn first-hand about specific safety precautions and laboratory methods so that they can more effectively teach their students in the laboratories. You will also become familiar with the chemical waste procedures for each lab experiment.

Teaching Assistant Meetings

The department holds weekly Teaching Assistant meetings to discuss the upcoming experiments and safety-related issues. The faculty member in charge of the meetings will provide tips for you to write on the blackboard for your students during lab. You should take careful notes at the weekly meetings and ask any questions that you might have regarding the laboratory program. You will find that these meetings provide an excllent forum for you to ask questions and to speak with veteran Teaching Assistants about teaching labs. Your attendance is mandatory at the meetings. You should always be punctual and attentive at the meetings. If you cannot attend a meeting for any reason, you must contact the Instructor in charge of the meetings to inform him or her of your absence. There will be a sign up sheet for each meeting. Teaching Assistant attendance records will be provided to the Chair and to the Safety Director.

Teaching Assistant Illnesses or Absences

You must inform the Instructor of the laboratory course if you cannot be present for a laboratory session. If an absence is anticipated due to personal illness or emergency, it is your responsibility to make prior arrangements for a substitute. Complete a Teaching Assistant Absence Form (example on page 61) and submit the completed form in a timely manner to the Safety Director.

Teaching Assistant Evaluations and Awards

Each Teaching Assistant is evaluated by the Instructor (example on page 60) and by his or her students (example on page 62) at the end of each semester. Outstanding Teaching Assistants are recognized at the C. Eugene Bennett Department of Chemistry Honors Day Program (held at the end of the spring semester) and awards are presented on the basis of these evaluations. A special award, the Forrest Ferrell Award, is presented at the Honors Day Program by the Safety Director to the Teaching Assistant who consistently enforces the departmental safety rules and best demonstrates, through his or her teaching methods and practices, concern and respect for the laboratory teaching facilities in Clark Hall.

Encourage a culture of safety and safe work practices in your laboratory.

Set a good example every day by following the safety rules, enforcing the safety rules, and providing a safe and healthy learning environment for your students.

CHAPTER 3

Chemical Management

Introduction

The prudent management of hazardous materials, from their procurement to their disposal, is a critical element of a successful laboratory safety program.[8] The laboratory staff handle most aspects of chemical management within the academic laboratories. As a Teaching Assistant, your main responsibilities will focus on chemical handling and chemical waste in the laboratories. However, as a graduate student, you will eventually become familiar with all of the processes that are involved with proper chemical management. 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

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? Check the departmental chemical inventory to determine if the chemical is listed on the inventory for another laboratory.
- 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's waste vendor accept this chemical as waste? 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), "Information on proper handling, storage, and disposal should be known to those who will be involved before a substance is received."[9] Additionally, Section D.2.a (Chemical Procurement, Distribution, and Storage; Procurement) states, "Only containers with adequate identifying labels should be accepted. Ideally, a central location should be used for receiving all chemical shipments."[10] Only authorized personnel should purchase chemicals and other hazardous materials, such as gas cylinders. Most institutions have formal, specific payment policies in place to prohibit unauthorized purchases of chemicals.

All chemical shipments in the Bennett Department of Chemistry are received and processed by the laboratory staff in Room 304 Clark Hall. Trained laboratory personnel should receive and open chemical shipments in a properly ventilated laboratory or a prep room. Office personnel in an office environment or other public areas should not receive or open chemical shipments.

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 SDS 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 Management of Chemical Hazards.[11]

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.

Highly toxic chemicals should 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, secure 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. Minimize quantities and restrict access.

Flammable liquids should be stored in approved flammable liquid 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.

Chemical Handling

Important information about handling chemicals can be found in the Safety Data Sheets (SDS). A comprehensive file of Safety Data Sheets (SDS) 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 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 Emergency Action Plan in the event of a chemical spill, fire, or explosion.

Chemical Inventory

Why do we maintain chemical inventories in our labs? The OSHA Lab Standard, Appendix A, Section D.2.a (Chemical Procurement, Distribution, and Storage - Chemical Inventory), states, "Prudent management of chemicals in any laboratory is greatly facilitated by keeping an accurate inventory of the chemicals stored." and "Unneeded items should be discarded or returned to the storeroom."[12]

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.

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.

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.[13] The hazard diamond provides information on the degree of danger for health hazards, fire hazards, and instability hazards.

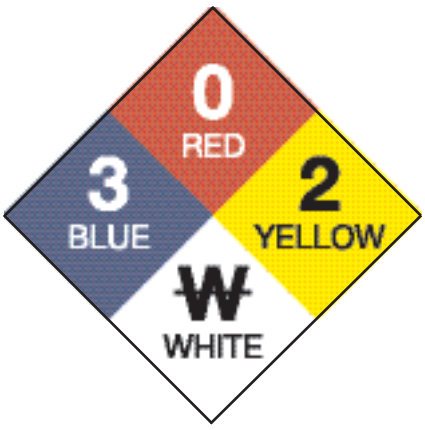
The NFPA hazard diamond is commonly displayed on chemical labels, secondary container labeling in the academic laboratories, and on the SDS. Additionally, it is posted on the laboratory door or other highly visible locations. When posted on the laboratory door, the numerical ratings refer to the contents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

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



NFPA
Hazard Diamond
for Sulfuric Acid
CAS #7664-93-9
NFPA 704 (2007)

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.

All chemicals that are transported to off-site events must be handled in a prudent manner, packaged appropriately, labeled properly, and returned to the department for disposal via the institutional waste policies.

The American Chemical Society (ACS) publication, "National Chemistry Week (NCW) and Community Activity Safety Guidelines" provides an excellent resource for personnel who perform demonstrations and magic shows and can be found at the ACS Web site.

Chemical Waste
Chemical waste must be processed according to the policies of the institution. Waste must be properly labeled, stored in approved screw-cap containers, and stored in the designated waste room after collection from the academic laboratories. Waste containers should be the minimum size that is required. Solid wastes should be discarded in the bottle labeled "Solid Waste Only" in the hood. Do not allow your students to place gloves or towels in the solid waste containers. Liquid wastes should be discarded in the bottle labeled "Liquid Waste Only" in the hood. Leave at least two inches of headspace in the liquid container to avoid a build up of gas which can cause a subsequent explosion. Place used weigh boats and filter paper in the laboratory containers that are marked for this purpose. If you need an empty waste bottle, call the Prep Room via the intercom. Do not send a student to the Prep Room to obtain waste bottles. Sinks should be kept clear of all debris, chemical waste, and solid waste matter. 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 allow your students to pour chemicals down the drains or in the wastebaskets.

CHAPTER 4

Emergency Preparedness

Emergency Procedures in the Academic Laboratories

Injury or Illness

If a student is injured or becomes ill during your laboratory session, immediately call the Prep Room on the intercom. Do not send the sick or injured student out of the laboratory room and you should not leave the laboratory room. The Prep Room Supervisor will then inform the Safety Director. Personnel who are trained in first aid will report to your laboratory. Most of the injuries in the teaching laboratories involve cuts, chemical burns, and burns that result from contact with hot glassware and equipment.

If a student splashes chemicals in his or her eyes, flush the eyes with the emergency eyewash for at least 15 minutes. Place injuries that involve thermal burns, chemical burns, or cuts under cool running water for at least 15 minutes, or until the laboratory personnel arrive. Use the safety shower for chemical accidents that involve areas of the body that cannot be flushed at the sink or by using the eyewash station. Remove the student's clothing after the student is standing under the running water in the shower.

All student injuries, however slight, must be reported to the Safety Director by completing an Accident Report Form (example on page 59). A packet of blank Accident Report Forms is located in each laboratory room. This form must by completed by the Teaching Assistant, not by the student. The completed form must be filed with the Safety Director on the day of the accident, or if necessary, the morning after the accident. Do not leave the Accident Report Form in the laboratory room. Submit the form to the Safety Director within 24 hours of the incident.

Each Teaching Assistant must become familiar with the safety equipment in each laboratory room in which he or she is assigned and know the locations of the fire extinguisher, fire blanket, eye wash station, and safety shower.

Fire Alarm Policy

If a fire alarm sounds in Clark Hall during your laboratory session, you must follow the evacuation directions that are posted by the laboratory door and proceed with an immediate and orderly evacuation of your students from the laboratory. Do not use the elevator. Extinguish all flames and turn off the main gas switch by the door as you exit the room. All students on the first floor, including students with ambulatory disabilities, must exit the building at the rear entrance of Clark Hall, near the Wise Library. Students on floors 2-4 must use the stairs and exit the front of the building, proceed across Prospect Street, and wait on the sidewalk across the street until the Teaching Assistant has been notified by a member of the laboratory staff that the students may return to their classrooms and laboratories. Students with disabilities on floors 2-4 who must routinely utilize the elevators to move from floor to floor should cross the connecting bridge to the Chemistry Research Laboratory Building (CRL). If the CRL fire alarm is also activated, the student should wait in the elevator lobby until trained rescue personnel from the Morgantown Fire Department arrive to evacuate him or her from the building via the stairway. If you are a Teaching Assistant in Room 480 CRL and a fire alarm sounds in the CRL, you and your students should exit the lab in an orderly manner via the stairs. Exit the front entrance of the CRL, proceed across Prospect Street, and wait on the sidewalk until you have been notified by a member of the laboratory staff that you may return to your laboratory room. Do not use the elevator. Notify a lab staff member when you exit the building if one of your students has a disability and is waiting by the elevator for assistance. Students with disabilities in Room 480 CRL who must routinely utilize the elevators to move from floor to floor should cross the connecting bridge to Clark Hall. If the Clark Hall fire alarm is also activated, the student should wait in the elevator lobby on the fourth floor of Clark Hall until emergency personnel arrive to evacuate him or her from the building via the stairway. The Teaching Assistant must notify a laboratory staff member that a student with a disability is waiting by the elevator so that the staff member can inform the Morgantown Fire Department.

Faculty and Teaching Assistants must ensure the expeditious and orderly evacuation of their students from their classrooms and laboratories.Personnel who violate this Fire Alarm Policy will be subject to citations and/or arrest by the responding University and City of Morgantown officials. The Morgantown Fire Department is the presiding authority at the scene. Laboratory staff will be posted at all exits to Clark Hall and will notify you when you can return to your laboratory room.

Pregnancy Policy

If there is a pregnant student in your laboratory, remember that her condition is confidential. The student may seek your advice on whether she should remain in the laboratory. Do not offer your opinion. Tell the student to contact the Safety Director as soon as possible. The Bennett Department of Chemistry has a formal process in place to work with the student and her physician. The Safety Director will send a list of all chemicals and solutions that the student will handle during the semester in the laboratory to the attending physician. The physician and the student will determine the course of action that should be taken by the student (i.e., whether to remain enrolled in the laboratory course or to drop the course.) The Safety Director will contact you regarding any additional safety precautions that should be taken by the pregnant student in your laboratory.

Latex and Chemical Allergies

Latex and chemical allergies can be life-threatening and must be handled appropriately in the laboratory. A chemical allergy is an adverse reaction (i.e., rash or hives) to a chemical (some examples include iodine, bromine, ammonia, chlorine, and sulfur). Such reactions are usually the result of a previous sensitization to that particular chemical, or one that is similar in nature. Latex allergies (i.e., rash or hives, sneezing, shortness of breath, coughing) can be mild or life-threatening in nature. The protein in soft, flexible latex rubber gloves can cause a mild or severe latex allergic reaction in some people. If a student tells you that he or she has either a latex allergy or a chemical allergy, immediately contact the faculty member in charge of the laboratory. The faculty member will work with the student and administration to determine the proper steps to take to reduce the risk of exposure for the student.

Emergency Procedures for an Acid Exposure on the Body

(Note: These procedures do not apply to an exposure to hydrofluoric acid. Follow the instructions on the SDS for hydrofluoric acid exposure and apply the calcium gluconate gel, as directed. Immediately inform the Safety Director. Seek immediate medical attention for an HF exposure.)

If a student spills a corrosive or hazardous material on his or her body:

- Do not panic. Remember your training.
- Do not waste time. Immediately place the victim under the nearest safety shower and flush the affected areas with water for at least 15 minutes.
- Call the Prep Room on the intercom.
- Immediately assist the victim with the removal of all contaminated clothing and jewelry (watch bands and rings can retain the chemical and cause serious burns on the wrist and fingers) while the victim is under the safety shower. After the initial drenching, cover the victim with a fire blanket for privacy and warmth. The first few seconds of your response are critical in determining the degree of injury to the victim. Whenever possible, remove the goggles last to prevent chemical splashes to the eyes.
- Use caution when removing sweaters and tight-fitting clothing. Cut the clothing, if necessary, so that you do not spread the chemical into the face and eyes. Be aware that creases and folds in clothing can trap the acid and promote tissue damage.
- Always protect your skin from chemical exposure as you assist the victim.
- Evacuate the room as soon as possible after the victim is under the safety shower. Send the other students to wait outside of the laboratory room.
- In accordance with ANSI Z358.1, American National Standard for Emergency Eyewash and Shower Equipment, the safety shower must be located in an easily accessible area, free of obstructions, and within 10 seconds in the event of an incident in the laboratory.[14] In the C. Eugene Bennett Department of Chemistry, the safety equipment is inspected on a regular basis by the laboratory staff.
- Use caution. The wet floor can become a very slippery hazard.
- Complete an Accident Report Form and submit it to the Safety Director.

Medical Emergency Action Plan

Should an accident or illness occur in a Chemistry laboratory or classroom involving either a student or an employee, you should take the following action:

Immediately notify the Prep Room staff via the intercom and the Instructor in charge of the course. Remain calm and provide requested information to the Prep Room staff. Listed below are common injuries and illnesses that can occur in a typical chemistry laboratory and treatments required for these injuries. Always wear latex gloves when dealing with any injury.

Cuts

If the injured person has experienced a minor cut, notify the Prep Room via the intercom and the laboratory staff will administer first aid and apply a bandage. When first aid procedures have been completed, complete an Accident Report Form. Submit this form to the Safety Director within 24 hours of the incident. Advise the victim that he or she should report any signs of infection to a physician. If there is a perceived reasonable possibility of contamination of the wound by either chemicals or glassware fragments, the victim should seek medical attention.

If the injury involves a cut that will require sutures, flush the wound with cool running water to remove any possible chemical contaminants and notify the Prep Room via the intercom. Complete an Accident Report Form before the victim leaves the building. Submit this form to the Safety Director within 24 hours of the incident.

Thermal Burns

First and Second Degree Burns (with no open blisters): Immediately flush the affected area with cool running water and maintain this treatment for 15 minutes, or until help arrives. Call the Prep Room on the intercom.

Second Degree Burns (with open blisters) and Third Degree Burns: Do not use water. Call the Prep Room on the intercom.

All Thermal Burns: Do not apply any ointments, ice, or baking soda to the wound. Notify the Prep Room on the intercom. The victim should be advised that a physician should examine all burns, however slight, to prevent infection and to ensure that the victim's tetanus vaccination records are up-to-date. The victim should remain in the building until transportation arrives. Complete an Accident Report Form before the victim leaves the building. Submit this form to the Safety Director within 24 hours of the incident.

Chemical Burns

Immediately flush the affected area with cool running water and maintain this treatment for 15 minutes, or until help arrives. Notify the Prep Room using the intercom. Remove any spilled chemicals or broken glassware from the general area. The victim should remove any contaminated clothing, jewelry, and shoes. Use the safety shower located in each laboratory room, if necessary. DO NOT apply any ointments, baking soda, ice, or gauze coverings to the wound. Complete an Accident Report Form before the victim leaves the building. Submit this form to the Safety Director within 24 hours of the incident.

Unconsciousness

Place the victim on his or her back and cover with a blanket. Do not attempt to otherwise move the victim. Notify the Prep Room using the intercom.Clear the area of any chemical spills or broken glassware. Look for Emergency Medical Information on the victim (i.e., bracelet or necklace). Remain with the victim until an ambulance arrives. If the victim begins to vomit, turn the head so that the stomach contents are not aspirated into the lungs. Complete an Accident Report Form before the victim leaves the building. Submit this form to the Safety Director within 24 hours of the incident.

Convulsions

Notify the Prep Room using the intercom. Remove anything nearby that might cause harm to the victim. 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 danger with as little interference as possible. Look for Emergency Medical Information on the victim (i.e., bracelet or necklace). Remain with the victim until an ambulance arrives. Complete an Accident Report Form before the victim leaves the building. Submit this form to the Safety Director within 24 hours of the incident.

Chemical Ingestion

DO NOT WASTE TIME. Immediately notify the Prep Room staff using the intercom. DO NOT INDUCE VOMITING EXCEPT UNDER THE ADVICE OF A PHYSICIAN. DO NOT follow label directions on the chemicals involved, as the directions are sometimes incorrect and only a physician or Poison Control Center should give advice on actions to be taken after a chemical ingestion. Remain with the victim until the ambulance arrives. Save all chemical containers and a small amount of vomitus (if any) for analysis. Complete an Accident Report Form, listing all known chemicals involved in the ingestion before the victim leaves the building. Submit this form to the Safety Director within 24 hours of the incident.

CHAPTER 5

Laboratory Facilties

General Chemistry Laboratories

The general chemistry laboratories (Chemistry 111, 112, 115, and 116) are located on the first and second floors of Clark Hall and the second floor at the National Research Center for Coal and Energy (NRCCE). Each laboratory room contains six benches with desk space for four students per bench. Each desk space includes an individual student benchtop hood. Twenty-four students can be accommodated in each laboratory room. At desk number one you will find twelve drawers labeled 1-A, 1-B, 1-C, ...1-L. At desk number two the drawers are labeled 2-A, 2-B, 2-C, ...2-L. Each letter represents a series of drawers for the laboratory room (i.e., series "C" would include desks 1-C, 2-C, 3-C...24-C). The common equipment for each student desk is stored in a plastic storage bin under the windows in the laboratory room. The common equipment is used by all students who are assigned that particular desk number. Each common equipment drawer in a general chemistry laboratory room contains the following common equipment.

- Bunsen burner (1)
- Ring clamp (1)
- Ring stand (1)
- Wire gauze (1)
- Sponge (1)
- Rubber tubing (1)
- Buret clamp, single (1)

Each Teaching Assistant is normally assigned a laboratory of twenty-four students. The Teaching Assistant will receive written notice of the drawer series assignments. It is extremely important that you follow the instructions regarding drawer series assignments. If you should have any questions regarding which series to use in your lab, immediately contact the Prep Room Supervisor via the intercom. Teaching Assistants who are assigned to teach general chemistry laboratories must check out laboratory manuals from the Stockroom Supervisor. Teaching Assistants must return their laboratory manuals to the Stockroom Supervisor at the end of each semester.

General Chemistry Prep Room Procedures

The Laboratory Managers prepare all reagents and unknowns that are used in the general chemistry laboratories. All solutions and chemicals that are to be used are placed in the laboratories by the laboratory staff prior to the beginning of the laboratory session. Always inspect your supply of solutions and chemicals for each laboratory session and immediately report any shortages to the Prep Room via the intercom system. Never send a student to the Prep Room to obtain supplies. The Prep Room staff will not dispense solutions and chemicals to students. Do not wait until the laboratory session begins to check your supplies. Reagents in the Nalgene carboys should be placed on the stands that are provided in the hoods. All reagent bottles must be kept in the hoods at all times. Do not allow the students to remove the reagent bottles from the hoods. Caution your students to take only what they need from the bottles since the Prep Room Supervisors have allotted the appropriate amounts of solutions per laboratory room. Instruct your students to dispense concentrated acids and bases into beakers (not test tubes) to avoid spilling the corrosive materials. In the event of a medical or chemical emergency, immediately notify the Prep Room via the intercom.

General Chemistry Unknowns

Each experiment that will involve the use of an unknown will be marked with an asterisk (*) on the laboratory syllabus. The unknown solutions will be placed in clean, dry test tubes that are provided by the students in your laboratories. It is your responsibility to collect the test tubes from the students one week in advance of the laboratory session involving an unknown.

Obtain a test tube rack from the Prep Room Supervisor on the day of test tube collection. Test tube racks are located on shelves in the Prep Room. The racks are labeled with the Instructor's name, chemistry course, room number, and date and time of laboratory. It is very important that you remember the location of your test tube rack and always return your rack to the proper location. Test tube labels may be obtained from the Stockroom. All test tubes must be clean, dry, and properly labeled. (The Prep Room Supervisors will not aliquot unknowns into test tubes that are contaminated or wet.) The label on each test tube should include Student Name (Last, First), Desk Number, Room Number, and Experiment Number. The test tube rack and properly labeled test tubes should be returned to the assigned location in the Prep Room at the end of the laboratory session. Each test tube rack is designed to accommodate two six-inch test tubes for twenty-four students. Teach your students to place their test tubes in the slots that correspond to their desk numbers.

In some experiments involving unknowns, the student will be required to perform a known experiment before attempting to perform the unknown portion of the experiment. You must insist that all students do the known portion before starting the unknown portion of the experiment. Withhold the unknown from each student until you are satisfied that he or she has satisfactorily completed the known portion. If a student should require more of an unknown, send the student to the Prep Room to obtain a refill.

The students should complete the forms provided in the laboratory manual when reporting the results from their unknowns. The Teaching Assistant must collect these reports at the end of the laboratory session and arrange them in order of increasing desk number. These forms must be submitted to the Prep Room Supervisor at the end of the laboratory session.

Third Floor Laboratories

Analytical chemistry (Chemistry 215) and the honors freshmen chemistry course (Chemistry 117/118) are taught in Rooms 300 and 301 Clark Hall. Physical chemistry laboratory courses (Chemistry 342, 347, and 349) are conducted in Rooms 305 and 313 Clark Hall. The third floor laboratories contain their own Prep Rooms. Students from the third floor laboratories utilize the departmental Stockroom. The Teaching Assistant will receive written notice of the drawer series assignments. If you should have questions regarding your drawer assignments, you should immediately contact the Safety Director in Room 217 Clark Hall. In the event of a medical or chemical emergency, the Teaching Assistant must immediately notify the Prep Room Supervisor via the intercom.

Fourth Floor Laboratories

Chemistry 231, 235, and 236 laboratories are conducted on the fourth floor in Clark Hall in Rooms 401, 403, 409, 413, and 417. Students from the fourth floor laboratories utilize the departmental Stockroom. In the event of a medical or chemical emergency, the Teaching Assistant must notify the Prep Room Supervisor via the intercom. Rooms 401, 403, 409, and 413 each contain two benches with desk space to accommodate eight students at each bench, or a total of 16 students per laboratory room. Each desk space includes a full-size chemical fume hood. The drawer series A-C are located under the fume hoods and the drawer series D-I are located on the benches in each laboratory room. Room 417 can accomodate eight students. The following common equipment items are stored in kits or plastic storage bins located in each laboratory room.

19/22 distilling column (1)
Heating mantle, 250mL (1)
Heating mantle, 100mL (1)
Variac control (1)
19/22 condenser (1)
19/22 100mL round bottom flask (2)
19/22 3-way connecting tube (1)
19/22 250mL round bottom flask (1)
19/22 Claisen connecting tube (1)
19/22 vacuum connecting tube (1)
Thermometer adapter (1)

The following common equipment items are stored in the large cabinet under each chemical fume hood.

- Screw clamp (1)
- Ring stand (1)
- Cork ring (1)
- Tripod (1)
- Condenser tubing (1)
- Hose clamp (1)

The Teaching Assistant will receive written notice of the drawer series assignments for each laboratory section. If you should have questions regarding your drawer assignments, you should immediately contact the Safety Director in Room 217 Clark Hall.

Room 480 Chemistry Research Laboratory Building (CRL)

Chemistry 335, 339, and 423 labs are conducted in Room 480 in the Chemistry Research Laboratory Building. The student drawers in this room are labeled with the corresponding course number. There are 16 chemical fume hoods in this lab; each fume hood is designed to be shared by two students. The common equipment cabinets that are located under the student hoods contain various clamps and tubing. Heating mantles, variac controllers, and lab jacks are stored in cabinets located on the sides of the laboratory room.

Laboratory Equipment

You must teach your students how to properly operate the thermometers, pH meters, centrifuges, balances, and other equipment in each laboratory room. It is your responsibility to ensure that the equipment in the laboratories is used properly by the students. Equipment can be seriously damaged or destroyed by improper usage or intentional misuse. You should circulate around the laboratory room and balance room (as appropriate) and closely supervise your students during each laboratory session.

Blunted needles are distributed to the Teaching Assistants in the organic chemistry laboratories for those experiments in which needles are required. If you have questions concerning the use of any equipment, contact the Prep Room Supervisor in charge of your laboratory.

Chemical Fume Hoods

General Chemistry Laboratory Fume Hoods

The general chemistry laboratory hoods are located on the bench tops. At the beginning of the laboratory session, always turn the switch located by the door to the "BENCH" position so that the student hoods will be fully functional. Ensure that the hoods are properly aligned with the ventilation duct that is located on the bench top. The hoods will not work efficiently if they are not aligned properly. Students should perform all experimental work in the student hood.

Organic Chemistry Laboratory Fume Hoods

Each student in the organic chemistry laboratories is provided with a full-size chemical fume hood. When using the hood, the sash opening should be kept at a minimum to maximize 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. Use the hood when working with any flammable liquid or gas. Keep hoods closed when not in use. Do not store chemicals or equipment in a hood where work is performed. Remind the students to keep their heads and bodies outside of the hood face. Do not rely on the hood for protection against explosions. Plan your experiments wisely.

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Appendix A: GLOSSARY

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
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

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 B: OSHA LABORATORY STANDARD

OSHA 29 CFR 1910.1450

Occupational Exposure to Hazardous Chemicals in Laboratories

1910.1450(a)

Scope and application.

1910.1450(a)(1)
This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

1910.1450(a)(2)
Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

1910.1450(a)(2)(i)
For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

1910.1450(a)(2)(ii)
Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

1910.1450(a)(2)(iii)
Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.

1910.1450(a)(3)
This section shall not apply to:

1910.1450(a)(3)(i)
Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.

1910.1450(a)(3)(ii)
Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

1910.1450(a)(3)(ii)(A)
Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

1910.1450(a)(3)(ii)(B)
Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

1910.1450(b)

Definitions

Action Level means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Carcinogen (see select carcinogen).

Chemical Hygiene Officer means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

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 (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

Combustible liquid means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Compressed gas means:
(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

Designated area means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.
Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Explosive means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable means a chemical that falls into one of the following categories:

(i) Aerosol, flammable means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) Gas, flammable means:
(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) Liquid, flammable means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) Solid, flammable means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous chemical means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

Laboratory means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory scale means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sases are a justed during use so that the airflow and the exhaust of air contaminants are not comprmised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii) Multiple chemical procedures or chemicals are used;

(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Medical consultation means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

Organic peroxide means an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an oganic radical.

Oxidizer means a chemical other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Physical hazard means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water-reactive.

Protective laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive toxins means chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

Unstable (reactive) means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Water-reactive means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

1910.1450(c)
Permissible exposure limits. For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

1910.1450(d)
Employee exposure determination —

1910.1450(d)(1)
Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

1910.1450(d)(2)
Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

1910.1450(d)(3)
Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.

1910.1450(d)(4)
Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

1910.1450(e)
Chemical hygiene plan — General. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan).

1910.1450(e)(1)
Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

1910.1450(e)(1)(i)
Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

1910.1450(e)(1)(ii)
Capable of keeping exposures below the limits specified in paragraph (c) of this section.

1910.1450(e)(2)
The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

1910.1450(e)(3)
The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;

1910.1450(e)(3)(i)
Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

1910.1450(e)(3)(ii)
Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

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

1910.1450(e)(3)(iv)
Provisions for employee information and training as prescribed in paragraph (f) of this section;

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

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

1910.1450(a) Scope and application.

1910.1450(a)(1)
This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

1910.1450(a)(2)
Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

1910.1450(a)(2)(i)
For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

1910.1450(a)(2)(ii)
Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

1910.1450(a)(2)(iii)
Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.

1910.1450(a)(3)
This section shall not apply to:

1910.1450(a)(3)(i)
Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.

1910.1450(a)(3)(ii)
Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

1910.1450(a)(3)(ii)(A)
Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

1910.1450(a)(3)(ii)(B)
Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

1910.1450(b) Definitions —

Action level means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Carcinogen (see select carcinogen).

Chemical Hygiene Officer means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

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 (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

Combustible liquid means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Compressed gas means: (i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or (ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or (iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

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

Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Explosive means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable means a chemical that falls into one of the following categories:
(i) Aerosol, flammable means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;
(ii) Gas, flammable means: (A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or (B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.
(iii) Liquid, flammable means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.
(iv) Solid, flammable means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:
(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or
(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or
(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)). Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous chemical means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

Laboratory means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.
Laboratory scale means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person.

"Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms. Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:
(i) Chemical manipulations are carried out on a "laboratory scale;"
(ii) Multiple chemical procedures or chemicals are used;
(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and (iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Medical consultation means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

Organic peroxide means an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer means a chemical other than a blasting agent or explosive as defined in 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Physical hazard means a chemical for which there is scientifically valid evidence tat it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water-reactive.

Protective laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive toxins means chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen means any substance which meets one of the following criteria:
(i) It is regulated by OSHA as a carcinogen; or
(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or
(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or (iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: (A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3); (B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or (C) After oral dosages of less than 50 mg/kg of body weight per day.

Unstable (reactive) means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Water-reactive means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

1910.1450(c)
Permissible exposure limits. For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

1910.1450(d)
Employee exposure determination —

1910.1450(d)(1)
Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

1910.1450(d)(2)
Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

1910.1450(d)(3)
Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.

1910.1450(d)(4)
Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

1910.1450(e)
Chemical hygiene plan — General. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan).

1910.1450(e)(1)
Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

1910.1450(e)(1)(i)
Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

1910.1450(e)(1)(ii)
Capable of keeping exposures below the limits specified in paragraph (c) of this section.

1910.1450(e)(2)
The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

1910.1450(e)(3)
The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;

1910.1450(e)(3)(i)
Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

1910.1450(e)(3)(ii)
Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

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

1910.1450(e)(3)(iv)
Provisions for employee information and training as prescribed in paragraph (f) of this section;

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

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

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

1910.1450(e)(3)(viii)
Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

1910.1450(e)(3)(viii)(A)
Establishment of a designated area;

1910.1450(e)(3)(viii)(B)
Use of containment devices such as fume hoods or glove boxes;

1910.1450(e)(3)(viii)(C)
Procedures for safe removal of contaminated waste; and

1910.1450(e)(3)(viii)(D)
Decontamination procedures.

1910.1450(e)(4)
The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

1910.1450(f)
Employee information and training.

1910.1450(f)(1)
The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

1910.1450(f)(2)
Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

1910.1450(f)(3)
Information. Employees shall be informed of:

1910.1450(f)(3)(i)
The contents of this standard and its appendices which shall be made available to employees;

1910.1450(f)(3)(ii)
The location and availability of the employer's Chemical Hygiene Plan;

1910.1450(f)(3)(iii)
The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

1910.1450(f)(3)(iv)
Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

1910.1450(f)(3)(v)
The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.

1910.1450(f)(4)
Training.

1910.1450(f)(4)(i)
Employee training shall include:

1910.1450(f)(4)(i)(A)
Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

1910.1450(f)(4)(i)(B)
The physical and health hazards of chemicals in the work area; and

1910.1450(f)(4)(i)(C)
The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

1910.1450(f)(4)(ii)
The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

1910.1450(g)
Medical consultation and medical examinations.

1910.1450(g)(1)
The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

1910.1450(g)(1)(i)
Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

1910.1450(g)(1)(ii)
Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

1910.1450(g)(1)(iii)
Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

1910.1450(g)(2)
All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

1910.1450(g)(3)
Information provided to the physician. The employer shall provide the following information to the physician:

1910.1450(g)(3)(i)
The identity of the hazardous chemical(s) to which the employee may have been exposed;

1910.1450(g)(3)(ii)
A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

1910.1450(g)(3)(iii)
A description of the signs and symptoms of exposure that the employee is experiencing, if any.

1910.1450(g)(4)
Physician's written opinion.

1910.1450(g)(4)(i)
For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

1910.1450(g)(4)(i)(A)
Any recommendation for further medical follow-up;

1910.1450(g)(4)(i)(B)
The results of the medical examination and any associated tests;

1910.1450(g)(4)(i)(C)
Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and

1910.1450(g)(4)(i)(D)
A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

1910.1450(g)(4)(ii)
The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

1910.1450(h)
Hazard identification.

1910.1450(h)(1)
With respect to labels and material safety data sheets:

1910.1450(h)(1)(i)
Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

1910.1450(h)(1)(ii)
Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

1910.1450(h)(2)
The following provisions shall apply to chemical substances developed in the laboratory:

1910.1450(h)(2)(i)
If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

1910.1450(h)(2)(ii)
If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

1910.1450(h)(2)(iii)
If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labeling.

1910.1450(i)
Use of respirators. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

1910.1450(j)
Recordkeeping.

1910.1450(j)(1)
The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.

1910.1450(j)(2)
The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.

1910.1450(k)
[Reserved]

1910.1450(l)
Appendices. The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation. [55 FR 3327, Jan. 31, 1990; 55 FR 7967, March, 6, 1990; 55 FR 12777, March 30, 1990; 61 FR 5507, Feb. 13, 1996; 71 FR 16674, April 3, 2006]

DEPARTMENT OF LABOR
Occupational Safety and Health Administration

29 CFR Part 1910

Occupational Exposure to Hazardous Chemicals in Laboratories (Non-Mandatory Appendix); Technical Amendment

AGENCY: Occupational Safety and Health Administration (OSHA), Labor.
ACTION: Technical amendment.

SUMMARY: This document updates anon-mandatory appendix in OSHA'sOccupational Exposure to Hazardous Chemicals in Laboratories Standard. The non-mandatory appendix is being updated to include the contents of the latest National Academy of Sciences publication entitled, "Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards," 2011 edition. All revisions being made are minor and non-substantive.
DATES: The effective date of this technical amendment to the standard is January 22, 2013.

For Further Information Contact:
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Supplementary Information:
Background
When the OSHA Laboratory Standard was published in 1990, the nonmandatory Appendix A was based on the 1981 edition of "Prudent Practices for Handling Hazardous Chemicals in Laboratories" and the 1983 edition of "Prudent Practices for Disposal of Chemicals from Laboratories," both published by National Academy Press. Since then, there have been many changes in the culture of safety in laboratories. The National Academies of Science (NAS) recognized these changes and has revised and updated its earlier "Prudent Practices," reflected in the 2011 edition of "Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards" (National Academies Press). The 2011 edition of "Prudent Practices" is being used by OSHA as the basis for nonmandatory Appendix A because of its wide distribution and acceptance and because of its preparation by recognized authorities in the laboratory community. OSHA has reviewed the 2011 edition and collaborated with the NAS to revise non-mandatory Appendix A. This new revision addresses current laboratory practices, security, and emergency response, as well as promoting safe handling of highly toxic and explosive chemicals and their waste products.

Inapplicability of Public Notice and Delayed Effective Date Requirements
Section 553 of the Administrative Procedure Act (APA), 5 U.S.C. 553(b)(3)(B), provides that, when an Agency for good cause finds that notice and public procedure are impracticable, unnecessary or contrary to the public interest, the Agency may issue a final rule without providing notice and an opportunity for public comment. OSHA has determined that there is good cause, pursuant to 5 U.S.C. 553(b)(3)(B), Section 6(b) of the Occupational Safety and Health Act of 1970 (29 U.S.C. 655(b)), and 29 CFR 1911.5, for making this technical amendment final without prior proposal and opportunity for comment because the amendment does not modify or revoke existing rights or obligations, and does not establish new rights or obligations. Its revisions are non-mandatory and disseminated for informational purposes only. For the same reasons, the Agency finds good cause under 5 U.S.C. 553(d)(3) to make the amendments effective upon publication.

List of Subjects in 29 CFR Part 1910
Occupational safety and health, Laboratories.

Authority and Signature
David Michaels, Ph.D., MPH, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, 200 Constitution Avenue NW., Washington, DC 20210, authorized the preparation of this document.

David Michaels,
Assistant Secretary of Labor for Occupational Safety and Health.

Accordingly, OSHA is amending 29 CFR part 1910 by making the following technical amendment:

Part 1910—Occupational Safety And Health Standards
Subpart Z—[Amended]
1. The authority citation for Part 1910 Subpart Z continues to read as follows:

Authority: Sections 4, 6, and 8 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), 9–83 (48 FR 35736), 1–90 (55 FR 9033), 6–96 (62 FR 111), 3–2000 (65 FR 50017), or 5–2007 (72 FR 31159), 4–2010 (75 FR 55355) or 1–2012 (77 FR 3912), as applicable; and 29 CFR part 1911.

All of subpart Z issued under section 6(b) of the Occupational Safety and Health Act of 1970, except those substances that have exposure limits listed in Tables Z–1, Z–2, and Z–3 of 29 CFR 1910.1000. The latter were issued under section 6(a) (29 U.S.C. 655(a)).

Section 1910.1000, Tables Z–1, Z–2 and Z– 3 also issued under 5 U.S.C. 553, but not under 29 CFR part 1911 except for the arsenic (organic compounds), benzene, cotton dust, and chromium (VI) listings.

Section 1910.1001 also issued under section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704) and 5 U.S.C. 553.

Section 1910.1002 also issued under 5 U.S.C. 553, but not under 29 U.S.C. 655 or 29 CFR part 1911. Sections 1910.1018, 1910.1029, and 1910.1200 also issued under 29 U.S.C. 653.

Section 1910.1030 also issued under Pub. L. 106–430, 114 Stat. 1901. Section 1910.1201 also issued under 49 U.S.C. 1801–1819 and 5 U.S.C. 533.

2. Amend 1910.1450 by revising Appendix A to read as follows:
1910. 1450 Occupational exposure to hazardous chemicals in laboratories.

Appendix A To 1910.1450 — National Research Council Recommendations Concerning Chemical Hygiene In Laboratories (Non-Mandatory)

To assist employers in developing an appropriate laboratory Chemical Hygiene Plan (CHP), the following non-mandatory recommendations were based on the National Research Council's (NRC) 2011 edition of "Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards." This reference, henceforth referred to as "Prudent Practices," is available from the National Academies Press, 500 Fifth Street NW., Washington DC 20001 (www.nap.edu). "Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by recognized authorities in the laboratory community through the sponsorship of the NRC. However, these recommendations do not modify any requirements of the OSHA Laboratory standard. This appendix presents pertinent recommendations from "Prudent Practices," organized into a form convenient for quick reference during operation of a laboratory and during development and application of a CHP. For a detailed explanation and justification for each recommendation, consult "Prudent Practices."

"Prudent Practices" deals with both general laboratory safety and many types of chemical hazards, while the Laboratory standard is concerned primarily with chemical health hazards as a result of chemical exposures. The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized in order to adapt them for this purpose. However, their sense has not been changed.

Section F contains information from the U.S. Chemical Safety Board's (CSB) Fiscal Year 2011 Annual Performance and Accountability report and Section F contains recommendations extracted from the CSB's 2011 case study, "Texas Tech University Laboratory Explosion," available from: www.csb.gov/.

Culture of Safety

With the promulgation of the Occupational Safety and Health Administration (OSHA) Laboratory standard (29 CFR 1910.1450), a culture of safety consciousness, accountability, organization, and education has developed in industrial, governmental, and academic laboratories. Safety and training programs have been implemented to promote the safe handling of chemicals from ordering to disposal, and to train laboratory personnel in safe practices. Laboratory personnel must realize that the welfare and safety of each individual depends on clearly defined attitudes of teamwork and personal responsibility. Learning to participate in this culture of habitual risk assessment, experiment planning, and consideration of worst-case possibilities—for oneself and one's fellow workers—is as much part of a scientific education as learning the theoretical background of experiments or the step-by-step protocols for doing them in a professional manner. A crucial component of chemical education for all personnel is to nurture basic attitudes and habits of prudent behavior so that safety is a valued and inseparable part of all laboratory activities throughout their career.

Over the years, special techniques have been developed for handling chemicals safely. Local, state, and federal regulations hold institutions that sponsor chemical laboratories accountable for providing safe working environments. Beyond regulation, employers and scientists also hold themselves personally responsible for their own safety, the safety of their colleagues and the safety of the general public. A sound safety organization that is respected by all requires the participation and support of laboratory administrators, workers, and students. A successful health and safety program requires a daily commitment from everyone in the organization. To be most effective, safety and health must be balanced with, and incorporated into, laboratory processes. A strong safety and health culture is the result of positive workplace attitudes— from the chief executive officer to the newest hire; involvement and buy-in of all members of the workforce; mutual, meaningful, and measurable safety and health improvement goals; and policies and procedures that serve as reference tools, rather than obscure rules.

In order to perform their work in a prudent manner, laboratory personnel must consider the health, physical, and environmental hazards of the chemicals they plan to use in an experiment. However, the ability to accurately identify and assess laboratory hazards must be taught and encouraged through training and ongoing organizational support. This training must be at the core of every good health and safety program. For management to lead, personnel to assess worksite hazards, and hazards to be eliminated or controlled, everyone involved must be trained.

A. General Principles

1. Minimize All Chemical Exposures and Risks

Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted. In addition to these general guidelines, specific guidelines for chemicals that are used frequently or are particularly hazardous should be adopted.

Laboratory personnel should conduct their work under conditions that minimize the risks from both known and unknown hazardous substances. Before beginning any laboratory work, the hazards and risks associated with an experiment or activity should be determined and the necessary safety precautions implemented. Every laboratory should develop facility-specific policies and procedures for the highest-risk materials and procedures used in their laboratory. To identify these, consideration should be given to past accidents, process conditions, chemicals used in large volumes, and particularly hazardous chemicals.

Perform Risk Assessments for Hazardous Chemicals and Procedures Prior to Laboratory Work:

(a) Identify chemicals to be used, amounts required, and circumstances of use in the experiment. Consider any special employee or laboratory conditions that could create or increase a hazard. Consult sources of safety and health information and experienced scientists to ensure that those conducting the risk assessment have sufficient expertise.
(b) Evaluate the hazards posed by the chemicals and the experimental conditions. The evaluation should cover toxic, physical, reactive, flammable, explosive, radiation, and biological hazards, as well as any other potential hazards posed by the chemicals.
(c) For a variety of physical and chemical reasons, reaction scale-ups pose special risks, which merit additional prior review and precautions.
(d) Select appropriate controls to minimize risk, including use of engineering controls, administrative controls, and personal protective equipment (PPE) to protect workers from hazards. The controls must ensure that OSHA's Permissible Exposure Limits (PELs) are not exceeded. Prepare for contingencies and be aware of the institutional procedures in the event of emergencies and accidents.

One sample approach to risk assessment is to answer these five questions:

- What are the hazards?
- What is the worst thing that could happen?
- What can be done to prevent this from happening?
- What can be done to protect from these hazards?
- What should be done if something goes wrong?

2. Avoid Underestimation of Risk

Even for substances of no known significant hazard, exposure should be minimized; when working with substances that present special hazards, special precautions should be taken. Reference should be made to the safety data sheet (SDS) that is provided for each chemical. Unless otherwise known, one should assume that any mixture will be more toxic than its most toxic component and that all substances of unknown toxicity are toxic.

Determine the physical and health hazards associated with chemicals before working with them. This determination may involve consulting literature references, laboratory chemical safety summaries (LCSSs), SDSs, or other reference materials. Consider how the chemicals will be processed and determine whether the changing states or forms will change the nature of the hazard. Review your plan, operating limits, chemical evaluations and detailed risk assessment with other chemists, especially those with experience with similar materials and protocols.

Before working with chemicals, know your facility's policies and procedures for how to handle an accidental spill or fire. Emergency telephone numbers should be posted in a prominent area. Know the location of all safety equipment and the nearest fire alarm and telephone.

3. Adhere to the Hierarchy of Controls

The hierarchy of controls prioritizes intervention strategies based on the premise that the best way to control a hazard is to systematically remove it from the workplace, rather than relying on employees to reduce their exposure. The types of measures that may be used to protect employees (listed from most effective to least effective) are: engineering controls, administrative controls, work practices, and PPE. Engineering controls, such as chemical hoods, physically separate the employee from the hazard. Administrative controls, such as employee scheduling, are established by management to help minimize the employees' exposure time to hazardous chemicals. Work practice controls are tasks that are performed in a designated way to minimize or eliminate hazards. Personal protective equipment and apparel are additional protection provided under special circumstances and when exposure is unavoidable.

Face and eye protection is necessary to prevent ingestion and skin absorption of hazardous chemicals. At a minimum, safety glasses, with side shields, should be used for all laboratory work. Chemical splash goggles are more appropriate than regular safety glasses to protect against hazards such as projectiles, as well as when working with glassware under reduced or elevated pressures (e.g., sealed tube reactions), when handling potentially explosive compounds (particularly during distillations), and when using glassware in high-temperature operations. Do not allow laboratory chemicals to come in contact with skin. Select gloves carefully to ensure that they are impervious to the chemicals being used and are of correct thickness to allow reasonable dexterity while also ensuring adequate barrier protection.

Lab coats and gloves should be worn when working with hazardous materials in a laboratory. Wear closed-toe shoes and long pants or other clothing that covers the legs when in a laboratory where hazardous chemicals are used. Additional protective clothing should be used when there is significant potential for skin-contact exposure to chemicals. The protective characteristics of this clothing must be matched to the hazard. Never wear gloves or laboratory coats outside the laboratory or into areas where food is stored and consumed.

4. Provide Laboratory Ventilation

The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by the use of hoods and other ventilation devices. To determine the best choice for laboratory ventilation using engineering controls for personal protection, employers are referred to Table 9.3 of the 2011 edition of "Prudent Practices." Laboratory chemical hoods are the most important components used to protect laboratory personnel from exposure to hazardous chemicals.

(a) Toxic or corrosive chemicals that require vented storage should be stored in vented cabinets instead of in a chemical hood.
(b) Chemical waste should not be disposed of by evaporation in a chemical hood.
(c) Keep chemical hood areas clean and free of debris at all times.
(d) Solid objects and materials, such as paper, should be prevented from entering the exhaust ducts as they can reduce the air flow.
(e) Chemical hoods should be maintained, monitored and routinely tested for proper performance.

A laboratory ventilation system should include the following characteristics and practices:

(a) Heating and cooling should be adequate for the comfort of workers and operation of equipment. Before modification of any building HVAC, the impact on laboratory or hood ventilation should be considered, as well as how laboratory ventilation changes may affect the building HVAC.
(b) A negative pressure differential should exist between the amount of air exhausted from the laboratory and the amount supplied to the laboratory to prevent uncontrolled chemical vapors from leaving the laboratory.
(c) Local exhaust ventilation devices should be appropriate to the materials and operations in the laboratory.
(d) The air in chemical laboratories should be continuously replaced so that concentrations of odoriferous or toxic substances do not increase during the workday.
(e) Laboratory air should not be recirculated but exhausted directly outdoors.
(f) Air pressure should be negative with respect to the rest of the building. Local capture equipment and systems should be designed only by an experienced engineer or industrial hygienist.
(g) Ventilation systems should be inspected and maintained on a regular basis. There should be no areas where air remains static or areas that have unusually high airflow velocities.

Before work begins, laboratory workers should be provided with proper training that includes how to use the ventilation equipment, how to ensure that it is functioning properly, the consequences of improper use, what to do in the event of a system failure or power outage, special considerations, and the importance of signage and postings.

5. Institute a Chemical Hygiene Program

A comprehensive chemical hygiene program is required. It should be designed to minimize exposures, injuries, illnesses and incidents. There should be a regular, continuing effort that includes program oversight, safe facilities, chemical hygiene planning, training, emergency preparedness and chemical security. The chemical hygiene program must be reviewed annually and updated as necessary whenever new processes, chemicals, or equipment is implemented. Its recommendations should be followed in all laboratories.

6. Observe the PELs and TLVs

OSHA's Permissible Exposure Limits (PELs) must not be exceeded. The American Conference of Governmental Industrial Hygienists' Threshold Limit Values (TLVs) should also not be exceeded.

B. Responsibilities

Persons responsible for chemical hygiene include, but are not limited to, the following:

1. Chemical Hygiene Officer

(a) Establishes, maintains, and revises the chemical hygiene plan (CHP).
(b) Creates and revises safety rules and regulations.
(c) Monitors procurement, use, storage, and disposal of chemicals.
(d) Conducts regular inspections of the laboratories, preparations rooms, and chemical storage rooms, and submits detailed laboratory inspection reports to administration.
(e) Maintains inspection, personnel training, and inventory records.
(f) Assists laboratory supervisors in developing and maintaining adequate facilities.
(g) Seeks ways to improve the chemical hygiene program.

2. Department Chairperson or Director

(a) Assumes responsibility for personnel engaged in the laboratory use of hazardous chemicals.
(b) Provides the chemical hygiene officer (CHO) with the support necessary to implement and maintain the CHP.
(c) After receipt of laboratory inspection report from the CHO, meets with laboratory supervisors to discuss cited violations and to ensure timely actions to protect trained laboratory personnel and facilities and to ensure that the department remains in compliance with all applicable federal, state, university, local and departmental codes and regulations.
(d) Provides budgetary arrangements to ensure the health and safety of the departmental personnel, visitors, and students.

3. Departmental Safety

(a) Committee reviews accident reports and makes appropriate recommendations to the department chairperson regarding proposed changes in the laboratory procedures.

4. Laboratory Supervisor or Principal Investigator has overall responsibility for chemical hygiene in the laboratory, including responsibility to:

(a) Ensure that laboratory personnel comply with the departmental CHP and do not operate equipment or handle hazardous chemicals without proper training and authorization.
(b) Always wear personal protective equipment (PPE) that is compatible to the degree of hazard of the chemical.
(c) Follow all pertinent safety rules when working in the laboratory to set an example.
(d) Review laboratory procedures for potential safety problems before assigning to other laboratory personnel.
(e) Ensure that visitors follow the laboratory rules and assumes responsibility for laboratory visitors.
(f) Ensure that PPE is available and properly used by each laboratory employee and visitor.
(g) Maintain and implement safe laboratory practices.
(h) Provide regular, formal chemical hygiene and housekeeping inspections, including routine inspections of emergency equipment;
(i) Monitor the facilities and the chemical fume hoods to ensure that they are maintained and function properly. Contact the appropriate person, as designated by the department chairperson, to report problems with the facilities or the chemical fume hoods.

5. Laboratory Personnel

(a) Read, understand, and follow all safety rules and regulations that apply to the work area;
(b) Plan and conduct each operation in accordance with the institutional chemical hygiene procedures;
(c) Promote good housekeeping practices in the laboratory or work area.
(d) Notify the supervisor of any hazardous conditions or unsafe work practices in the work area.
(e) Use PPE as appropriate for each procedure that involves hazardous chemicals.

C. The Laboratory Facility

General Laboratory Design Considerations

Wet chemical spaces and those with a higher degree of hazard should be separated from other spaces by a wall or protective barrier wherever possible. If the areas cannot be separated, then workers in lower hazard spaces may require additional protection from the hazards in connected spaces.

1. Laboratory Layout and Furnishing

(a) Work surfaces should be chemically resistant, smooth, and easy to clean.
(b) Hand washing sinks for hazardous materials may require elbow, foot, or electronic controls for safe operation.
(c) Wet laboratory areas should have chemically resistant, impermeable, slip- resistant flooring. Walls should be finished with a material that is easy to clean and maintain.
(d) Doors should have view panels to prevent accidents and should open in the direction of egress.
(f) Operable windows should not be present in laboratories, particularly if there are chemical hoods or other local ventilation systems present.

2. Safety Equipment and Utilities

(a) An adequate number and placement of safety showers, eyewash units, and fire extinguishers should be provided for the laboratory.
(b) Use of water sprinkler systems is resisted by some laboratories because of the presence of electrical equipment or water- reactive materials, but it is still generally safer to have sprinkler systems installed. A fire large enough to trigger the sprinkler system would have the potential to cause far more destruction than the local water damage.

D. Chemical Hygiene Plan (CHP)

The OSHA Laboratory standard defines a CHP as "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." (29 CFR 1910.1450(b)). The Laboratory Standard requires a CHP: "Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan." (29 CFR 1910.1450(e)(1)). The CHP is the foundation of the laboratory safety program and must be reviewed and updated, as needed, and at least on an annual basis to reflect changes in policies and personnel. A CHP should be facility specific and can assist in promoting a culture of safety to protect workers from exposure to hazardous materials.

1. The Laboratory's CHP must be readily available to workers and capable of protecting workers from health hazards and minimizing exposure. Include the following topics in the CHP:

(a) Individual chemical hygiene responsibilities;
(b) Standard operating procedures;
(c) Personal protective equipment, engineering controls and apparel;
(d) Laboratory equipment;
(e) Safety equipment;
(f) Chemical management;
(g) Housekeeping;
(h) Emergency procedures for accidents and spills;
(i) Chemical waste;
(j) Training;
(k) Safety rules and regulations;
(l) Laboratory design and ventilation;
(m) Exposure monitoring;
(n) Compressed gas safety;
(o) Medical consultation and examination.

It should be noted that the nature of laboratory work may necessitate addressing biological safety, radiation safety and security issues.

2. Chemical Procurement, Distribution, and Storage

Prudent chemical management includes the following processes:

Chemical Procurement:

(a) Information on proper handling, storage, and disposal should be known to those who will be involved before a substance is received.
(b) Only containers with adequate identifying labels should be accepted.
(c) Ideally, a central location should be used for receiving all chemical shipments.
(d) Shipments with breakage or leakage should be refused or opened in a chemical hood.
(e) Only the minimum amount of the chemical needed to perform the planned work should be ordered.
(f) Purchases of high risk chemicals should be reviewed and approved by the CHO.
(g) Proper protective equipment and handling and storage procedures should be in place before receiving a shipment.

Chemical Storage:

(a) Chemicals should be separated and stored according to hazard category and compatibility.
(b) SDS and label information should be followed for storage requirements.
(c) Maintain existing labels on incoming containers of chemicals and other materials.
(d) Labels on containers used for storing hazardous chemicals must include the chemical identification and appropriate hazard warnings.
(e) The contents of all other chemical containers and transfer vessels, including, but not limited to, beakers, flasks, reaction vessels, and process equipment, should be properly identified.
(f) Chemical shipments should be dated upon receipt and stock rotated.
(g) Peroxide formers should be dated upon receipt, again dated upon opening, and stored away from heat and light with tight- fitting, nonmetal lids.
(h) Open shelves used for chemical storage should be secured to the wall and contain 3⁄4- inch lips. Secondary containment devices should be used as necessary.
(i) Consult the SDS and keep incompatibles separate during transport, storage, use, and disposal.
(j) Oxidizers, reducing agents, and fuels should be stored separately to prevent contact in the event of an accident.
(k) Chemicals should not be stored in the chemical hood, on the floor, in areas of egress, on the benchtop, or in areas near heat or in direct sunlight.
(l) Laboratory-grade, flammable-rated refrigerators and freezers should be used to store sealed chemical containers of flammable liquids that require cool storage. Do not store food or beverages in the laboratory refrigerator.
(m) Highly hazardous chemicals should be stored in a well-ventilated and secure area designated for that purpose.
(n) Flammable chemicals should be stored in a spark-free environment and in approved flammable-liquid containers and storage cabinets. Grounding and bonding should be used to prevent static charge buildups when dispensing solvents.
(o) Chemical storage and handling rooms should be controlled-access areas. They should have proper ventilation, appropriate signage, diked floors, and fire suppression systems.

Chemical Handling:

(a) As described above, a risk assessment should be conducted prior to beginning work with any hazardous chemical for the first time.
(b) All SDS and label information should be read before using a chemical for the first time.
(c) Trained laboratory workers should ensure that proper engineering controls (ventilation) and PPE are in place.

Chemical Inventory:

(a) Prudent management of chemicals in any laboratory is greatly facilitated by keeping an accurate inventory of the chemicals stored.
(b) Unneeded items should be discarded or returned to the storeroom.

Transporting Chemicals:

(a) Secondary containment devices should be used when transporting chemicals.
(b) When transporting chemicals outside of the laboratory or between stockrooms and laboratories, the transport container should be break-resistant.
(c) High-traffic areas should be avoided.

Transferring Chemicals:

(a) Use adequate ventilation (such as a fume hood) when transferring even a small amount of a particularly hazardous substance (PHS).
(b) While drum storage is not appropriate for laboratories, chemical stockrooms may purchase drum quantities of solvents used in high volumes. Ground and bond the drum and receiving vessel when transferring flammable liquids from a drum to prevent static charge buildup.
(c) If chemicals from commercial sources are repackaged into transfer vessels, the new containers should be labeled with all essential information on the original container.

Shipping Chemicals:

Outgoing chemical shipments must meet all applicable Department of Transportation (DOT) regulations and should be authorized and handled by the institutionalshipper.

3. Waste Management

A waste management plan should be in place before work begins on any laboratory activity. The plan should utilize the following hierarchy of practices:

(a) Reduce waste sources. The best approach to minimize waste generation is by reducing the scale of operations, reducing its formation during operations, and, if possible, substituting less hazardous chemicals for a particular operation.
(b) Reuse surplus materials. Only the amount of material necessary for an experiment should be purchased, and, if possible, materials should be reused.

(c) Recycle waste. If waste cannot be prevented or minimized, the organization should consider recycling chemicals that can be safely recovered or used as fuel.
(d) Dispose of waste properly. Sink disposal may not be appropriate. Proper waste disposal methods include incineration, treatment, and land disposal. The organization's environmental health and safety (EHS) office should be consulted in determining which methods are appropriate for different types of waste.

Collection and Storage of Waste:

(a) Chemical waste should be accumulated at or near the point of generation, under the control of laboratory workers.
(b) Each waste type should be stored in a compatible container pending transfer or disposal. Waste containers should be clearly labeled and kept sealed when not in use.
(c) Incompatible waste types should be kept separate to ensure that heat generation, gas evolution, or another reaction does not occur.
(d) Waste containers should be segregated by how they will be managed. Waste containers should be stored in a designated location that does not interfere with normal laboratory operations. Ventilated storage and secondary containment may be appropriate for certain waste types.
(e) Waste containers should be clearly labeled and kept sealed when not in use. Labels should include the accumulation start date and hazard warnings as appropriate.
(f) Non-explosive electrical systems, grounding and bonding between floors and containers, and non-sparking conductive floors and containers should be used in the central waste accumulation area to minimize fire and explosion hazards. Fire suppression systems, specialized ventilation systems, and dikes should be installed in the central waste accumulation area. Waste management workers should be trained in proper waste handling procedures as well as contingency planning and emergency response. Trained laboratory workers most familiar with the waste should be actively involved in waste management decisions to ensure that the waste is managed safely and efficiently. Engineering controls should be implemented as necessary, and personal protective equipment should be worn by workers involved in waste management.

4. Inspection Program

Maintenance and regular inspection of laboratory equipment are essential parts of the laboratory safety program. Management should participate in the design of a laboratory inspection program to ensure that the facility is safe and healthy, workers are adequately trained, and proper procedures are being followed.

Types of inspections:

The program should include an appropriate combination of routine inspections, self-audits, program audits, peer inspections, EHS inspections, and inspections by external entities.

Elements of an inspection:

(a) Inspectors should bring a checklist to ensure that all issues are covered and a camera to document issues that require correction.
(b) Conversations with workers should occur during the inspection, as they can provide valuable information and allow inspectors an opportunity to show workers how to fix problems.
(c) Issues resolved during the inspection should be noted.
(d) An inspection report containing all findings and recommendations should be prepared for management and other appropriate workers.
(e) Management should follow-up on the inspection to ensure that all corrections are implemented.

5. Medical Consultation and Examination

The employer must provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations that the examining physician determines to be necessary, whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory. If an employee encounters a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee must be provided an opportunity for a medical consultation by a licensed physician. All medical examinations and consultations must be performed by or under the direct supervision of a licensed physician and must be provided without cost to the employee, without loss of pay and at a reasonable time and place. The identity of the hazardous chemical, a description of the incident, and any signs and symptoms that the employee may experience must be relayed to the physician.

6. Records

All accident, fatality, illness, injury, and medical records and exposure monitoring records must be retained by the institution in accordance with the requirements of state and federal regulations (see 29 CFR part 1904 and § 1910.1450(j)). Any exposure monitoring results must be provided to affected laboratory staff within 15 working days after receipt of the results (29 CFR 1910.1450(d)(4)).

7. Signs

Prominent signs of the following types should be posted:
(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers;
(b) Location signs for safety showers, eyewash stations, other safety and first aid equipment, and exits; and
(c) Warnings at areas or equipment where special or unusual hazards exist.

8. Spills and Accidents

Before beginning an experiment, know your facility's policies and procedures for how to handle an accidental release of a hazardous substance, a spill or a fire. Emergency response planning and training are especially important when working with highly toxic compounds. Emergency telephone numbers

should be posted in a prominent area. Know the location of all safety equipment and the nearest fire alarm and telephone. Know who to notify in the event of an emergency. Be prepared to provide basic emergency treatment. Keep your co-workers informed of your activities so they can respond appropriately. Safety equipment, including spill control kits, safety shields, fire safety equipment, PPE, safety showers and eyewash units, and emergency equipment should be available in well- marked highly visible locations in all chemical laboratories. The laboratory supervisor or CHO is responsiblefor ensuring that all personnel are aware of the locations of fire extinguishers and are trained in their use. After an extinguisher has been used, designated personnel must promptly recharge or replace it (29 CFR 1910.157(c)(4)). The laboratory supervisor or CHO is also responsible for ensuring proper training and providing supplementary equipment as needed.

Special care must be used when handling solutions of chemicals in syringes with needles. Do not recap needles, especially when they have been in contact with chemicals. Remove the needle and discard it immediately after use in the appropriate sharps containers. Blunt-tip needles are available from a number of commercial sources and should be used unless a sharp needle is required to puncture rubber septa or for subcutaneous injection.

For unattended operations, laboratory lights should be left on, and signs should be posted to identify the nature of the experiment and the hazardous substances in use. Arrangements should be made, if possible, for other workers to periodically inspect the operation. Information should be clearly posted indicating who to contact in the event of an emergency. Depending on the nature of the hazard, special rules, precautions, and alert systems may be necessary.

9. Training and Information

Personnel training at all levels within the organization, is essential. Responsibility and accountability throughout the organization are key elements in a strong safety and health program. The employer is required to provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area (29 CFR 1910.1450(f)). This information must be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training should be determined by the employer. At a minimum, laboratory personnel should be trained on their facility's specific CHP, methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released), the physical and health hazards of chemicals in the work area and means to protect themselves from these hazards. Trained laboratory personnel must know shut-off procedures in case of an emergency. All SDSs must be made available to the employees.

E. General Procedures for Working With Chemicals

The risk of laboratory injuries can be reduced through adequate training, improved engineering, good housekeeping, safe work practice and personal behavior.

1. General Rules for Laboratory Work With Chemicals

(a) Assigned work schedules should be followed unless a deviation is authorized by the laboratory supervisor.
(b) Unauthorized experiments should not be performed.
(c) Plan safety procedures beforebeginning any operation.
(d) Follow standard operating procedures at all times.
(e) Always read the SDS and label before using a chemical.
(f) Wear appropriate PPE at all times.
(g) To protect your skin from splashes, spills and drips, always wear long pants and closed-toe shoes.
(h) Use appropriate ventilation when working with hazardous chemicals.
(i) Pipetting should never be done by mouth.
(j) Hands should be washed with soap and water immediately after working with any laboratory chemicals, even if gloves have been worn.
(k) Eating, drinking, smoking, gum chewing, applying cosmetics, and taking medicine in laboratories where hazardous chemicals are used or stored should be strictly prohibited.
(l) Food, beverages, cups, and other drinking and eating utensils should not be stored in areas where hazardous chemicals are handled or stored.
(m) Laboratory refrigerators, ice chests, cold rooms, and ovens should not be used for food storage or preparation.
(n) Contact the laboratory supervisor, Principal Investigator, CHO or EHS office with all safety questions or concerns.
(o) Know the location and proper use of safety equipment.
(p) Maintain situational awareness.
(q) Make others aware of specialhazards associated with your work.
(r) Notify supervisors of chemical sensitivities or allergies.
(s) Report all injuries, accidents, incidents, and near misses.
(t) Unauthorized persons should not be allowed in the laboratory.
(u) Report unsafe conditions to the laboratory supervisor or CHO.
(v) Properly dispose of chemical wastes.

Working Alone in the Laboratory

Working alone in a laboratory isdangerous and should be strictly avoided. There have been many tragic accidents that illustrate this danger. Accidents are unexpected by definition, which is why coworkers should always be present. Workers should coordinate schedules to avoid working alone.

Housekeeping

Housekeeping can help reduce or eliminate a number of laboratory hazards. Proper housekeeping includes appropriate labeling and storage of chemicals, safe and regular cleaning of the facility, and proper arrangement of laboratory equipment.

2. Nanoparticles and Nanomaterials

Nanoparticles and nanomaterials have different reactivities and interactions with biological systems than bulk materials, and understanding and exploiting these differences is an active area of research. However, these differences also mean that the risks and hazards associated with exposure to engineered nanomaterials are not well known. Because this is an area of ongoing research, consult trusted sources for the most up to date information available. Note that the higher reactivity of many nanoscale materials suggests that they should be treated as potential sources of ignition, accelerants, and fuel that could result in fire or explosion. Easily dispersed dry nanomaterials may pose the greatest health hazard because of the risk of inhalation. Operations involving these nanomaterials deserve more attention and more stringent controls than those where the nanomaterials are embedded in solid or suspended in liquid matrixes.

Consideration should be given to all possible routes of exposure to nanomaterials including inhalation, ingestion, injection, and dermal contact (including eye and mucous membranes). Avoid handling nanomaterials in the open air in a free- particle state. Whenever possible, handle and store dispersible nanomaterials, whether suspended in liquids or in a dry particle form, in closed (tightly-sealed) containers. Unless cutting or grinding occurs, nanomaterials that are not in a free form (encapsulated in a solid or a nanocomposite) typically will not require engineering controls. If a synthesis is being performed to create nanomaterials, it is not enough to only consider the final material in the risk assessment, but consider the hazardous properties of the precursor materials as well.

To minimize laboratory personnel exposure, conduct any work that could generate engineered nanoparticles in an enclosure that operates at a negative pressure differential compared to the laboratory personnel breathing zone. Limited data exist regarding the efficacy of PPE and ventilation systems against exposure to nanoparticles. However, until further information is available, it is prudent to follow standard chemical hygiene practices. Conduct a hazard evaluation to determine PPE appropriate for the level of hazard according to the requirements set forth in OSHA's Personal Protective Equipment standard (29 CFR 1910.132).

3. Highly Toxic and Explosive/Reactive Chemicals/ Materials

The use of highly toxic and explosive/ reactive chemicals and materials has been an area of growing concern. The frequency of academic laboratory incidents in the U.S. is an area of significant concern for the Chemical Safety Board (CSB). The CSB issued a case study on an explosion at Texas Tech University in Lubbock, Texas, which severely injured a graduate student handling a high-energy metal compound. Since 2001, the CSB has gathered preliminary information on 120 different university laboratory incidents that resulted in 87 evacuations, 96 injuries, and three deaths.

It is recommended that each facility keep a detailed inventory of highly toxic chemicals and explosive/reactive materials. There should be a record of the date of receipt, amount, location, and responsible individual for all acquisitions, syntheses, and disposal of these chemicals. A physical inventory should be performed annually to verify active inventory records. There should be a procedure in place to report security breaches, inventory discrepancies, losses, diversions, or suspected thefts.

Procedures for disposal of highly toxic materials should be established before any experiments begin, possibly even before the chemicals are ordered. The procedures should address methods for decontamination of any laboratory equipment that comes into contact with highly toxic chemicals. All waste should be accumulated in clearly labeled impervious containers that are stored in unbreakable secondary containment.

Highly reactive and explosive materials that may be used in the laboratory require appropriate procedures and training. An explosion can occur when a material undergoes a rapid reaction that results in a violent release of energy. Such reactions can happen spontaneously and can produce pressures, gases, and fumes that are hazardous. Some reagents pose a risk on contact with the atmosphere. It is prudent laboratory practice to use a safer alternative whenever possible.

If at all possible, substitutes for highly acute, chronic, explosive, or reactive chemicals should be considered prior to beginning work and used whenever possible.

4. Compressed Gas

Compressed gases expose laboratory personnel to both chemical and physical hazards. It is essential that these are monitored for leaks and have the proper labeling. By monitoring compressed gas inventories and disposing of or returning gases for which there is no immediate need, the laboratory can substantially reduce these risks. Leaking gas cylinders can cause serious hazards that may require an immediate evacuation of the area and activation of the emergency response system. Only appropriately trained hazmat responders may respond to stop a leaking gas cylinder under this situation.

F. Safety Recommendations—Physical Hazards

Physical hazards in the laboratory include combustible liquids, compressed gases, reactives, explosives and flammable chemicals, as well as high pressure/energy procedures, sharp objects and moving equipment. Injuries can result from bodily contact with rotating or moving objects, including mechanical equipment, parts, and devices. Personnel should not wear loose- fitting clothing, jewelry, or unrestrained long hair around machinery with moving parts.

The Chemical Safety Board has identified the following key lessons for laboratories that address both physical and other hazards:

1. Ensure that research-specific hazards are evaluated and then controlled by developing specific written protocols and training.
2. Expand existing laboratory safety plans to ensure that all safety hazards, including physical hazards of chemicals, are addressed.
3. Ensure that the organization's EHS office reports directly to an identified individual/office with organizational authority to implement safety improvements.
4. Develop a verification program that ensures that the safety provisions of the CHP are communicated, followed, and enforced at all levels within the organization.
5. Document and communicate all laboratory near-misses and previous incidents to track safety, provide opportunities for education and improvement to drive safety changes at the university.
6. Manage the hazards unique to laboratory chemical research in the academic environment. Utilize available practice guidance that identifies and describes methodologies to assess and control hazards.
7. Written safety protocols and training are necessary to manage laboratory risk.

G. Emergency Planning

In addition to laboratory safety issues, laboratory personnel should be familiar with established facility policies and procedures regarding emergency situations. Topics may include, but are not limited to:

1. Evacuation procedures—when it is appropriate and alternate routes;
2. Emergency shutdown procedures—equipment shut-down and materials that should be stored safely;
3. Communications during an emergency—what to expect, how to report, where to call or look for information;
4. How and when to use a fire extinguisher;
5. Security issues—preventing tailgating and unauthorized access;
6. Protocol for absences due to travel restrictions or illness;
7. Safe practices for power outage;
8. Shelter in place—when it is appropriate;
9. Handling suspicious mail or phone calls;
10. Laboratory-specific protocols relating to emergency planning and response;
11. Handling violent behavior in the workplace; and
12. First-aid and CPR training, including automated external defibrillator training if available.

It is prudent that laboratory personnel are also trained in how to respond to short-term, long-term and large-scale emergencies. Laboratory security can play a role in reducing the likelihood of some emergencies and assisting in preparation and response for others. Every institution, department, and individual laboratory should consider having an emergency preparedness plan. The level of detail of the plan will vary depending on the function of the group and institutional planning efforts already in place.

Emergency planning is a dynamic process. As personnel, operations, and events change, plans will need to be updated and modified. To determine the type and level of emergency planning needed, laboratory personnel need to perform a vulnerability assessment. Periodic drills to assist in training and evaluation of the emergency plan are recommended as part of the training program.

H. Emergency Procedures

1. Fire alarm policy. Most organizations use fire alarms whenever a building needs to be evacuated—for any reason. When a fire alarm sounds in the facility, evacuate immediately after extinguishing all equipment flames. Check on and assist others who may require help evacuating.
2. Emergency safety equipment. The following safety elements should be met:
   a. A written emergency action plan has been provided to workers;
   b. Fire extinguishers, eyewash units, and safety showers are available and tested on a regular basis; and
   c. Fire blankets, first-aid equipment, fire alarms, and telephones are available and accessible.
3. Chemical spills. Workers should contact the CHO or EHS office for instructions before cleaning up a chemical spill. All SDS and label instructions should be followed, and appropriate PPE should be worn during spill cleanup.
4. Accident procedures. In the event of an accident, immediately notify appropriate personnel and local emergency responders. Provide an SDS of any chemical involved to the attending physician. Complete an accident report and submit it to the appropriate office or individual within 24 hours.
5. Employee safety training program. New workers should attend safety training before they begin any activities. Additional training should be provided when they advance in their duties or are required to perform a task for the first time. Training documents should be recorded and maintained. Training should include hands-on instruction of how to use safety equipment appropriately.
6. Conduct drills. Practice building evacuations, including the use of alternate routes. Practice shelter-in-place, including plans for extended stays. Walk the fastest route from your work area to the nearestfire alarm, emergency eye wash and emergency shower. Learn how each is activated. In the excitement of an actual emergency, people rely on what they learned from drills, practice and training.
7. Contingency plans. All laboratories should have long-term contingency plans in place (e.g., for pandemics). Scheduling, workload, utilities and alternate work sites may need to be considered.

I. Laboratory Security

Laboratory security has evolved in the past decade, reducing the likelihood of some emergencies and assisting in preparation and response for others. Most security measures are based on the laboratory's vulnerability. Risks to laboratory security include, but are not limited to:

1. Theft or diversion of chemicals, biologicals, and radioactive or proprietary materials, mission-critical or high-value equipment;
2. Threats from activist groups;
3. Intentional release of, or exposure to, hazardous materials;
4. Sabotage or vandalism of chemicals or high-value equipment;
5. Loss or release of sensitive information; and
6. Rogue work or unauthorized laboratory experimentation.

Security systems in the laboratory are used to detect and respond to a security breach, or a potential security breach, as well as to delay criminal activity by imposing multiple layered barriers of increasing stringency. A good laboratory security system will increase overall safety for laboratory personnel and the public, improve emergency preparedness by assisting with preplanning, and lower the organization's liability by incorporating more rigorous planning, staffing, training, and command systems and implementing emergency communications protocols, drills, background checks, card access systems, video surveillance, and other measures. The security plan should clearly delineate response to security issues, including the coordination of institution and laboratory personnel with both internal and external responders.

Appendix C: Safety Rules for Undergraduate Students in Chemistry Laboratories

The following guidelines and policies are designed to protect students from exposure to hazardous chemicals in the academic laboratories. According to the Occupational Safety and Health Administration definition, 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. The safety rules will be enforced at all times by authorized departmental personnel. Students who do not follow the safety rules will be subject to dismissal from the laboratory.

I. Guidelines for Personal Apparel in the Laboratory

A. Students must wear approved chemical splash goggles (over regular eyeglasses) and approved laboratory aprons or cotton lab coats (not lab jackets) at all times in the laboratory.

B. The use of contact lenses in the laboratory is strongly discouraged. In the event of a chemical splash or vapor release, contact lenses can increase the degree of injury to the eye and may prevent prompt first-aid and eye-flushing procedures.

C. Students should wear cotton clothing that provides protection from chemical spills. Clothing which completely covers the legs must be worn at all times in the laboratory. Shorts and skirts that do not completely cover the leg are inappropriate apparel in the laboratory and are not permitted.

D. To avoid exposure to hazardous materials, open-backed shirts, bare midriff shirts, or shirts which expose areas of the torso are not permitted.

E. Wear shoes which completely cover the feet. Sandals, perforated shoes, open-toed shoes, open-backed shoes, or high-heeled shoes are not permitted in the laboratory.

F. For your safety, hair longer than shoulder length and loose sleeves must be confined when working in the laboratory.

G. Wear the disposable gloves that are provided in each laboratory when working with hazardous chemicals. Inspect the gloves for defects before wearing. Be sure to notify your Teaching Assistant if you have an allergy to latex. Always remove gloves before exiting the laboratory. Upon removal, discard the disposable gloves in the wastebasket.

H. You are advised to avoid wearing synthetic fingernails in the chemistry laboratory. Synthetic fingernails can be damaged by solvents and are made of extremely flammable polymers which can burn to completion and are not easily extinguished.

I. For your protection, jewelry should not be worn in the laboratory. Dangling jewelry can become entangled in equipment and can conduct electricity. Chemicals can seep under the jewelry and cause injuries to the skin. Chemicals can ruin jewelry and change its composition.

II. Procedures to Avoid Exposure to Hazardous Chemicals

A. Minimize all chemical exposure. Avoid ingestion, injection, inhalation, eye contact, and skin contact with all hazardous materials in the laboratory.

B. No chemical should ever be tasted. Do not pipet by mouth in the laboratory; use a pipet aid.

C. When you are instructed to smell a chemical, you should gently waft the vapors toward your nose using your gloved hand or a folded sheet of paper. Do not place the container directly under your nose and inhale the vapors.

D. Use the chemical fume hood when there is a possibility of release of toxic chemical vapors, dust, or gases. Before you begin your experimental work in the general chemistry laboratories, always ensure that the back of the desk top fume hood is properly aligned with the ventilation duct that is located on the bench top at each student desk.
When using a chemical fume hood that has a sash, the sash opening should be kept at a minimum to protect the user and to ensure the efficiency of the operation. Keep your head and body outside of the hood face. All chemicals and equipment should be placed at least six inches from the hood face to ensure proper airflow.

E. If any chemical spills onto the skin, immediately flush the affected area with water and notify the Teaching Assistant.

F. Eating, drinking, smoking, chewing gum, applying cosmetics, and using smokeless tobacco products are prohibited in the laboratory. Beverage containers, cups, bottled water, and food containers are not permitted in the laboratory. Never use laboratory glassware for eating or drinking purposes.

G. Always remove gloves before exiting the laboratory. Dispose of gloves in a wastebasket, not in the solid waste container. Do not reuse gloves.

H. Notify your Teaching Assistant if you spill any chemicals. Clean up chemical spills (including water) immediately. Do not leave spilled chemicals on the bench top or floor. At the termination of your experimental work, the desktop and student hood must be thoroughly cleaned before you leave the laboratory. The Teaching Assistant will advise you of the proper manner to dispose of the cleaning materials.

I. Notify the Teaching Assistant about any sensitivities that you may have to particular chemicals prior to the start of the particular laboratory experiment.
J. Due to possible contamination of laboratory coats with chemicals, students are advised that they should not wear laboratory coats outside of the Chemistry buildings and that they should not wash laboratory coats with personal clothing items.
K. Always wash your hands at the end of each laboratory session before you exit the laboratory.

III. General Guidelines for Laboratory Procedures

A. Do not enter the laboratory room without the supervision of your Teaching Assistant or the faculty member in charge of the laboratory. Working in the laboratory without supervision by the Teaching Assistant or the faculty member in charge is prohibited. The performance of unauthorized experiments and the use of any equipment in an unauthorized or unsafe manner are strictly forbidden.
B. When diluting concentrated acids always pour the acid slowly into the water with stirring. Never add water to concentrated acids because of the danger of splattering.
C. When cutting glass tubing, always protect your hands with a towel. When inserting rods, tubing, or thermometers into stoppers, the glass must be lubricated with soapy water or glycerol. Tubing ends must always be fire-polished. Make sure that the glass is cool before you touch it. Hot glass looks just like cool glass.
D. Do not attempt to dry glassware by inserting a towel wrapped around a glass rod.
E. Glass tubing should extend well through rubber stoppers so that no closure of the tube can occur if the rubber swells.
D. F. All water, gas, air, electrical, and other service connections must be made in a safe and secure manner.
G. Practical jokes, boisterous conduct, and excessive noise are prohibited.
H. The use of personal audio and visual equipment and cell phones is prohibited in the laboratory.
I. Gas valves must be kept closed except when a burner is in use.
J. Do not heat flammable liquids with a Bunsen burner or other open flame. If in doubt about the flammability of a liquid, consult your Teaching Assistant.
K. Dispose of waste chemicals in the containers that have been provided and labeled for this purpose. Do not dispose of waste chemicals in the sinks or the wastebaskets. Paper towels and gloves should be placed in the wastebasket, not the chemical waste containers. Used filter paper and weighing dishes must be placed in the containers that are marked for this purpose.
L. Examine all apparatus for defects before performing any experiments. Do not use damaged, cracked or otherwise defective glassware. Dispose of broken glassware in the containers provided in the laboratory.
M. If you break a thermometer (or find a broken thermometer), report it to your Teaching Assistant immediately.
N. Do not insert medicine droppers into reagent bottles unless they are specifically supplied with the bottles.
O. Never return unused chemicals to the stock reagent bottles. Take only what you need. Use the quantities of reagents recommended in your laboratory manual. Do not waste chemicals.
P. Do not remove stock reagent bottles from the dispensing areas without the permission of the Teaching Assistant or the instructor.
Q. All materials (i.e., chemicals, paper, towels, broken glass, stoppers, and rubber tubing) must be kept out of the sinks at all times to minimize the danger of plugging drains. Such items are to be kept away from positions where they might fall into the sinks or drains.
R. Maintain clean glassware. When cleaning glassware with water, wash your equipment with tap water. Use distilled water only for rinsing. Do not use more distilled water than is necessary. Ethanol and acetone rinses must be placed in the appropriately labeled container in the laboratory, as instructed by the Teaching Assistant.
S. Heavy pieces of glass apparatus and filter flasks should be supported with clamps
suitably protected with rubber or plastic pads. Heavy pieces of glass apparatus that are not sitting directly on the bench top should have appropriate bottom supports, such as rings or tripods.

Appendix D: Check in Materials and Laboratory Forms

C. Eugene Bennett Department of Chemistry
West Virginia University
Eberly College of Arts and Sciences

Laboratory Check In Procedures

Attention: Carefully read the following information.

- There is a laboratory fee, payable with your tuition. This fee is non-refundable after the first week of classes.
- If you drop the course you must check out of your laboratory desk at the next scheduled laboratory session.
- A charge of excessive breakage will be levied.
- You are responsible for the equipment in your drawer. All of the items should be clean and damage-free when you check out of your desk.
- You must bring your student ID to every laboratory session in order to obtain replacements for broken glassware.

During the first laboratory session you will be assigned a desk. In addition to this form, you will receive a Check In Sheet and a Desk Condition Report.

The Teaching Assistant will unlock your drawer. You should find the combination to your lock in the drawer. You should test the combination to ensure that it is correct. If the combination does not open the lock, notify your Teaching Assistant. You will be responsible for unlocking your drawer at the beginning of each laboratory and locking the drawer at the end of each laboratory. If you forget the combination, notify the Teaching Assistant to obtain the appropriate form.

Remove all the items from the drawer and inspect each item carefully. Glass items should not have any visible chips or cracks. If an item is missing or unsuitable for use, list that item on your Desk Condition Report. If an item is in good condition, initial that item on your Check In Sheet and place the item back into your drawer.

When you have completed your inventory of equipment, signal your Teaching Assistant. If you have listed items on your Desk Condition Report, the Teaching Assistant will check to confirm that missing items are missing and that broken items are broken. Your Teaching Assistant will then sign the Desk Condition Report. You should then take the Desk Condition Report and the Check In Sheet to the Stockroom, Room 204, to obtain replacements for the items on your list.

When you have initialed ALL of the items on your Check In Sheet, the Teaching Assistant will sign this sheet. You must signify that all of the items are in your drawer by signing BOTH the Desk Condition Report and the Check In Sheet.

Return the Check In Sheet, the Desk Condition Report, the Safety Rules sign-off sheet, and the Contact Lens Waiver to the Teaching Assistant before you leave the laboratory on Check In Day.

Barbara L. Foster, Director of Laboratory Safety
Certified Chemical Hygiene Officer
July 2014

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY

ROOM CONDITION REPORT

Name (please print) TA LAB ROOM CONDITION REPORT SHEET

TA Name _____ Lab Date _____ /_____ /_____

Lab Room_____ Lab Day_____ Lab Time _____:_____AM/PM

Please complete this sheet at the beginning of EVERY lab period.

1.	Is the balance room and balances wiped clean and free of debris?	YES	NO
2.	Are all the benchtops wiped clean and free of debris?	YES	NO
3.	Is the chalkboard erased?	YES	NO
4.	Are the SPARK units turned off and put away?	YES	NO
5.	Are the hot plates turned off and put away?	YES	NO
6.	Is all the common equipment accounted for? (Stir bars, rulers, etc.)	YES	NO
7.	Are all the reagent hoods and chemical trays clean with all bottles properly capped/corked?	YES	NO
8.	Are the waste containers overflowing or need to be emptied?	YES	NO
9.	Are there adequate supplies for students, including gloves, weigh boats, chemicals, paper towels, ect?	YES	NO
10.	Are the windows closed and locked?	YES	NO

Please comment on any of the above; be as detailed as possible.

Comments: _____

_____

_____

_____

Return this form to the Operations Manager in Rm 302A at the completion of your lab.

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY

DESK CONDITION REPORT

Name (please print) _____

Room Number_____

Desk Number _____

Local Telephone Number (_____) _____

Course Number_____

Day of Lab: M Tu W Th F

Time of Lab: _____

Check (X) the appropriate statement:

_____ I find my desk to be completely stocked and all items are in good condition. I do not require any replacement items from the Stockroom.

_____ I find that some items are missing or unsuitable for use. I have listed these items below and obtained my Teaching Assistant=s signature in order to obtain replacements from the Stockroom.

1. _____ 4. _____

2. _____ 5. _____

3. _____ 6. _____

I need my lock combination. The number on the back of the lock is _____

Student Signature:_____ Date:_____

Teaching Assistant Signature:_____Date:_____

B.L. Foster
July 2014

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY

USE OF CONTACT LENSES IN CHEMISTRY LABORATORY

SAFETY GOGGLES WITH SHIELDED VENTS ONLY MUST BE WORN AT ALL TIMES IN CHEMISTRY LABORATORIES WHEN WEARING CONTACT LENSES. Such safety goggles prevent liquids or solid particles from being splashed or sprayed into the eyes and they reduce contact with laboratory vapors. Gases and vapors can concentrate under the contact lenses and cause permanent eye damage. It has been shown that soft contact lenses can pose an even greater risk of vapor absorption and possible eye damage than hard contact lenses. In addition to the possible vapor and gas hazards, contact lenses may trap foreign matter in the eye and produce abrasion of the cornea. Contact lens wearers are advised to remove their contact lenses and replace them with conventional eyeglasses before coming to the Chemistry laboratory when possible to avoid the possibility of the aforementioned hazards as well as any unforeseen problems which might occur as a result of wearing contact lenses. The exceptions to this general rule include persons who cannot wear corrective glasses for medical reasons or persons for whom contact lenses are medically required for therapeutic reasons.

RELEASE IN FULL OF ALL CLAIMS

I have read and understand the information set out above pertaining to the potential risks of wearing contact lenses in the Chemistry laboratory.

In consideration of being permitted to participate in the laboratory course, I agree to wear safety goggles at ALL times in the laboratory and to notify my Teaching Assistant that I am wearing contact lenses each time I enter the laboratory wearing such lenses.

I fully understand that I assume FULL RESPONSIBILITY for any injury which might occur as a result of or connected in any way to the fact that I wear contact lenses in the Chemistry laboratory.

Printed Name _____

Chemistry Course: _____ Section Number:_____

Room Number: _____ Desk Number: _____

Student Signature:_____ Date:_____

Witness Signature:_____ Date:_____

B.L. Foster
July 2014

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY

TEACHING ASSISTANT LABORATORY CHECK-OUT FORM

If a student is not present for Laboratory Check-out, the Teaching Assistant is responsible for the proper check-out of that desk.

Complete this report and give it to the Stockroom Supervisor (Room 204 Clark Hall).

Name: _____

Desk Number _____, Course Number _____ was not present to check out of laboratory. I have completed the check-out of this desk.

Check (X) The Appropriate Statement:

_____ I find this desk to be in good condition with no missing or unsuitable items.

_____ I find that some items are missing or unsuitable. I have listed these items below and I have obtained the replacements for these items from the Stockroom Supervisor, (Room 204).

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

Teaching Assistant Signature:_____Date:_____

STUDENT OR VISITOR ACCIDENT REPORT FORM

West Virginia University
Environmental Health and Safety

The injured student or visitor and wvu department representative should complete this form.

Name:_____ Status: (circle one Student or Visitor

_____ Phone:_____

Date: _____ Time accident occurred:_____

Sex: (circle one) Male or Female Age: _____

Building/Location and Room or area in which accident occurred: _____

_____

Description of Accident: Please describe how the accident happened. What was the injured person doing? List any specific acts by individuals or conditions that led to the accident. (include any tools, machinery or instruments involved)

_____

_____

_____

_____

Nature of Injury			Part of Body Injured		
___ Abrasion	___ Cut	___ Scratch	___ Abdomen	___ Face	___ Leg
___ Amputation	___ Dislocation	___ Shock	___ Ankle	___ Finger	___ Mouth
___ Asphyxiation	___ Fracture	___ Sprain	___ Back	___ Foot	___ Nose
___ Bite	___ Laceration	___ Splinter	___ Chest	___ Forearm	___ Shoulder
___ Bruise	___ Poisoning	___ Strain	___ Ear	___ Hand	___ Teeth
___ Burn	___ Puncture	___ Fainted	___ Elbow	___ Head	___ Wrist
___ Concussion	___ Repetitive Stress Injury		___ Eye	___ Knee	
Other specify_____			Other specify _____		
_____			_____		

Was first aid administered? (circle one) Yes or No

Did you receive medical treatment? (circle one) Yes or No

Treatment location: _____

Student:_____
signature

Visitor:_____
signature

WVU Department Representative:_____
signature

Department of Chemistry
Laboratory Teaching Assistant Evaluation by Faculty

Please evaluate your Teaching Assistant on a scale of A-E with "A" being the highest rating for each of the following questions.

	Highest Rating				Lowest Rating
1. Does the person appear to have sufficient knowledge of the subject matter in the course to be an effective Assistant?	-A-	-B-	-C-	-D-	-E-
2. Did the person consult you about matters he/she didn't understand?	-A-	-B-	-C-	-D-	-E-
3. Does the person seek out the students to offer his/her help? (i.e. not spend his/her time standing against the wall)	-A-	-B-	-C-	-D-	-E-
4. Is the person readily available to students during the entire period? (i.e. not outside of the room, talking to other assistants or friends, studying, etc.)	-A-	-B-	-C-	-D-	-E-
5. Is the person punctual in reporting to lab?	-A-	-B-	-C-	-D-	-E-
6. Did the person grade quizzes, notebooks and products promptly?	-A-	-B-	-C-	-D-	-E-
7. Does the person try to make sure that the students do their work properly? (i.e. does he/she insist on knowns before unknowns; does he/she require students to answer questions in lab manuals, or does he/she write the answers on the board so that they can be copied?)	-A-	-B-	-C-	-D-	-E-
8. Does the person require students to keep a neat and orderly lab? (i.e. desks, sideshelves and sinks clean and chemicals arranged in order?)	-A-	-B-	-C-	-D-	-E-
9. Does the person attend meetings that are for information about the course being taught?	-A-	-B-	-C-	-D-	-E-
10. Does the person inform you when he/she cannot be present and make arrangements for a substitute?	-A-	-B-	-C-	-D-	-E-
11. Did the person assign reasonable grades?	-A-	-B-	-C-	-D-	-E-
12. Does this person possess sufficient language skills necessary to function as an effective Teaching Assistant?	-A-	-B-	-C-	-D-	-E-

Name of Teaching Assistant: _____

Course Number _____ Date: _____

Name of Evaluator: _____

Please provide additional comments regarding the performance of this TA below:

_____

_____

_____

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY

TEACHING ASSISTANT ABSENCE FORM

As a reminder, it is the responsibility of the Teaching Assistant to arrange a substitute TA when he/she plans to be out of town and will be unable to fulfill the assigned teaching obligations. Complete one form for each lab section that will be affected by the planned absence. Submit the completed form to the faculty member in charge of the laboratory course and the Safety Director at least one week prior to the planned absence.

Name: _____

Reason for absence (i.e., conference, interview) _____

Date(s) of absence from department: _____

Course number: _____ Day/time of lab section: _____

Faculty member in charge of laboratory course: _____

Name, email address, and phone number of the TA substitute for the laboratory assignment:

_____

_____

_____

Signature of TA substitute: _____ agrees to teach the laboratory section on the specified day/time.

Date of completion of this form: _____

Faculty signature and date: _____

Safety Director signature and date: _____

Department of Chemistry
Laboratory Teaching Assistant Evaluation

Please evaluate your Teaching Assistant on a scale of A-E with "A" being the highest rating for each of the following questions.

Did the Teaching Assistant:	Highest Rating				Lowest Rating
1. Come well prepared for the class?	-A-	-B-	-C-	-D-	-E-
2. Clarify difficult concepts?	-A-	-B-	-C-	-D-	-E-
3. Enforce the safety regulations?	-A-	-B-	-C-	-D-	-E-
4. Speak clearly and distinctly?	-A-	-B-	-C-	-D-	-E-
5. Give correct information about laboratory work?	-A-	-B-	-C-	-D-	-E-
6. Encourage questions from students?	-A-	-B-	-C-	-D-	-E-
7. Help you with your understanding of chemistry?	-A-	-B-	-C-	-D-	-E-
8. Treat all students with respect?	-A-	-B-	-C-	-D-	-E-
9. Give reasonable amount of individual help when requested?	-A-	-B-	-C-	-D-	-E-
10. Would you recommend this Teaching Assistant to a friend?	-A-	-B-	-C-	-D-	-E-

If you could make one suggestion to improve the effectiveness of your Teaching Assistant, then what would it be?

LOCK NUMBER:_____ (located on back of lock) Revised 07/14

WEST VIRGINIA UNIVERSITY

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY
Chemistry 111/112

PLEASE PRINT

Name _____

Date _____ Room Number _____ Desk Number _____

Lecture Instructor _____

Local Telephone Number _____ Email Address _____

Chemistry 111/112 Day of Lab _____ Time of Lab _____

ATTENTION: CAREFULLY READ THE FOLLOWING INFORMATION

1. This apparatus is the property of the University and is loaned to you for the semester. These items are to be returned clean, dry, and in good condition when leaving the course.
2. Check all items carefully, listing missing or broken items on your DESK CONDITION REPORT. Obtain your Teaching Assistant's signature to verify that these items are broken or missing. Obtain replacement items in from the Stock room, Room 204 Clark Hall. Upon completion of the check-in procedures, hand this sheet and your DESK CONDITION REPORT to your Teaching Assistant.
3. You are responsible for this equipment, as well as any items checked out from the Stockroom.
4. NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY
5. To signify that you have read and understood all laboratory procedures and Safety Regulations and that you agree to abide by these rules, sign below:

Student Signature _____ Date _____

NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY

IN	OUT		IN	OUT	
___	___	1 Beaker, 100mL	___	___	1 Rubber Policeman w/glass stirring rod
___	___	1 Beaker, 250mL	___	___	1 Pipet, 10mL
___	___	1 Beaker, 400mL	___	___	4 Test tube caps
___	___	1 Erlenmeyer flask, 125mL	___	___	1 Wash bottle, 250 mL
___	___	2 Erlenmeyer flasks, 250mL	___	___	1 Metal scoopula
___	___	1 Cylinder, graduated, 10mL	___	___	1 Test tube clamp
___	___	1 Cylinder, graduated, 100mL	___	___	1 Clay triangle
___	___	1 Funnel, 65mm	___	___	1 Test tube rack
___	___	1 Watch glass, 75 x 125mm	___	___	1 Pipet pump, 10 mL
___	___	10 Test tubes 12 x 75mm	___	___	2 Porcelian evaporating dishes
___	___	3 Test tubes 16 x 100mm	___	___	1 Rubber stopper #6 solid
___	___	4 Test tubes 18 x 150mm	___	___	1 Buret-teflon stopcock, 25mL
___	___	2 Medicine droppers	___	___	1 Combination lock
___	___	2 Dropping bottles			

I received the above equipment in good condition on _____

Student Signature _____ Date _____

Teaching Assistant Signature _____ Date _____

Check-Out Assistant Signature _____ Date _____

LOCK NUMBER:_____ (located on back of lock) Revised 07/14

WEST VIRGINIA UNIVERSITY

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY
Chemistry 115/116

PLEASE PRINT

Name _____

Date _____ Room Number _____ Desk Number _____ Section _____

Local Telephone Number _____ Email Address _____

Chemistry 115/116 Day of Lab _____ Time of Lab_____

ATTENTION: CAREFULLY READ THE FOLLOWING INFORMATION

1. This apparatus is the property of the University and is loaned to you for the semester. These items are to be returned clean, dry, and in good condition when leaving the course.
2. Check all items carefully, listing missing or broken items on your DESK CONDITION REPORT. Obtain your Teaching Assistant's signature to verify that these items are broken or missing. Obtain replacement items in from the Stock room, Room 204 Clark Hall. Upon completion of the check-in procedures, hand this sheet and your DESK CONDITION REPORT to your Teaching Assistant. (Very Important)
3. You are responsible for this equipment, as well as any items checked out from the Stockroom.
4. NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY
5. To signify that you have read and understood all laboratory procedures and Safety Regulations and that you agree to abide by these rules, sign below:

Student Signature _____ Date _____

NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY

IN	OUT		IN	OUT	
___	___	1 Beaker, 100mL	___	___	1 Buret with teflon stopcock
___	___	1 Beaker, 250mL	___	___	1 Wash bottle, 250mL
___	___	1 Erlenmeyer flask, 125mL	___	___	1 Metal scoopula
___	___	1 Erlenmeyer flask, 250mL	___	___	1 Test tube clamp
___	___	1 Cylinder, graduated, 10mL	___	___	1 Clay triangle
___	___	1 Cylinder, graduated, 100mL	___	___	1 Forceps
___	___	1 Funnel, 65mm	___	___	1 Clay triangle
___	___	1 Watch glass, 75 x 125mm	___	___	1 Test tube rack
___	___	10 Test tubes 12 x 75mm	___	___	1 Rubber stopper, size 6 solid
___	___	4 Test tubes 18 x 150mm	___	___	1 Rubber stopper, size 1-2H
___	___	4 Test tube caps, 18mm	___	___	4 Glass stirring rods
___	___	4 Test tubes 18 x 150mm	___	___	1 Pipet pump, 10mL
___	___	3 Dropping bottles w/out caps	___	___	1 Combination lock
___	___	1 Porcelain evaporating dish			
___	___	3 Medicine Droppers			

I received the above equipment in good condition on _____

Student Signature _____ Date _____

Teaching Assistant Signature _____ Date _____

Check-Out Assistant Signature _____ Date _____

LOCK NUMBER:_____ (located on back of lock) Revised 07/14

WEST VIRGINIA UNIVERSITY

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY
Chemistry 117/118

PLEASE PRINT

Name _____

Date _____ Room Number _____ Desk Number _____ Section _____

Local Telephone Number _____ Email Address _____

Chemistry 117/118 Day of Lab _____ Time of Lab_____

ATTENTION: CAREFULLY READ THE FOLLOWING INFORMATION

1. This apparatus is the property of the University and is loaned to you for the semester. These items are to be returned clean, dry, and in good condition when leaving the course.
2. Check all items carefully, listing missing or broken items on your DESK CONDITION REPORT. Obtain your Teaching Assistant's signature to verify that these items are broken or missing. Obtain replacement items in from the Stock room, Room 204 Clark Hall. Upon completion of the check-in procedures, hand this sheet and your DESK CONDITION REPORT to your Teaching Assistant. (Very Important)
3. You are responsible for this equipment, as well as any items checked out from the Stockroom.
4. To signify that you have read and understood all laboratory procedures and Safety Regulations and that you agree to abide by these rules, sign below:

Student Signature _____ Date _____

NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY

IN OUT

TOP DRAWER

___ ___ 1 Cylinder, grad., 10ml
___ ___ 1 Cylinder, grad., 100ml
___ ___ 2 Weighing bottles
___ ___ 3 Crucibles with covers
___ ___ 3 Gooch crucibles with holder
___ ___ 3 Nichrome triangles
___ ___ 1 Scoopula
___ ___ 1 Thermometer, 110EC
___ ___ 2 Buret funnels
___ ___ 3 Funnels, 65mm
___ ___ 3 Stirring rods
___ ___ 3 Stirring rods with rubber policemen
___ ___ 1 Test tube clamp
___ ___ 2 Assorted rubber stoppers
___ ___ 1 Wing top
___ ___ 1 Pair tongs
___ ___ 1 Triangular file
___ ___ 2 Test tube brushes
___ ___ 3 Wire gauze-asbestos center
___ ___ 3 Watch glasses, 125mm

IN OUT

TOP DRAWER

___ ___ 1 Pipet bulb, 60ml
___ ___ Litmus paper
___ ___ 1 Pipet grad. 0.01, 1ml
___ ___ 1 Pipet grad. 0.1, 10ml
___ ___ 1 Pipet, volumetric, 10ml
___ ___ 1 Pipet, volumetric, 25ml
___ ___ 1 Combination lock
___ ___ 4 Medium test tubes, 6"
___ ___ 6 Large test tubes, 8"
___ ___ 1 Test tube rack

MIDDLE DRAWER

___ ___ 3 Beakers, 50ml
___ ___ 6 Beakers, 100ml
___ ___ 3 Beakers, 250ml
___ ___ 4 Beakers, 400ml
___ ___ 1 Beaker, 600ml
___ ___ 1 Wash bottle ___ ___ 1 Desiccator/plate
___ ___ 1 Filter flask, 250ml
___ ___ 1 Filter flask, 500ml
___ ___ 2 Lengths vacuum tubing

IN OUT

MIDDLE DRAWER

___ ___ 2 Erlenmeyer flasks, 125ml
___ ___ 4 Erlenmeyer flasks, 250ml
___ ___ 1 Erlenmeyer flask, 500ml
___ ___ 5 Volumetric flasks, 100ml w/stoppers
___ ___ 2 Volumetric flasks, 250ml w/stoppers
___ ___ 1 Volumetric flask, 500ml w/stoppers

Cupboard Equipment

___ ___ 1 Evaporating dish
___ ___ 1 Buchner funnel
___ ___ 1 Sponge
___ ___ 1 Glass bottle, 2 liter
___ ___ 2 Plastic bottles, 1 liter
___ ___ 2 Small bottles, dropping

___ ___ 2 Small test tubes, 3"
___ ___ 2 Burets, 50ml
___ ___ 1 Buret, 25ml

I received the above equipment in good condition on _____

Student Signature _____ Date _____

Teaching Assistant Signature _____ Date _____

Check-Out Assistant Signature _____ Date _____

LOCK NUMBER:_____ (located on back of lock) Revised 07/15

WEST VIRGINIA UNIVERSITY

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY
Chemistry 215

PLEASE PRINT

Name _____

Date _____ Room Number _____ Desk Number _____ Section _____

Local Telephone Number _____ Email Address _____

Chemistry 215 Day of Lab _____ Time of Lab_____

ATTENTION: CAREFULLY READ THE FOLLOWING INFORMATION

1. This apparatus is the property of the University and is loaned to you for the semester. These items are to be returned clean, dry, and in good condition when leaving the course.
2. Check all items carefully, listing missing or broken items on your DESK CONDITION REPORT. Obtain your Teaching Assistant's signature to verify that these items are broken or missing. Obtain replacement items in from the Stock room, Room 204 Clark Hall. Upon completion of the check-in procedures, hand this sheet and your DESK CONDITION REPORT to your Teaching Assistant. (Very Important)
3. You are responsible for this equipment, as well as any items checked out from the Stockroom.
4. To signify that you have read and understood all laboratory procedures and Safety Regulations and that you agree to abide by these rules, sign below:

Student Signature _____ Date _____

NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY

IN	OUT	
___	___	1 Beaker, 1000mL
___	___	3 Beakers, 100mL
___	___	3 Beakers, 250mL
___	___	3 Beakers, 400mL
___	___	3 Beakers, 600 mL
___	___	2 Bottles with droppers
___	___	2 Buret funnels (small)
___	___	2 Burets, 50 mL
___	___	1 Combination lock
___	___	3 Crucibles with lids
___	___	1 Dessicator with plate and lid
___	___	1 Filter flask, 250 mL, with pressure tubing
___	___	1 Flask, Erlenmeyer, 500 mL
___	___	3 Flasks, Erlenmeyer, 250 mL
___	___	1 Flask, volumetric, 500 mL
___	___	2 Flasks, volumetric, 250 mL
___	___	1 Flask, volumetric, 100 mL
___	___	1 Funnel, 2.5"
___	___	1 Glass bottle, 1 L, with ground glass stopper
___	___	1 Gooch crucible adapter
___	___	3 Gooch crucibles (holes in bottom)

IN	OUT	
___	___	1 Graduated cylinder, 10 mL
___	___	1 Graduated cylinder, 100 mL
___	___	1 Pair of tongs
___	___	1 Pipet bulb
___	___	1 Pipet, volumetric, 10 mL
___	___	1 Pipet, volumetric, 25 mL
___	___	1 Plastic bottle, 1 L, with lid
___	___	2 Rubber stoppers, solid, #6
___	___	1 Scoopula
___	___	3 Stirring rods with rubber tips
___	___	1 Test tube brush
___	___	1 Test tube clamp
___	___	1 Test tube rack
___	___	6 Test tubes, 6"
___	___	1 Thermometer, digital
___	___	2 Vials, 4 dram, with stoppers
___	___	1 Wash bottle, 250 mL
___	___	3 Watch glasses, 3.5"
___	___	2 Weighing bottles with ground glass lids
___	___	2 Wire gauzes

I received the above equipment in good condition on _____

Student Signature _____ Date _____

Teaching Assistant Signature _____ Date _____

Check-Out Assistant Signature _____ Date _____

LOCK NUMBER:_____ (located on back of lock) Revised 07/14

WEST VIRGINIA UNIVERSITY

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY
Chemistry 231/235/236

PLEASE PRINT

Name _____

Date _____ Room Number _____ Desk Number _____ Section _____

Local Telephone Number _____ Email Address _____

Chemistry 231/235/236 Day of Lab _____ Time of Lab_____

ATTENTION: CAREFULLY READ THE FOLLOWING INFORMATION

1. This apparatus is the property of the University and is loaned to you for the semester. These items are to be returned clean, dry, and in good condition when leaving the course.
2. Check all items carefully, listing missing or broken items on your DESK CONDITION REPORT. Obtain your Teaching Assistant's signature to verify that these items are broken or missing. Obtain replacement items in from the Stock room, Room 204 Clark Hall. Upon completion of the check-in procedures, hand this sheet and your DESK CONDITION REPORT to your Teaching Assistant. (Very Important)
3. You are responsible for this equipment, as well as any items checked out from the Stockroom.
4. To signify that you have read and understood all laboratory procedures and Safety Regulations and that you agree to abide by these rules, sign below:

Student Signature _____ Date _____

NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY

IN	OUT	
___	___	6 Beakers, 2-50 ml, 1-100ml, 1-250ml, 1-400ml, 1-600ml
___	___	2 Cylinders, grad., 1-10ml, 1-50ml
___	___	1 Filter flask, 125ml
___	___	6 Erlenmeyer flasks, 2-25ml, 2-50ml, 2-125ml
___	___	1 Funnel, 65mm, no stem
___	___	1 Hirsch funnel, size 40
___	___	1 Filter adapter, size 2
___	___	1 Forceps
___	___	1 Spatula (micro)
___	___	2 Stirring rods, 125mm
___	___	1 Test tube holder
___	___	12 Test tubes, 3"

IN	OUT	
___	___	6 Test tubes, 6"
___	___	1 Combination lock
___	___	1 Sample syringe, 1ml
		KIT ITEMS
___	___	1 Air Condenser 14/10-14/19
___	___	1 Jacketed condenser 14/10-14/10
___	___	1 Claisen hd, threaded both top joints 14/10
___	___	1 Craig tube, btm 2ml
___	___	1 Craig tube, teflon plug
___	___	1 Conical, reaction, student vial, 3ml
___	___	1 Spin vane
___	___	2 Conical reaction, student vials, 5ml
___	___	1 Flask, RB, 10ml, 14/10 threaded outer joint

I received the above equipment in good condition on _____

Student Signature _____ Date _____

Teaching Assistant Signature _____ Date _____

Check-Out Assistant Signature _____ Date _____

LOCK NUMBER:_____ (located on back of lock) Revised 07/17

WEST VIRGINIA UNIVERSITY

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY
Chemistry 335

PLEASE PRINT

Name _____

Date _____ Room Number _____ Desk Number _____ Section _____

Local Telephone Number _____ Email Address _____

Chemistry 335 Day of Lab _____ Time of Lab_____

ATTENTION: CAREFULLY READ THE FOLLOWING INFORMATION

1. This apparatus is the property of the University and is loaned to you for the semester. These items are to be returned clean, dry, and in good condition when leaving the course.
2. Check all items carefully, listing missing or broken items on your DESK CONDITION REPORT. Obtain your Teaching Assistant's signature to verify that these items are broken or missing. Obtain replacement items in from the Stock room, Room 204 Clark Hall. Upon completion of the check-in procedures, hand this sheet and your DESK CONDITION REPORT to your Teaching Assistant. (Very Important)
3. You are responsible for this equipment, as well as any items checked out from the Stockroom.
4. To signify that you have read and understood all laboratory procedures and Safety Regulations and that you agree to abide by these rules, sign below:

Student Signature _____ Date _____

NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY

IN OUT
___ ___ 2 Beakers, 50mL
___ ___ 3 Beakers, 100mL
___ ___ 1 Beaker, 250mL
___ ___ 1 Beaker, 400mL
___ ___ 1 Beaker, 600mL
___ ___ 1 Cylinder, grad., 10mL
___ ___ 1 Cylinder, grad., 100mL
___ ___ 1 Filter flask, 250mL
___ ___ 1 Filter flask rubber adapter, size 3
___ ___ 2 Erlenmeyer flasks, 50mL
___ ___ 2 Erlenmeyer flasks 125mL
___ ___ 1 Erlenmeyer flasks, 250mL
___ ___ 2 Funnels, 65mm (1-No stem)
___ ___ 1 Buchner funnel
___ ___ 10 Sample vials, 1 dram
___ ___ 1 Metal scoopula
___ ___ 2 Stirring rods
___ ___ 12 Test tubes, 3"
___ ___ 12 Test tubes, 6"
___ ___ 1 Cork ring, 90mm

IN OUT
___ ___ 4 NMR tubes
___ ___ 1 Test tube rack
___ ___ 1 Test tube rack
___ ___ 2 Wash bottles, 250mL
___ ___ 1 Combination lock

The following items are 19/22 ground glassware:
___ ___ 1 Condenser, west
___ ___ 1 Distilling column
___ ___ 1 Flask, round bottom, 25mL
___ ___ 1 Flask, round bottom, 50mL
___ ___ 2 Flask, round bottom, 100mL
___ ___ 1 Flask, round bottom, 250mL
___ ___ 1 Funnel, separatory, 125mL
___ ___ 1 Glass stopper, 125mL
___ ___ 1 Tube, Thermometer Adapter
___ ___ 1 Tube, 3-Way Connector
___ ___ 1 Tube, Claisen

I received the above equipment in good condition on _____

Student Signature _____ Date _____

Teaching Assistant Signature _____ Date _____

Check-Out Assistant Signature _____ Date _____

LOCK NUMBER:_____ (located on back of lock) Revised 07/17

WEST VIRGINIA UNIVERSITY

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY
Chemistry 339

PLEASE PRINT

Name _____

Date _____ Room Number _____ Desk Number _____ Section _____

Local Telephone Number _____ Email Address _____

Chemistry 339 Day of Lab _____ Time of Lab_____

ATTENTION: CAREFULLY READ THE FOLLOWING INFORMATION

1. This apparatus is the property of the University and is loaned to you for the semester. These items are to be returned clean, dry, and in good condition when leaving the course.
2. Check all items carefully, listing missing or broken items on your DESK CONDITION REPORT. Obtain your Teaching Assistant's signature to verify that these items are broken or missing. Obtain replacement items in from the Stock room, Room 204 Clark Hall. Upon completion of the check-in procedures, hand this sheet and your DESK CONDITION REPORT to your Teaching Assistant. (Very Important)
3. You are responsible for this equipment, as well as any items checked out from the Stockroom.
4. To signify that you have read and understood all laboratory procedures and Safety Regulations and that you agree to abide by these rules, sign below:

Student Signature _____ Date _____

NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY

IN OUT
___ ___ 4 Beakers, 30mL
___ ___ 2 Beakers, 50 mL
___ ___ 2 Beakers, 100 mL
___ ___ 2 Beaker, 250 mL
___ ___ 1 Beaker, 600mL
___ ___ 1 Beaker, 1000ml
___ ___ 2 Glass Stir rods
___ ___ 1 Grad. Cylinder, 50 mL
___ ___ 1 Condenser, west
___ ___ 1 Filter Flask, 50 mL
___ ___ 1 Distilling column
___ ___ 1 Filter Flask, 500 mL
___ ___ 2 Rubber Stoppers, filter flask
___ ___ 2 Erlenmeyer flasks, 50 mL
___ ___ 2 Erlenmeyer flasks, 250 mL
___ ___ 2 Funnels, 65 mm
___ ___ 1 Buchner Funnel
___ ___ 1 Hirsch Funnel
___ ___ 2 Scoopulas
___ ___ 1 Microspatula
___ ___ 1 Test Tube Clamp
___ ___ 1 Magnetic Stir Bar 1"

IN OUT
___ ___ 1 Separatory Funnel 250 mL
___ ___ 2 Rubber filter adapters
___ ___ 1 Adapter 19/38-24/40
___ ___ 1 Adapter 24/40-19/38
___ ___ 4 Watch Glasses, 50 mm
___ ___ 1 Triangular File
___ ___ 1 Forceps
___ ___ 1 Combination Lock

The following items are 19/22 ground glassware:
___ ___ 1 Condenser, West
___ ___ 1 Distilling column
___ ___ 1 Flask, round bottom, 25mL
___ ___ 1 Flask, round bottom, 50mL
___ ___ 1 Flask, round bottom, 100mL
___ ___ 1 Flask, round bottom, 250mL
___ ___ 1 Flask, round bottom, 500mL
___ ___ 1 Funnel Separatory Funnel, 125 mL
___ ___ 1 Glass Stopper
___ ___ 1 Tube, Straight, w/Thermometer opening
___ ___ 1 Tube, Connecting, (Claisen)

I received the above equipment in good condition on _____

Student Signature _____ Date _____

Teaching Assistant Signature _____ Date _____

Check-Out Assistant Signature _____ Date _____

LOCK NUMBER:_____ (located on back of lock) Revised 07/14

WEST VIRGINIA UNIVERSITY

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY
Chemistry 342

PLEASE PRINT

Name _____

Date _____ Room Number _____ Desk Number _____ Section _____

Local Telephone Number _____ Email Address _____

Chemistry 342 Day of Lab _____ Time of Lab_____

ATTENTION: CAREFULLY READ THE FOLLOWING INFORMATION

1. This apparatus is the property of the University and is loaned to you for the semester. These items are to be returned clean, dry, and in good condition when leaving the course.
2. Check all items carefully, listing missing or broken items on your DESK CONDITION REPORT. Obtain your Teaching Assistant's signature to verify that these items are broken or missing. Obtain replacement items in from the Stock room, Room 204 Clark Hall. Upon completion of the check-in procedures, hand this sheet and your DESK CONDITION REPORT to your Teaching Assistant. (Very Important)
3. You are responsible for this equipment, as well as any items checked out from the Stockroom.
4. To signify that you have read and understood all laboratory procedures and Safety Regulations and that you agree to abide by these rules, sign below:

Student Signature _____ Date _____

NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY

IN	OUT		IN	OUT	
___	___	4 Beakers, 50mL	___	___	1 Forceps
___	___	2 Beakers, 250mL	___	___	1 Mohr Pipet, 10mL
___	___	2 Beakers, 400mL	___	___	1 Funnel, 22" stem
___	___	2 Volumetric flasks, 100mL,gs	___	___	1 Scoopula
___	___	10 Erlenmeyer flasks, 50mL	___	___	2 Vials, glass, 20mL
___	___	2 Erlenmeyer flasks, 125mL	___	___	1 Wash bottle, plastic, 250mL
___	___	4 Erlenmeyer flasks, 250mL	___	___	1 Pipet bulb, 60mL
___	___	1 Thermometer, 110EC	___	___	1 Combination lock
___	___	1 Cylinder, graduated, 100mL	___	___	4 Stirring rods
___	___	1 Watch glass, 32"	___	___	4 Medicine droppers
___	___	1 Watch glass, 5"	___	___	3 Volumetric flasks, 50mL
___	___	12 Test tubes, 3"			

I received the above equipment in good condition on _____

Student Signature _____ Date _____

Teaching Assistant Signature _____ Date _____

Check-Out Assistant Signature _____ Date _____

LOCK NUMBER:_____ (located on back of lock) Revised 07/14

WEST VIRGINIA UNIVERSITY

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY
Chemistry 347/349

PLEASE PRINT

Name _____

Date _____ Room Number _____ Desk Number _____ Section _____

Local Telephone Number _____ Email Address _____

Chemistry 347/349 Day of Lab _____ Time of Lab_____

ATTENTION: CAREFULLY READ THE FOLLOWING INFORMATION

1. This apparatus is the property of the University and is loaned to you for the semester. These items are to be returned clean, dry, and in good condition when leaving the course.
2. Check all items carefully, listing missing or broken items on your DESK CONDITION REPORT. Obtain your Teaching Assistant's signature to verify that these items are broken or missing. Obtain replacement items in from the Stock room, Room 204 Clark Hall. Upon completion of the check-in procedures, hand this sheet and your DESK CONDITION REPORT to your Teaching Assistant. (Very Important)
3. You are responsible for this equipment, as well as any items checked out from the Stockroom.
4. To signify that you have read and understood all laboratory procedures and Safety Regulations and that you agree to abide by these rules, sign below:

Student Signature _____ Date _____

NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY

IN	OUT		IN	OUT	
___	___	3 Eye droppers	___	___	1 Funnel, 65mm
___	___	1 Stirring rod	___	___	1 Grad. cylinder, 10mL
___	___	1 Test tube brush	___	___	1 Grad. cylinder, 100mL
___	___	1 Sponge	___	___	1 Watch glass, 32"
___	___	4 Beakers, 50mL	___	___	1 Watch glass, 5"
___	___	2 Beakers, 250mL	___	___	1 Wash bottle, 250mL
___	___	2 Beakers, 400mL	___	___	2 Vials, glass, 20mL
___	___	2 Volumetric flasks, 100mL, gs	___	___	1 Pipet bulb, 60mL
___	___	2 Volumetric flasks, 250mL, gs	___	___	1 Pipet (grad.), 10mL
___	___	10 Erlenmeyer flasks, 50mL	___	___	1 Scoopula
___	___	2 Erlenmeyer flasks, 125mL	___	___	1 Thermometer, -20EC - +110EC
___	___	4 Erlenmeyer flasks, 250mL	___	___	1 Combination lock

I received the above equipment in good condition on _____

Student Signature _____ Date _____

Teaching Assistant Signature _____ Date _____

Check-Out Assistant Signature _____ Date _____

LOCK NUMBER:_____ (located on back of lock) Revised 07/14

WEST VIRGINIA UNIVERSITY

C. EUGENE BENNETT DEPARTMENT OF CHEMISTRY
Chemistry 423

PLEASE PRINT

Name _____

Date _____ Room Number _____ Desk Number _____ Section _____

Local Telephone Number _____ Email Address _____

Chemistry 423 Day of Lab _____ Time of Lab_____

ATTENTION: CAREFULLY READ THE FOLLOWING INFORMATION

1. This apparatus is the property of the University and is loaned to you for the semester. These items are to be returned clean, dry, and in good condition when leaving the course.
2. Check all items carefully, listing missing or broken items on your DESK CONDITION REPORT. Obtain your Teaching Assistant's signature to verify that these items are broken or missing. Obtain replacement items in from the Stock room, Room 204 Clark Hall. Upon completion of the check-in procedures, hand this sheet and your DESK CONDITION REPORT to your Teaching Assistant. (Very Important)
3. You are responsible for this equipment, as well as any items checked out from the Stockroom.
4. To signify that you have read and understood all laboratory procedures and Safety Regulations and that you agree to abide by these rules, sign below:

Student Signature _____ Date _____

NO EQUIPMENT OR CHEMICALS MAY BE REMOVED FROM THE LABORATORY

IN OUT
___ ___ 2 Beakers, 50mL
___ ___ 2 Beakers, 100mL
___ ___ 2 Beakers, 250mL
___ ___ 1 Beaker, 400mL
___ ___ 1 Beaker, 600mL
___ ___ 2 Glass stir rods
___ ___ 1 Grad. Cylinder, 10mL
___ ___ 1 Thermometer, 110EC
___ ___ 2 Buret funnels
___ ___ 3 Funnels, 65mm
___ ___ 1 Grad. Cylinder, 100mL
___ ___ 6 Test tubes, 6″
___ ___ 1 Test tube clamp
___ ___ 1 Test tube rack
___ ___ 1 Tube connecting, three-way
___ ___ 1 Tube connecting, vacuum
___ ___ 2 NMR tubes
___ ___ 2 Magnetic stir bars, 1″
___ ___ 1 Separatory Funnel, 250mL, with stopper

IN OUT
___ ___ 2 Watch glasses, 100mm
___ ___ 1 Wash bottle, 250mL
___ ___ 1 Forceps
___ ___ 1 Combination lock
___ ___ 2 Watch glasses, 100mm
___ ___ 1 Cork ring, small
___ ___ 1 Cork ring, large
___ ___ 1 Filter flask, 250mL
___ ___ 1 Rubber filter adapters, #2
___ ___ 1 Rubber filter adapters, #3
___ ___ 2 Erlenmeyer flasks, 25mL
___ ___ 2 Erlenmeyer flasks, 50mL
___ ___ 2 Erlenmeyer flasks, 125mL
___ ___ 2 Erlenmeyer flasks, 250mL
___ ___ 1 Erlenmeyer flask, 500mL
___ ___ 2 Funnels, 65mm (1-Liquid, 1-Powder)
___ ___ 1 Buchner funnel
___ ___ 1 Hirsch funnel
___ ___ 2 Scoopulas
___ ___ Micro spatula

IN OUT
The following items are 19/22 ground glassware:
___ ___ 1 Condenser, West
___ ___ 1 Distilling column
___ ___ 1 Flask, round bottom, 25mL
___ ___ 1 Flask, round bottom, 50mL
___ ___ 1 Flask, round bottom, 100mL
___ ___ 1 Flask, round bottom, 250mL
___ ___ 1 24/40 Nitrogen Inlet Connector
___ ___ 3 Glass stoppers
___ ___ 1 Tube, straight w/thermometer opening
___ ___ 1 Tube, connecting, Claisen
___ ___ 1 Funnel, addition, with stopper and adapter

I received the above equipment in good condition on _____

Student Signature _____ Date _____

Teaching Assistant Signature _____ Date _____

Check-Out Assistant Signature _____ Date _____