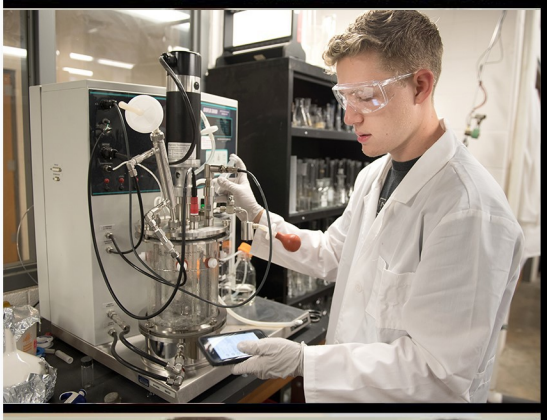

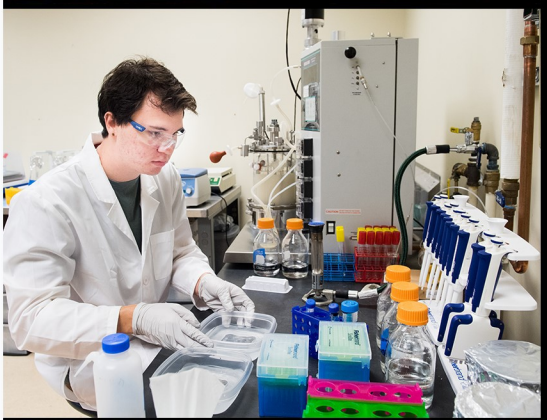

THE UNIVERSITY OF TENNESSEE
CHATTANOOGA
College of Engineering and Computer Science

Laboratory Safety Manual

October 2021

This document is subject to revision.
Students, faculty, and staff who have questions regarding manual content and procedures are encouraged to contact
Dr. Bradley Harris, CECS Hygiene Officer
at Bradley-Harris @utc.edu or (423) 425-2209

Version 1.5

CECS Important Information and Contacts

- **In any situation where there is question as to how to handle a spill safely, contact the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) immediately.**
- **In any situation where there are severe health hazards due to a chemical spill contact the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) who will in turn contact the Director of Safety and Risk Management (Bob Jackson, 425-5949), when necessary. If Bradley Harris is unavailable, contact Karen Lomen, EMCS 430, 425-4020.**
- **For after-hours emergencies, call Campus Security (423) 425-HELP via cell phone the dispatcher will be able to contact Dr. Harris via his cell (423) 312-0790.**

Medical attention should be obtained for body contact with hazardous chemicals, concrete, electrical power sources, shop equipment, or any other laboratory items which may cause injury.

In the event that an emergency threatens the safety of any student, faculty, or staff, dial 911 immediately. Dialing 911 from a campus landline will direct the call to Campus Police. Dialing 911 from a cell phone will route the call to the Chattanooga Police Department

The UTC Office of Safety and Risk Management is responsible for the safety and environmental concerns of the university. Should guidance be required for a safety or environmental issue, please call the appropriate person below:

UTC Office of Safety & Risk Management:	423-425-5741
Robert Mullins, Health and Safety Supervisor:	423-425-5820 Robert-Mullins@utc.edu
Bob Jackson, Safety and Risk Management:	423-425-5949 Bob-Jackson@utc.edu
Joel Wands, Life Safety Technician	423-425-5794 Joel-Wands@utc.edu
Campus Police, Non-Emergency	423-425-4357
Bradley Harris, CECS Chemical Hygiene Officer	423-425-2209 Office 423-312-0790 Cell
Karl Fletcher, CECS Technical Support	423-425-4306
Ben Swords, Design Lab Supervisor	423-425-2154
Chris Thornton, Lab Support Engineer	423-425-2175
CECS Technical Support, Computer Support	423-425-2175
Poison Control Hotline	800-222-1222

Remember

If health or life is in danger, dial 911

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1. Introduction

Safety for students, staff, and faculty is the top priority in the College of Engineering and Computer Science at the University of Tennessee, Chattanooga. The college is committed to creating an environment that places personal safety and health of students, staff, faculty, and visitors first by controlling or eliminating recognized hazards. This safety manual describes policies and procedures that govern access to laboratories, handling of hazardous materials, inspection, and inventory control. Anyone accessing and/or using equipment or handling materials in laboratories within the college must follow accepted procedures and adhere to the publishedpolicies. The procedures and policies were developed to assist the college to control hazardoussituations, and therefore, it is critical that everyone in the college be familiar with the contents of this manual and know the appropriate actions to take dealing with potential hazards.

2. Safety Standards and Policies

This manual specifies laboratory safety policies and standards. In addition to this manual, all personnel handling chemicals and hazardous materials must follow the OSHA (Occupational Safety and Health Administration) standards and policies. Other federal, state, and local regulations specified by the Environmental Protection Agency and National Institutes of Health should also be followed.

Hazards can cause injuries, loss of physical or cognitive functions, or even death. It is everyone's responsibility to maintain laboratory safety and report any suspected hazards to the right personnel, immediately (See page 2 of this manual). Laboratory managers should assess the risks and identify hazards periodically. Once assessed and identified, specific standards and policies must be developed. Students, staff, and faculty using the laboratory must be trained and learn developed policies and procedures.

3. Roles and Responsibilities

   a. CECS College Laboratory Safety Committee
      The committee is consisted of the following 14 members, appointed by the Dean, representing the Dean's office and departments operating teaching and research laboratory spaces:
      - Associate Dean of the college (Dr. Michael Danquah, permanent member by position)
      - Head of Civil and Chemical Engineering (Dr. Joe Owino, permanent member by position)
      - Head of Electrical Engineering (Dr. Abdelrahman Karrar, permanent member by position)
      - Head of Mechanical Engineering (Dr. James Newman, permanent member by position)
      - Head of Engineering Management and Technology (Dr. Ahad Nasab, permanent member by position)

- Head of Computer Science and Engineering (Dr. Luay A. Wahsheh, permanent member by position)
- Hygiene Officer for the college (Dr. Bradley Harris, three year term)
- Chemical Engineering Laboratory Manager (Dr. Sungwoo Yang, two year term)
- Civil Engineering Laboratory Manager (Dr. Weidong Wu, two year term)
- Computer Science and Engineering Laboratory Manager (Dr. Farah Kandah, two year term)
- Electrical Engineering Laboratory Manager (Dr. Raga Ahmed, two year term)
- Engineering Management and Technology (Dr. Seong Dae Kim, two year term)
- Mechanical Engineering (Dr. Charles Margraves, Dr. Gary McDonald, two year term)
- Machine Shop and IT Manager (Mr. Karl Fletcher, permanent member by position)

The committee is responsible to faithfully carry out the policies and procedures stated in UTC CECS Laboratory Safety Manual, perform an annual inspection of each laboratory, and discuss ways to improve the overall safety. The committee will meet once per semester.

b. Dean
The Dean of the college is directly responsible for the safety of all departments and units under his or her authority.

c. Associate Dean
As chair of the College Laboratory Safety Committee, the Associate Dean is responsible for overseeing the implementation of the safety procedures and policies within the department.

d. Department Heads
The department heads are responsible for identifying individuals to serve as the lab manager for each teaching laboratory within their departments, and the responsible parties are fulfilling their stated responsibilities.

e. Faculty, Principle Investigator, or Laboratory Manager
The individual is responsible for the safety of the people working in his or her laboratory. The responsibility includes compliance with the procedures specified in the LaboratorySafety Manual, establishing laboratory specific operating procedures and policy, and identifying and managing potential future hazards.

f. Students, laboratory personnel and visitors
Students and visitors must follow the directions of the faculty or lab manager. Students and laboratory personnel must be trained before obtaining access to laboratories, using equipment, or handling materials. All students, laboratory personnel, and visitors must read and adhere to the laboratory safety rules and procedures specified. If potential hazards are identified, they must be reported to the faculty or the lab manager.

4. Laboratory Access Control Measures

The College of Engineering and Computer Science maintains an open lab policy.

Use of Engineering and Computer Science facilities is only for students majoring in Engineering, Computer Science, Engineering, and Engineering Management and Technology, or who are currently taking one or more classes in these programs.

The Open Lab Policy means students who are majors in the College or taking one or more classes in the College concentrations can work in the lab during the evenings or on weekends, once they have ***completed appropriate training, signed the required lab responsibilities agreement included in their course syllabi, and have been approved for lab access by their instructor or lab manager***. Once students have completed these requirements for access to the labs, the lab instructors and lab managers will convey to the administrative assistants in each department that information, so that the students' Mocs card access permissions can be updated accordingly.

There is a swipe card lock on each of the laboratory doors; ***each person must swipe their own Mocs card for entry into the labs.***

In addition to using the card swipe to access the labs, all students must utilize the Laboratory Access Log present in each lab. Students must enter into the Log, their names, date, and times of entry and exit.

Training and review of safety procedures will be conducted during initial class meetings.

All safety and operating procedures must be followed at all times. If the Open Lab Policy is not followed, students' open lab privilege will be revoked.

5. Hazard Assessment Process

    1. Faculty, staff and/or students employing the use of hazardous chemicals (see below) or powered or manual machinery (e.g. machine tools, band saws, breaks, shears, welding equipment, etc.) in CECS laboratories or shops, student projects, or student club or group activities are required to conduct a formal risk assessment consistent with the CECS template (see Appendix B).
    2. A hazardous chemical, as defined by the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard (CFR 1910.1200), is any chemical which can cause a physical or health hazard (e.g. irritants, flammables, corrosives, carcinogens, etc.). If you are unsure as to whether or not a chemical is hazardous, you should review the safety data sheet (SDS) issued by the manufacturer. A folder containing copies of SDS's for all chemicals present is maintained for each lab and can be found on a shelf on the back of the lab door.
        a. Identify the 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.
    3. All risks will be mitigated to the lowest level to protect workers from hazards using a combination of engineering controls, administrative controls, and personal protective equipment (PPE), listed in order of priority. 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.
    4. Safety concerns for each laboratory or shop will be reviewed in relevant courses at the beginning of the semester prior to entering the lab and included in course syllabi for reference. In addition, lab safety rules, hazard communication pictograms and emergency procedures will be posted at the entrance to each lab.
    5. All laboratory accidents will be reported to the CECS Laboratory Safety Committee and reviewed for root cause.

    In addition to the initial risk assessment, the Office of Safety and Risk Management (OSRM) and/or the CECS Laboratory Safety Committee may deem additional exposure assessment(s) merited based on annual inspection results. Assessing exposure to hazardous chemicals may be accomplished through a number of methods, including employee interviews, visual observation of chemical use, evaluation of engineering controls, use of direct reading instrumentation, or the collection of analytical samples from the employee's breathing zone. Personal exposure assessment will be performed under either of the following situations:

1. Based on chemical inventories, review of Standard Operating Procedures (SOPs), types of engineering controls present, laboratory inspection results and/or review of the initial laboratory hazard assessment, the OSRM and/or the CECS Lab Safety Committee determines whether an exposure assessment is warranted; or
2. User of a hazardous chemical has concern or reason to believe exposure is not minimized or eliminated through use of engineering controls or administrative practices and the potential for exposure exists. The user should then inform his or her PI/Laboratory Supervisor, who will in turn contact the CECS Chemical Hygiene Officer and the OSRM. The OSRM will then determine the best course of action in assessing employee exposure, including visual assessment, air monitoring, medical evaluation, examination, or medical surveillance.

Medical Evaluation

All employees, student workers, medical health services volunteers, or laboratory personnel who work with hazardous chemicals shall have an opportunity to receive a medical evaluation, including supplemental examinations which the evaluating physician determines necessary, under the following circumstances:

1. Whenever an employee or student develops signs or symptoms associated with a hazardous chemical to which an employee may have been exposed in a laboratory;
2. Where personal monitoring indicates exposure to a hazardous chemical
3. Whenever an uncontrolled event takes place in the work area such as a spill, leak, explosion, fire, etc., resulting in the likelihood of exposure to a hazardous chemical; or
4. Upon reasonable request of the employee or student to discuss medical issues and health concerns regarding work-related exposure to hazardous chemicals.

Any laboratory employee or student worker who exhibits signs and symptoms of adverse health effects from work-related exposure to a hazardous chemical should report to Public Safety immediately for a medical evaluation.

Information to Provide to the Clinician

At the time of the medical evaluation, the following information shall be provided:

1. Personal information such as age, weight and university employee or student ID number;
2. Common and/or IUPAC name of the hazardous chemicals to which the individual may have been exposed;
3. A description of the conditions under which the exposure occurred;
4. Quantitative exposure data, if available;
5. A description of the signs and symptoms of exposure that the employee is experiencing
6. A copy of the Safety Data Sheet (SDS) of the hazardous chemical in question;
7. History of exposure including previous employment and non-occupational (recreational) hobbies; and
8. Any additional information helpful to Public Safety in assessing or treating an exposure or injury such as a biological component of exposure or existence of an antitoxin.

Physician's Written Opinion

For evaluation or examination information from the examining physician shall include the following:

1. Recommendation for further medical follow-up;
2. Results of the medical examination and any associated tests, if requested by the employee or student;
3. Any medical condition which may be revealed in the course of the examination which may place the employee or student at increased risk as a result of exposure to a hazardous chemical found in the workplace; and
4. A statement that the employee or student 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.

Confidentiality & Individual's Access to Personal Medical Records

All patient medical information is protected by Tennessee and federal law and is considered strictly confidential. UTC is prohibited from disclosing any patient medical information that is not directly related to the work-related exposure under evaluation and should not reveal any diagnosis unrelated to exposure.

6. Operating Procedures – Open Laboratory Policy

The College of Engineering and Computer Science maintains an open lab policy. This means you can work in the lab during the evenings or on weekends, once you have permission to do so from your instructor. There is a swipe card lock on each of the laboratory doors; each person must swipe their own Mocs card in addition to signing the entry log. In order to gain access to the lab, you must first have permission and safety training given by your lab instructor or lab manager. The training and review of safety procedures will be conducted during your initial class meeting.

The following safety and operating procedures must be followed at all times. If this policy is not followed, your open lab privilege will be revoked.

- Engineering and Computer Science facilities are only for the use of students majoring in Engineering, Computer Science and Engineering, Engineering Technology & Management or who arecurrently taking one or more classes in these programs.
- Anyone working in the lab after normal hours (see lab manager) must follow the specific access requirements identified by the lab manager or instructor.
- There must be at minimum two persons in the lab at all times, including when work is conducted after hours (short 5 minutes breaks are permitted). The last person to leave the lab needs to ensure that all lights, heat sources, and equipment are turned off.
- No hazardous materials of any type may be brought into the lab without permission of the appropriate chemical hygiene officer.
- You will be held responsible for all equipment. Do not let anyone take equipment from the labs. Call the Campus Police at (423) 425-HELP (4357) to enforce this policy if necessary.
- Doors may not be propped open at any time. Use your Mocs Card for access. If you don't have access, see the Administrative Assistant of your major department.
- Never give unauthorized persons access to the lab.
- The college is not responsible for personal items left in the laboratories or classrooms.
- Do not conduct any activity that might be considered dangerous or in violation of any of the university's acceptable use policies.
- **No food, drinks or tobacco products are allowed in the labs.**
- Leave the labs neat and orderly.
- Technical support issues should be e-mailed to **CECSTECH@utc.edu.**

7. Emergency and Medical Procedures

In all emergencies, the Director of Safety and Risk Management (Bob Jackson, 425-5549) should be contacted as soon as possible.

A. Extreme hazards, such as high radiation levels or the possibility of airborne contamination from dry or volatile radioactive materials.

1. Cease work as rapidly as possible. If the hood was in use, close the hood door.
2. Evacuate the laboratory immediately. Close and lock the door. A notice not to enter the room must be placed on the door to prevent entry.
3. Summon a representative of UTC's Office of Safety and Risk Management immediately.
4. Remove contaminated clothing and wash contaminated areas of the body with detergent.

B. Accidents and spills: consult the SDS file found in room 445A, EMCS Building.

Eye contact: Promptly flush eyes with water for 15 minutes and seek medical attention. Medical attention should be obtained for body contact with hazardous chemicals.

Ingestion: Consult the SDS (file found in room 445C, EMCS Building) and/or Erlanger Poison Control Center (778-7000). Each chemical affects the body differently. Medical attention should be obtained for ingestion of hazardous chemicals.

Skin contact: Promptly flush the affected area with water and remove contaminated clothing. Use a safety shower if chemical contact is extensive. If symptoms persist after washing, seek medical attention. Medical attention should be obtained for body contact with hazardous chemicals.

Clean-up: Promptly clean up spills, using appropriate protective apparel and equipment. Dispose of clean-up materials properly. If possible, clean-up should be performed by the staff technician.

In any situation where there is question as to how to handle a spill safely, contact the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) immediately.

In any situation where there are severe health hazards due to a chemical spill contact the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) who will in turn contact the Director of Safety and Risk Management (Bob Jackson, 425-5949), when necessary.

If Bradley Harris is unavailable, contact Karen Lomen, EMCS 435, 425-4020.

For after-hours emergencies, call Campus Security (911) who will be able to contact Dr. Harris.

Medical attention should be obtained for body contact with hazardous chemicals.

8. Inspection

CECS adopted a policy of periodic yearly inspections (environmental, health, and safety) of all laboratory facilities by Associate Dean of the college, Hygiene Officer, and of an annual unannounced inspection by a team of UTC's Office of Safety and Risk Management.

Self-Inspection

The team responsible for conducting the internal inspection is made up of the College Laboratory Safety Committee members and members of UTC's Office of Safety and Risk Management. The inspection consists of both interviews of faculty, staff, and students with access to laboratories and laboratory/shop inspection. The committee is responsible for developing questionnaires used in the interviews. The shop/laboratory inspection includes

1. Posted signage of emergency procedure and laboratory policy

2. First aid equipment

3. Personal protective equipment

4. Cleanness of laboratory and environmental hazards

5. Adherence to lab procedures and rules

6. Chemical storage/inventory/disposal procedure

7. Electrical safety

8. Working status of eye washers and fire extinguishers

The internal inspection will take place during the fall semester of each academic year. The findings will be summarized and sent to the department heads and laboratory managers. Any corrective actions should be made within 30 days by the department.

External-Inspection

At the start of each academic year, the Hygiene Officer of the college will make a request to the UTC's Office of Safety and Risk Management for an unannounced inspection to take place during the spring semester of each academic year. The findings of the comprehensive inspection will be reported to the Dean, Associate Dean, and heads of departments. Any corrective actions should be made within 30 days by the department where risks or hazards arefound.

9. Inventory Control, Labeling, Storage, and Transport

Chemical Inventory Control

The Custodian of Record for each CECS laboratory is required to maintain a current chemical inventory that lists the chemicals and compressed gases used and stored in the labs and the quantity of these chemicals (see Appendix H). Chemical inventories are used to ensure compliance with storage limits and fire regulations and can be used in an emergency to identify potential hazards for emergency response operations.

The chemical inventory list should be reviewed prior to ordering new chemicals and only the minimum quantities of chemicals necessary for the research should be purchased. All hazardous chemical purchase requests must be submitted to the Manager of College Technical Support and approved by the Chemical Hygiene Officer (see Appendix C for the Hazardous Materials Procurement Form). If you are unsure as to whether or not a chemical is hazardous, you should review the SDS issued by the manufacturer.

As new chemicals are added to the inventory, each laboratory group must confirm that they have access to the Safety Data Sheets (SDS) for those chemicals. Where practical, each chemical should be dated so that expired chemicals can be easily identified for disposal. Inventory the materials in your laboratory frequently (at least annually) to avoid overcrowding with materials that are no longer useful and note the items that should be replaced, have deteriorated, or show container deterioration. Compromised items should be discarded as chemical waste.

Indications for disposal include:

- Cloudiness in liquids
- Color change
- Evidence of liquids in solids, or solids in liquids
- “Pudding” of material around outside of containers
- Pressure build-up within containers
- Obvious deterioration of containers

Access to hazardous chemicals, including toxic and corrosive substances, should be restricted at all times. These materials must be stored in laboratories or storerooms that are kept locked when authorized personnel are not present. Locked storage cabinets or other precautions are always recommended, and in some cases may be required in the case of unusually toxic or hazardous chemicals. Unusually toxic chemicals may include those that are associated with very low immediately dangerous to life or health (IDLH) conditions. For guidance on locked storage requirements, please contact the Chemical Hygiene Officer (423-425-2209) or the OSRM (423-425-2297). On termination or transfer of laboratory personnel, all related hazardous materials should be properly disposed of, or transferred to the laboratory supervisor or a designee.

Chemical Labeling

Every chemical found in the laboratory must be properly labeled. Most chemicals come with a manufacturer's label that contains the necessary information, so care should be taken to not damage or remove these labels. Each chemical bottle, including diluted chemical solutions, must be labeled with its contents and the hazards associated with this chemical. It is recommended that each bottle also be dated when received and when opened to assist in determining which chemicals are expired and require disposal. When new chemicals and compounds are generated by laboratory operations, these new chemical bottles must be labeled with the name, date, and hazard information; the generator or other party responsible for this chemical should be named on the container so that they may be contacted if questions arise about the container's contents.

Peroxide forming chemicals (e.g., ethers) must be labeled with a date on receipt and on first opening the bottle. This information can be found on the SDS issued by the manufacturer. These chemicals are only allowed a one year shelf life and should be disposed of as waste in one year. These chemicals can degrade to form shock sensitive, highly reactive compounds and should be stored and labeled very carefully.

Chemical Storage & Segregation

Storage guidelines are included for materials that are flammable, oxidizers, corrosive, water reactive, explosive and highly toxic. The specific Safety Data Sheet (SDS) should always be consulted when doubts arise concerning chemical properties and associated hazards. All procedures employed must comply with TN/OSHA, Fire Code and building code regulations. Always wear appropriate personal protective equipment (e.g., laboratory coat, safety glasses, gloves, safety goggles, apron) when handling hazardous chemicals. Be aware of the locations of the safety showers and emergency eyewash stations. Each laboratory is required to provide appropriate laboratory-specific training on how to use this equipment prior to working with hazardous chemicals.

Keep in mind that most chemicals have multiple hazards and a decision must be made as to which storage area would be most appropriate for each specific chemical. Keep to the following priorities:

1. **Flammability**. When establishing a storage scheme, the number one consideration should be the flammability characteristics of the material. If the material is flammable, it should be stored in a flammable cabinet.
2. **Isolate**. If the material will contribute significantly to a fire (e.g., oxidizers), it should be isolated from the flammables. If there were a fire in the laboratory and response to the fire with water would exaggerate the situation, isolate the water-reactive material away from contact with water.

3. **Corrosivity**. Next look at the corrosivity of the material and store accordingly.
4. **Toxicity**. Finally, consider the toxicity of the material, with particular attention paid to regulated materials. In some cases, this may mean that certain chemicals will be isolated within a storage area. For example, a material that is an extreme poison but is also flammable should be locked away in the flammable storage cabinet to protect it against accidental release.

There will always be some chemicals that will not fit neatly in one category or another, but with careful consideration of the hazards involved, most of these cases can be handled in a reasonable fashion. If you have any questions or concerns regarding chemical storage and segregation, contact the Chemical Hygiene Officer (423-425-2209) or the OSRM (423-425-2297).

A. General Recommendations for Safe Storage of Chemicals

Each chemical in the laboratory must be stored in a specific location and returned there after each use. Acceptable chemical storage locations may include corrosive cabinets, flammable cabinets, laboratory shelves, or appropriate refrigerators or freezers. Fume hoods should not be used as general storage areas for chemicals, as this may seriously impair the ventilating capacity of the hood. Figure 1 depicts improper fume hood storage. Chemicals should not be routinely stored on bench tops or stored on the floor. Additionally, bulk quantities of chemicals (i.e., larger than one-gallon) should be stored in a separate storage area, such as a stockroom or supply room.

Laboratory shelves should have a raised lip along the outer edge to prevent containers from falling. Hazardous liquids or corrosive chemicals should not be stored on shelves above eye level and chemicals which are highly toxic or corrosive should be in unbreakable secondary containers.

Chemicals must be stored at an appropriate temperature and humidity level and should never be stored in direct sunlight or near heat sources, such as laboratory ovens. Incompatible materials should be stored in separate cabinets, whenever possible. If these chemicals must be stored in one cabinet, due to space limitations, adequate segregation and secondary containment must be ensured to prevent adverse reactions. All stored containers and research samples must be appropriately labeled and tightly capped to prevent vapor interactions and to alleviate nuisance odors. Flasks with cork, rubber or glass stoppers should be avoided because of the potential for leaking.

Figure 1. Improper Fume Hood Storage

Laboratory refrigerators and freezers must be labeled appropriately with “No Food/Drink” and

must never be used for the storage of consumables. Freezers should be defrosted periodically so that chemicals do not become trapped in ice formations. Never store peroxide formers (e.g., ether) in a refrigerator!

B. Flammable and Combustible Liquids

Large quantities of flammable or combustible materials should not be stored in the laboratory. The maximum total quantity of flammable and combustible liquids must not exceed 60 gallons within a flammable storage cabinet. The maximum quantity allowed to be kept outside a flammable storage cabinet, safety can, or approved refrigerator/freezer is 10 gallons. Only the amounts needed for the current procedure should be kept on bench tops and the remainder should be kept in flammable storage cabinets, explosion proof refrigerators/freezers that are approved for the storage of flammable substances, or approved safety cans or drums that are grounded. Always segregate flammable or combustible liquids from oxidizing acids and oxidizers. Flammable materials must never be stored in domestic-type refrigerators/freezers and should not be stored in a refrigerator/freezer if the chemical has a flash point below the temperature of the equipment. Flammable or combustible liquids must not be stored on the floor or in any exit access.

Handle flammable and combustible substances only in areas free of ignition sources and use the chemical in a fume hood whenever practical. Only the amount of material required for the experiment or procedure should be stored in the work area. Always transfer flammable and combustible chemicals from glass containers to glassware or from glass container/glassware to plastic. Transferring these types of chemicals between plastic containers may lead to a fire hazard due to static electricity. <u>The transfer of flammable liquid from 5 gallon or larger metal containers should **not** be done in the laboratory.</u>

C. Pyrophoric and Water Reactive Substances

Because pyrophoric substances can spontaneously ignite on contact with air and/or water, they must be handled under an inert atmosphere and in such a way that rigorously excludes air and moisture. Some pyrophoric materials are also toxic and many are dissolved or immersed in a flammable solvent. Other common hazards include corrosivity, teratogenicity, or peroxide formation.

Only minimal amounts of reactive chemicals should be used in experiments or stored in the laboratory. These chemicals must be stored as recommended in the SDS. Reactive materials containers must be clearly labeled with the correct chemical name, in English, along with a hazard warning.

Suitable storage locations may include inert gas-filled desiccators or glove boxes; however, some pyrophoric materials must be stored in a flammable substance approved freezer. If pyrophoric or water reactive reagents are received in a specially designed shipping, storage or

dispensing container (such as the Aldrich Sure/Seal packaging system), ensure that the integrity of that container is maintained. Ensure that sufficient protective solvent, oil, kerosene, or inert gas remains in the container while pyrophoric materials are stored. Never store reactive chemicals with flammable materials or in a flammable liquids storage cabinet.

Never return excess reactive chemical to the original container. Small amounts of impurities introduced into the container may cause a fire or explosion. For storage of excess chemical, use a thoroughly dried storage vessel sealed with a septum and purged with dry inert gas. For long-term storage, the septum should be secured with a copper wire.

D. Oxidizers

Oxidizers (e.g., hydrogen peroxide, ferric chloride, potassium dichromate, sodium nitrate) should be stored in a cool, dry place and kept away from flammable and combustible materials, such as wood, paper, styrofoam, plastics, flammable organic chemicals, and away from reducing agents, such as zinc, alkaline metals, and formic acid.

E. Peroxide Forming Chemicals

Peroxide forming chemicals (e.g., ethyl ether, diethyl ether, cyclohexene) should be stored in airtight containers in a dark, cool, and dry place and must be segregated from other classes of chemicals that could create a serious hazard to life or property should an accident occur (e.g., acids, bases, oxidizers). The containers should be labeled with the date received and the date opened. This information, along with the chemical identity, should face forward to minimize container handling during inspection. These chemicals must also be tested and documented for the presence of peroxides periodically. Minimize the quantity of peroxide forming chemicals stored in the laboratory and dispose of peroxide forming chemicals before peroxide formation. Contact the Chemical Hygiene Officer (423-425-2209) or the OSRM (423-425-2297) with any questions or concerns.

F. Corrosives

Store corrosive chemicals (i.e. acids, bases) below eye level and in secondary containers that are large enough to contain at least 10% of the total volume of liquid stored or the volume of the largest container, whichever is greater. Acids must always be segregated from bases and from active metals (e.g., sodium, potassium, magnesium) at all times and must also be segregated from chemicals which could generate toxic gases upon contact (e.g., sodium cyanide, iron sulfide).

Specific types of acids require additional segregation. Mineral acids must be kept away from organic acids, and oxidizing acids must be segregated from flammable and combustible substances. Perchloric acid should be stored by itself, away from other chemicals. Picric acid is reactive with metals or metal salts and explosive when dry and must contain at least 10% water to inhibit explosion.

G. Special Storage Requirements

a. Compressed Gas Cylinders

Compressed gas cylinders must be stored with the safety cap in place when not in use. Cylinders must be stored either chained to the wall or chained within a cylinder storage rack. The cylinders must be restrained by two chains; one chain must be placed at one third from the top of the cylinder, and the other placed at one third from the bottom of the cylinder (see Figure 2). For wall storage, no more than three cylinders may be chained together in the laboratory. Bolted “clam shells” may be used in instances where gas cylinders must be stored or used away from the wall. Store liquefied fuel-gas cylinders securely in the upright position. Cylinders containing certain gases are prohibited from being stored in a horizontal position, including those which contain a water volume of more than 5 liters. Do not expose cylinders to excessive dampness, corrosive chemicals or fumes.

Certain gas cylinders require additional precautions. Flammable gas cylinders must use only flame-resistant gas lines and hoses which carry flammable or toxic gases from cylinders and must have all connections wired. Compressed oxygen gas cylinders must be stored at least 20 feet away from combustible materials and flammable gases.

Gas cylinder connections must be inspected frequently for deterioration and must never be used without a regulator. Never use a leaking, corroded or damaged cylinder and never refill compressed gas cylinders. When stopping a leak between cylinder and regulator, always close the valve before tightening the union nut. The regulator should be replaced with a safety cap when the cylinder is not in use. Move gas cylinders with the safety cap in place using carts designed for this purpose.

b. Liquid Nitrogen

Because liquid nitrogen containers are at low pressure and have protective rings mounted around the regulator, they are not required to be affixed to a permanent fixture such as a wall. However, additional protection considerations should be addressed when storing liquid nitrogen in a laboratory. The primary risk to laboratory personnel from liquid nitrogen is skin or eye thermal damage caused by contact with the material. In addition, nitrogen expands 696:1 when changing from a cryogenic liquid to a room temperature gas. The gases usually are not toxic, but if too much oxygen is displaced, asphyxiation is a possibility. Always use appropriate thermally insulated gloves when handling liquid nitrogen. Face shields may be needed in cases where splashing can occur.

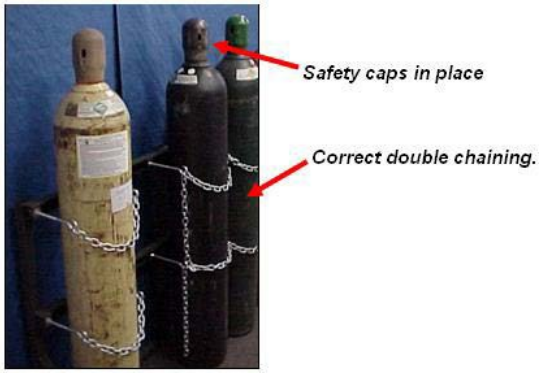


Figure 2. Correct cylinder storage

On-Campus Distribution of Hazardous Chemicals

Precautions must be taken when transporting hazardous substances between laboratories. Chemicals must be transported between stockrooms and laboratories in break-resistant, secondary containers such as commercially available bottle carriers made of rubber, metal, or plastic, that include carrying handle(s) and which are large enough to hold the contents of the chemical container in the event of breakage.

Off-Campus Distribution of Hazardous Chemicals

The transportation of hazardous chemicals and compressed gases over public roads, or by air, is strictly governed by international, federal, and state regulatory agencies, including the U.S. Department of Transportation (DOT) and the International Air Transport Association (IATA). Any person who prepares and/or ships these types of materials must ensure compliance with pertinent regulations regarding training, quantity, packaging, and labeling. Without proper training, it is illegal to ship hazardous materials. Those who violate the hazardous materials shipment regulations are subject to criminal investigation and penalties. UTC campus personnel who sign hazardous materials manifests, shipping papers, or those who package hazardous material for shipment, must be trained and certified by the OSRM. Individuals who wish to ship or transport hazardous chemicals or compressed gases off-campus must first contact the Chemical Hygiene Officer (423-425-2209) and the OSRM (423-425-2297).

10. Discipline Specific Information

10.1 Chemical Engineering Labs:

Chemical Engineering
Laboratory Safety Manual

Contents

Part 1. Introduction and General Information

1.0 Purpose and Scope

The purpose of this Laboratory Safety Manual is to provide guidance to students, faculty, and staff with the goal of preventing human injury and environmental damage from hazardous chemicals, equipment, procedures, and testing methods used at the University of Tennessee at Chattanooga chemical engineering laboratories. Specifically, the UTC chemical engineering laboratories currently include EMCS 119 and 120.

1.1 Emergency Services Personnel Contact Information

The UTC Office of Safety and Risk Management is responsible for the safety and environmental concerns of the University. Should guidance be required for a safety or environmental issue, please call the appropriate person below. **In the event that an emergency threatens the safety of any student, faculty, or staff, dial 911 immediately.**

UTC Office of Safety & Risk Management:	423-425-5741
Robert Mullins, Health and Safety Specialist:	423-425-5820 Robert-Mullins@utc.edu
Bob Jackson, Safety and Risk Management:	423-425-5949 Bob-Jackson@utc.edu
Joel Wands, Life Safety Technician	423-425-5794 Joel-Wands@utc.edu
Campus Police, Non-Emergency	423- 425-4357

***** If health or life is in danger, dial 911 *****

1.2 Responsible Laboratory Manager Contact Information

Dr. Sungwoo Yang is the responsible laboratory manager for the chemical engineering laboratories. Dr. Yang be contacted via telephone or email should any of the following occur:

- Student needs to request access after-hours or during weekends/holidays
- Any material from outside the laboratory is brought inside the laboratory. This includes raw materials, chemicals, powders, and any other substance that may be unintentionally inhaled, spilled, or come into contact with human skin. If in doubt about the reportable nature of the material, contact Dr. Sungwoo Yang.
- Any time a potentially hazardous material is required for completion of an experiment or project. If in doubt about the reportable nature of the material, contact Dr. Yang.
- Any time a spill occurs.
- Any time a project will require laboratory space for more than one day.
- Any time a tool or other piece of equipment not previously used in the laboratory or detailed in this manual is required for completion of an experiment or project.
- Any time tours are expected to take place where non-UTC students or personnel will be present in the laboratory.

Dr. Sungwoo Yang Contact Information: Phone – (423) 425-4366
E-mail: Sungwoo-Yang@utc.edu

1.3 Precedence of the University's Chemical Hygiene Plan

The University's Chemical Hygiene Plan is required by OSHA, and is therefore the document governing the activities outlined in this manual. Should any of the policies or procedures outlined in this manual conflict with the University's Chemical Hygiene Plan, the University's Chemical Hygiene Plan shall take precedence. A copy of the University's Chemical Hygiene Plan can be found at: https://www.utc.edu/safety-risk-management/environmental-compliance/index.php

1.4 Responsibilities of the Laboratory Manager

The Laboratory Manager has overall responsibility for implementation and enforcement of safety procedures in the chemical engineering laboratories, including but not limited to:

- Knowing current University policies and procedures as noted in the University Chemical Hygiene Plan, this Laboratory Safety Manual, and any related documents.
- Laboratory Safety Manual compliance.
- Enforcing the University Chemical Hygiene Plan.

- Ensuring that each student, student worker, or collaborating researcher understands how to complete each assigned task safely.
- Monitoring and enforcing chemical procurement, storage, use, and disposal procedures in the chemical engineering laboratories.
- Ensuring facilities and training are adequate for any chemical used or stored in their laboratory, and ensuring appropriate training has been provided.
- Being familiar with the training requirements of the University's Hazardous Materials Communication Program, and ensure that all laboratory employees, students, or researchers using or exposed to hazardous materials are trained as required.
- Ensuring laboratory employees who work with or are exposed to materials are provided with the appropriate protective and safety equipment.
- Ensuring Emergency Action Plans are in place and a first aid kit is available.
- Documenting that the appropriate training has been provided and forwarding training records to the University Office of Safety and Risk Management quarterly.
- Providing regular, formal chemical hygiene, safety, and housekeeping inspections including inspections of emergency equipment.
- Advising management of the safety needs of subordinates.
- Encouraging each employee to develop safe and healthy work habits.

1.5 Training

Users of the laboratories will be trained to perform the following tasks:

- Follow the requirements of this Laboratory Safety Manual, the University Chemical Hygiene Plan, prudent laboratory practices, and other applicable rules.
- Follow oral and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned.
- Plan and conduct each operation in accordance with the chemical hygiene plan, safety plans and prudent laboratory practices.
- Review and understand the hazards of materials and processes in the laboratory prior to conducting work.
- Develop and use good personal hygiene and safety habits.
- Wear all required personal protective equipment/clothing.
- Keep the work areas safe and uncluttered.
- Utilize appropriate measures to control identified hazards, including consistent and proper use of engineering controls, administrative controls, and personal protective equipment.
- Understand the capabilities and limitations of personal protective equipment issued to them.

- Gain prior approval from the lab supervisor for the use of any new chemicals introduced to the laboratory.
- Promptly report accidents to the laboratory supervisor.
- Complete all required health, safety and environmental training.
- Inform the lab supervisor of any work modifications ordered by a physician as a result of medical surveillance, an occupational injury or exposure.

1.6 Chemicals Requiring Approval for Use

The following hazardous chemicals must have prior approval for use before beginning a project or bringing the chemical into the laboratory. The Laboratory Manager will contact the Office of Safety and Risk Management for guidance. In addition, if any chemical beyond the following list is suspected to present a hazard (as identified on the SDS), the Laboratory Manager will contact the Office of Safety and Risk Management for guidance.

Health Hazard Compounds:	Ethanol; Ethylene Glycol; Isopropyl Alcohol; Kerosene; Magnesium; Manganese Dioxide; Manganese Sulfate; Methanol; Methylene Blue; Nalidixic Acid; n-Heptane; n-Hexane; Phthalic Anhydride; Potassium Bromate; Potassium Persulfate; Toluene; Trichloroethylene
Flammable Compounds:	Acetic Acid; Acetone; Ethanol; Isopropyl Alcohol; Methanol; n-Heptane; n-Hexane; Pyridine; Toluene; Universal Indicator Solution
Irritant/Sensitizing Compounds:	Acetone; Aluminum Ammonium Sulfate; Ammonium Molybdate; Calcium Oxide; Copper Sulfate; Ethylene Glycol; Iron 2,4-pentanedionate; Isopropyl Alcohol; Kerosene; Lithium Chloride; Manganese Dioxide; Methyl Red; Methylene Blue; Nalidixic Acid; n-Heptane; n-Hexane; Phthalic Anhydride; Potassium Hydroxide; Potassium Permanganate; Potassium Persulfate; Pyridine; Sodium Bicarbonate; Sodium Phosphate; Toluene; trans-Cinnamaldeyde; Trichloroethylene; Universal Indicator Solution; Zinc Sulfate
Gases Under Pressure:	Air, Carbon Dioxide, Hydrogen, Sulfur Dioxide
Corrosive Compounds:	Acetic Acid; Calcium Oxide; Crystal Violet; Hydrochloric Acid; Iron Chloride; Manganese Sulfate; Phthalic Anhydride; Potassium Hydroxide; Potassium Permanganate; Silver Nitrate; Sodium Hydroxide; Sulfuric Acid

Explosive/Self-Reactive Compounds: None typically used.

Oxidizing Compounds:	Potassium Bromate; Potassium Permanganate; Potassium Persulfate
Acutely Toxic Compounds:	1,2-Dicyanobenzene; Methanol; Potassium Bromate

1.7 Chemical Inventory

A record of the chemicals housed in each laboratory will be maintained, along with their respective SDS, by the laboratory manager. Annually, or when requested by the Office of Safety and Risk Management, a chemical inventory will be performed detailing the chemicals and quantities associated with them and the room number in which they reside. See Appendix H for a copy of the chemical inventory form.

1.8 Labeling

All chemicals and materials should be kept in their original, labeled containers when possible. If temporary alternate storage is required, the SDS must be consulted to ensure that the appropriate material (glass, plastic etc.) is chosen for the temporary storage. Temporary storage containers should be clearly labeled. Temporary storage in alternate containers should be avoided whenever possible. In no case should alternate containers be used for long-term (more than 2 weeks) storage.

Part 2 – Procedures and Operations

2.1 Description of Laboratories

2.1.1 Room 119: Chemical Engineering Research Lab

EMCS Room 119 serves as a research laboratory for both chemical engineering faculty and student organizations (i.e. ChemE Car). Only students who have been approved by the Laboratory Manager and have signed the Open Laboratory Policy Acknowledgement Form (Appendix F) are permitted in this lab. It is not intended to be used for teaching purposes.

2.1.2 Room 120: Chemical Engineering Teaching Lab

EMCS 120 serves as a teaching laboratory for chemical engineering students to learn the fundamentals of chemical engineering unit operations and process control.

2.2 Description of Physical, Chemical, and Flammable Hazards

Physical hazards are defined in this manual as those with potential risk of injury or death not associated with chemical exposure. Physical hazards in this manual are divided into the sub-categories of electrical hazards, pinch-point hazards, airborne particulate hazards, trip hazards, noise hazards, and high temperature hazards. Chemical hazards are defined in this manual as being hazardous to humans to the extent that exposure (limited or prolonged) should be

avoided, or that require the use of personal protective equipment (PPE). Flammable hazards are defined in this manual as those substances that can catch fire easily, such as petroleum distillates and solvents.

2.2.1 Room 119: Chemical Engineering Research Lab

Electrical hazards: Water is used in this laboratory for creating aqueous solutions. Ensure that all water sources do not come into contact with electrical outlets or cords. Ensure that all electrical cords are maintained away from foot-traffic areas and are not frayed, bent, or have contacts missing.

Pinch-point hazards: No moving mechanical equipment is used in this laboratory.

Airborne Particulates hazards: No airborne particulates are generated in this laboratory.

Trip hazards: Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards.

Noise hazards: No equipment used in this laboratory is suspected to meet threshold limits for hearing protection under normal operation.

High Temperature Hazards: No high temperatures are typically encountered in this laboratory.

Chemical Hazards: Several hazardous chemicals are typically utilized in this laboratory. Please consult the relevant SDS's prior to conducting experiments to ensure that you are wearing the appropriate PPE. Typical chemicals used in this laboratory include:

Table 1. Chemical Hazards in EMCS 119

Chemical	CAS#	Hazards
Hydrochloric Acid	7647-91-0	May be corrosive to metals Causes skin irritation Causes serious eye damage
Methanol	67-56-1	Highly flammable liquid and vapor Toxic in contact with skin Toxic if swallowed
Pyridine	110-86-1	Harmful in contact with skin Harmful if swallowed Harmful if inhaled Causes skin irritation Causes eye irritation

		May cause respiratory irritation May cause drowsiness or dizziness
Sodium Hydroxide	1310-73-2	May be corrosive to metals Causes severe skin burns Causes serious eye damage

2.2.2 Room 120: Chemical Engineering Teaching Lab

Electrical hazards: Water is used in this laboratory for creating aqueous solutions. Ensure that all water sources do not come into contact with electrical outlets or cords. Ensure that all electrical cords are maintained away from foot-traffic areas and are not frayed, bent, or have contacts missing.

Pinch-point hazards: No moving mechanical equipment is used in this laboratory.

Airborne Particulates hazards: No airborne particulates are generated in this laboratory.

Trip hazards: Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards.

Noise hazards: No equipment used in this laboratory is suspected to meet threshold limits for hearing protection under normal operation.

High Temperature Hazards: Ovens are utilized in this laboratory for solids drying. Typical oven temperatures are 90-100°C (~195-212°F). Training and operation of the ovens should include the use of appropriate PPE.

Chemical Hazards: Several hazardous chemicals are typically utilized in this laboratory. Please consult the relevant SDS's prior to conducting experiments to ensure that you are wearing the appropriate PPE. Typical chemicals used in this laboratory include:

Table 2. Chemical Hazards in EMCS 120

Chemical	CAS#	Hazards
Acetic Acid	64-19-7	Flammable liquid and vapor Causes severe skin burns and eye damage
Acetone	67-64-1	Highly flammable liquid and vapor Causes serious eye irritation May cause drowsiness or dizziness
Ethanol	64-17-5	Highly flammable liquid and vapor May cause damage to organs
Ethylene Glycol	107-21-1	Harmful if swallowed May cause drowsiness or dizziness May cause damage to organs
Hydrochloric Acid	7647-91-0	May be corrosive to metals Causes skin irritation Causes serious eye damage
Iron 2,4-pentanedionate	14024-18-1	Harmful if swallowed Causes serious eye irritation
Isopropyl Alcohol	7732-18-5	Highly flammable liquid and vapor Causes serious eye irritation May cause drowsiness or dizziness May cause damage to organs May be fatal if swallowed and enters airways
Kerosene	64742-47-8	Combustible liquid Causes skin irritation May cause drowsiness or dizziness May be fatal if swallowed and enters airways
Magnesium	7439-95-4	Flammable solid Self-heating in large quantities; may catch fire Contact with water releases flammable gas
Methanol	67-56-1	Highly flammable liquid and vapor Toxic in contact with skin Toxic if swallowed
n-Hexane	110-54-3	Highly flammable liquid and vapor Causes skin irritation Causes serious eye irritation May cause respiratory irritation May cause drowsiness or dizziness May be fatal if swallowed and enters airways
Sodium Hydroxide	1310-73-2	May be corrosive to metals Causes severe skin burns Causes serious eye damage

10.2 Civil Engineering Labs:

Civil Engineering
Laboratory Safety Manual

Contents

Part 1 – Introduction and General Information

1.0 Purpose and Scope

The purpose of this Laboratory Safety Manual is to provide guidance to employees, administration, managers, and students with the goal of preventing human injury and environmental damage from hazardous chemicals, equipment, procedures, and testing methods used in the University of Tennessee at Chattanooga civil engineering materials testing laboratories. Specifically, the UTC civil engineering materials testing laboratories currently include EMCS 102, 103, 122, 214A, and the SimCenter Fuel Cell Building.

1.1 Emergency Services Personnel Contact Information

The UTC Office of Safety and Risk Management is responsible for the safety and environmental concerns at the university. Should guidance be required for a safety or environmental issue, please call the appropriate person below. If an emergency that threatens safety of any student, faculty, or staff is occurring, dial 9-1-1.

UTC Office of Safety & Risk Management:	**423-425-5741**
Robert Mullins, Health and Safety Specialist:	423-425-5820 Robert-Mullins@utc.edu
Bob Jackson, Safety and Risk Management:	423-425-5949 Bob-Jackson@utc.edu
Joel Wands, Life Safety Technician	423-425-5794 Joel-Wands@utc.edu
Campus Police, Non-Emergency	423-425-4357

***** If health or life is in danger, dial 911 *****

1.2 Responsible Laboratory Manager Contact Information

The responsible laboratory manager for the laboratories above is Weidong Wu. He should be contacted via telephone or email should any of the following occur:

- Student needs to request access after-hours or during weekends or holidays.
- Any outside material is brought into the laboratory. This includes raw materials, chemicals, powders, cements, asphalt, paint, stain, dyes, and any other substance that may be

unintentionally inhaled, spilled, or come into contact with human skin. If in doubt about the reportable nature of the material, contact Dr. Wu.

- Any time a spill occurs.
- Any time a student or other project will take up laboratory space for more than one day.
- Any time a tool or other piece of equipment not previously used in the laboratory or detailed in this manual is required for completion of a project or experiment.
- Any time tours are expected to take place where non-UTC students or personnel will be present in the laboratory.

Dr. Wu's contact information:

Phone (office): 423-425-5822

Email: Weidong-Wu@utc.edu

1.3 Manual's Position in reference to the University's Chemical Hygiene Plan

The University's Chemical Hygiene Plan is required by OSHA, and is therefore the document governing the activities outlined in this manual. Should any of the procedures contained in this manual conflict with the University's Chemical Hygiene Plan, the University's Chemical Hygiene Plan shall take precedence. A copy of the University's Chemical Hygiene Plan can be found at: https://www.utc.edu/safety-risk-management/environmental-compliance/index.php

1.4 Responsibilities of the Laboratory Manager

The Laboratory Manager has overall responsibility for implementation and enforcement of safety procedures in the civil engineering laboratories, including, but not limited to:

- Knowing current University policies and procedures as noted in the University Chemical Hygiene Plan, this Laboratory Safety Manual, and applicable test methods.
- Laboratory Safety Manual compliance.
- Enforcing the Chemical Hygiene Plan (CHP).
- Ensuring that each student, student worker, or collaborating researcher understands how to complete each assigned task safely.
- Monitoring and enforcing chemical procurement, storage, use, and disposal procedures in the civil engineering laboratories.
- Ensuring facilities and training are adequate for any chemical used or stored in their laboratory, and ensuring appropriate training has been provided.
- Being familiar with the training requirements of the University's Hazardous Materials Communication Program, and ensure that all laboratory employees, students, or researchers using or exposed to hazardous materials are trained as required.
- Ensuring laboratory employees who work with or are exposed to materials are provided with the appropriate protective and safety equipment.
- Ensuring Emergency Action Plans are in place and a first aid kit is available.
- Documenting that the appropriate training has been provided and forwarding training records to the University Office of Safety and Risk Management quarterly.

- Providing regular, formal chemical hygiene, safety, and housekeeping inspections including inspections of emergency equipment.
- Advising management of the safety needs of subordinates.
- Encouraging each employee to develop safe and healthy work habits.

1.5 Training

Users of the laboratories will be trained to perform the following tasks.

- Follow the requirements of this Laboratory Safety Manual, the University Chemical Hygiene Plan, prudent laboratory practices, and other applicable rules.
- Follow oral and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned.
- Plan and conduct each operation in accordance with the chemical hygiene plan, safety plans and prudent laboratory practices.
- Review, understand, and document the hazards of materials, machinery, and processes in the laboratory prior to conducting work.
- Develop and use good personal hygiene and safety habits.
- Wear all required personal protective equipment/clothing.
- Keep the work areas safe and uncluttered.
- Utilize appropriate measures to control identified hazards, including consistent and proper use of engineering controls, personal protective equipment, and administrative controls.
- Understand the capabilities and limitations of personal protective equipment issued to them.
- Gain prior approval from the lab supervisor for the use of any new chemicals introduced to the laboratory.
- Promptly report accidents to the laboratory supervisor.
- Complete all required health, safety and environmental training.
- Inform the lab supervisor of any work modifications ordered by a physician as a result of medical surveillance, an occupational injury or exposure.

1.6 Chemicals requiring approval for use

There are rarely any potentially hazardous chemicals used in the civil engineering laboratories. However, should the need arise, the following hazardous chemicals must have prior approval for use before beginning a project or bringing the chemical into the laboratory. The Laboratory Manager will contact the Office of Safety and Risk Management for guidance. In addition, if any chemical beyond the following list is suspected to present a hazard (as identified on the SDS), the Laboratory Manager will contact the Office of Safety and Risk Management for guidance.

Toxic Gas:	None typically used.
Acutely Toxic Compounds:	None typically used.
Sensitive Compounds:	None typically used.

Highly Corrosive Compounds:	Sulfuric Acid
Flammable Compounds:	Mineral spirits Acetone Solvent-based concrete sealers

1.7 Chemical inventory

A record of the chemicals housed in each laboratory will be maintained, along with their respective SDS, by the laboratory manager. Annually or when requested by the Office of Safety and Risk Management, a chemical inventory will be performed detailing the chemicals and quantities associated with them and the room number in which they reside. See Appendix A for a copy of the chemical inventory form.

1.8 Labeling

All chemicals and materials should be kept in their original, labeled containers when possible. If temporary alternate storage is required, the SDS must be consulted to ensure that the appropriate material (glass, plastic etc.) is chosen for the temporary storage. Temporary storage containers should be clearly labeled. Temporary storage in alternate containers should be avoided whenever possible. In no case should alternate containers be used for long-term (more than 2 weeks) storage.

1.9 Hazardous waste

All hazardous chemical waste will be kept in proper containers which are properly closed and labeled. They will be clearly marked “HAZARDOUS WASTE”. Containers will be stored in satellite collection areas designated in each lab.

Part 2 – Procedures and Operations

2.1 Description of Laboratories

2.1.1 Room 102: Soils Lab

EMCS Room 102 is known as the “Soils Lab” or “Soil Mechanics Laboratory”. Its purpose is to allow successful teaching of laboratory soils characterization techniques, and research regarding soils, rock, and sand.

2.1.2 Room 103: Asphalt Lab

EMCS Room 103 is known as the “Asphalt Lab”. Its purpose is to allow successful teaching of laboratory asphalt mixing and testing procedures, and to serve as a location for faculty, staff, and students to conduct research on asphalt-related technologies.

2.1.3 Room 122: Concrete Lab

EMCS Room 122 is known as the "Concrete Lab". Its purpose is to allow successful teaching of laboratory concrete mixing and testing procedures, and to serve as a location for faculty, staff, and students to conduct research on concrete-related technologies.

2.1.4 Room 214A: Holmes Concrete Long Term Durability Lab

EMCS 214A is also known as the "Dalton Holmes Concrete Long Term Durability Research Laboratory". It serves as a research area and office for Civil Engineering Materials Research Laboratory Director A. Brent Rollins. With Mr. Rollins' permission, it also serves as a location for graduate student research.

2.1.5 SimCenter Fuel Cell Building: Student Projects Lab

The SimCenter Fuel Cell Building serves primarily as a civil engineering student projects laboratory, housing activities associated with ASCE concrete canoe and steel bridge competitions. It also contains some equipment associated with the Dalton Holmes Concrete Long Term Durability Research Laboratory.

2.2 Description of Physical, Chemical, and Flammable Hazards

Physical hazards are defined in this manual as those potential risks of injury or death not associated with chemical exposure. Physical hazards in this manual are divided into the sub-categories of electrical hazards, pinch-point hazards, airborne particulate hazards, trip hazards, noise hazards, and high temperature hazards. Chemical hazards are defined in this manual as being hazardous to humans to the extent that exposure (limited or prolonged) should be avoided, or that require the use of personal protective equipment (PPE). Flammable hazards are defined in this manual as those substances that can catch fire easily, such as petroleum distillates and solvents.

2.2.1 Room 102: Soils Lab

Electrical hazards: Water is used in this laboratory to condition soils and aggregates. Ensure that all water sources do not come into contact with electrical outlets or cords. Ensure that all electrical cords are maintained away from foot-traffic areas and are not frayed, bent, or have contacts missing.

Pinch-Point hazards: Moving mechanical equipment is utilized in this laboratory. Direct physical contact with machinery should be avoided while it is operating. Specific equipment and precautions are listed below:

- Coarse Aggregate Sieve Shaker: This equipment is utilized for determining the particle size distribution of coarse-grained material (approximately 0.25" to 1.5"). During operation the cabinet enclosing the shaker should be closed and fastened. If properly seated, moving sieves represent a very unlikely source of injury. However, care must be taken when removing the

sieves for analysis. The sieves can be relatively heavy (5-25 lbs. each) and can cause injury to hands or feet if dropped. No open-toed shoes should be worn when using this equipment.

- Fine Aggregate Sieve Shaker: This equipment is utilized for determining the particle size distribution of fine-grained material (approximately 0.02 mm to 3/8"). Because smaller amounts of material are used than with the coarse aggregate sieve shaker, it is unlikely that dropping the equipment on hands or feet will cause significant injury. The sieve shaker should be free from human contact during operation.
- Dynamic Cone Penetrometer: This equipment is used to approximate the bearing ratio of soil. It utilizes a ten pound hammer that is lifted 24" and then released, striking an anvil which then drives the penetrating head into the soil being tested. Use and training of this equipment should stress the importance of not placing a hand in between the hammer and the anvil. No open toed shoes should be worn when operating this equipment.

Airborne Particulates hazards:

The primary source of airborne particulates hazards in this laboratory are from dry soil being moved about, particularly when being tested with the fine aggregate sieve shaker. Because soil may contain fine silica particles, an N-95 respirator should be worn when in the presence of airborne soil particles. A lid on the sieve stack should always be utilized when performing fine aggregate sieve analysis.

Trip Hazards:

Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards.

Noise hazards:

No equipment used in this laboratory is suspected to meet threshold limits for hearing protection under normal operation.

High Temperature Hazards:

Ovens are utilized in this laboratory for drying soils and aggregates. Typical oven temperatures are 230 degrees F (110 C) Training and operation of the ovens should include the use of appropriate PPE.

Chemical Hazards:

No chemicals requiring protection beyond eye protection are typically utilized in this laboratory. Typical chemicals found in this laboratory include:

Table 1: Chemical Hazards in EMCS 102

Material	CAS#	Hazards
Sodium Hexametaphosphate*	10124-56-8 or 68915-31-1	Ingestion (LD50 6200 mg/kg) Skin (irritant), eyes (irritant)

*These values are for 100% concentration. The typical student/laboratory use is 15% concentration in distilled water.

2.2.2 Room 103: Asphalt Lab

Electrical hazards: Water is used in this laboratory to condition aggregates and in the specific gravity tanks. Ensure that all water sources do not come into contact with electrical outlets or cords. Ensure that all electrical cords are maintained away from foot-traffic areas and are not frayed, bent, or have contacts missing.

Pinch-Point hazards: Moving mechanical equipment is utilized in this laboratory. Direct physical contact with machinery should be avoided while it is operating. Specific equipment and precautions are listed below:

- Asphalt mixer: The asphalt mixer has a pinch point hazard between the mixer and the frame. Do not allow contact during mixer operation. Loose hair, clothing, or jewelry are not permitted while using the asphalt mixer.
- Load frames: There are several load frames used to measure various properties of asphalt. The load frames engage very slowly, so the likelihood of pinch point injuries is negligible.
- Automatic Marshall Hammer: The automatic Marshall hammer device represents a significant pinch point hazard. While in operation, the wooden cabinet doors should be kept closed. Loose hair, clothing, or jewelry are not permitted while operating the automatic Marshall hammer device.

Airborne Particulates and inhalation hazards:

Airborne particulates are not a concern during normal operation of this laboratory. However, when either the asphalt cement pot or the sulfur capping compound pot are operating, or if asphalt is being heated in the large oven the exhaust hoods should be on to reduce odor.

Trip Hazards:

Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards.

Noise hazards:

No equipment used in this laboratory is suspected to meet threshold limits for hearing protection under normal operation.

High Temperature Hazards:

- Ovens are utilized in this laboratory for drying aggregates. Typical oven temperatures are 230 degrees F (110 C) Training and operation of the ovens should include the use of appropriate PPE.
- Hot asphalt is one of the primary high temperature hazards in this laboratory. Asphalt is typically heated to 300 degrees F (150 C) during use. Aprons, gloves, face protection, closed-toed shoes, and long sleeves and trousers are required while handling hot asphalt.
- Molten sulfur is used in this laboratory for capping concrete cylinders for research purposes. The molten sulfur is typically used near 300 degrees F (150 C). While in use, the hood must be on, and Aprons, gloves, face protection, closed-toed shoes, and long sleeves and trousers are required while handling molten sulfur. No student use of molten sulfur is approved.

Chemical Hazards:

The chemicals typically found in this laboratory and their associated hazards are listed below:

Table 2: Chemical Hazards in EMCS 103

Material	CAS#	Hazards
Asphalt cement (1 to 5 gallons typically)	8052-42-4	Physical hazards Not classified. Health hazards Not classified. Environmental hazards Not classified. OSHA defined hazards Not classified. Prevention Wear protective gloves/eye protection/face protection.
Tween 80 (1 qt. typically)	N/A	This product contains no hazardous constituents, or the concentration of all chemical constituents are below the regulatory threshold limits described by Occupational Safety Health Administration Hazard Communication Standard 29 CFR 1910.1200 and the European Directive 91/155/EEC, and 93/112/EC.
M-Bond Catalyst (6 1 oz. bottles typically)	98% Propan-2-ol 2% n-Phenyldiethanolamine	H225: Highly flammable liquid and vapor. H319: Causes serious eye irritation. H336: May cause drowsiness or dizziness.)
M-Bond 200 Catalyst C (8 1 oz. bottles typically)	98% Propan-2-ol 2% n-Phenyldiethanolamine	H225: Highly flammable liquid and vapor. H319: Causes serious eye irritation. H336: May cause drowsiness or dizziness.
M-Prep Conditioner (8 1 qt. bottles typically)	Phosporic Acid <6% Distilled water > 94%	H290: May be corrosive to metals.
Chemlube Premium Gold (1 2 oz. bottle typically)	Mineral Oil Petroleum Additives	This material has no known hazards under applicable laws.
Isopropyl Alcohol (1 1 qt bottle typically)	67-63-0	H226: Flammable liquid and vapor. H319: Causes serious eye irritation. H336: May cause drowsiness or dizziness.
Vacuum pump oil (2 1 qt bottles typically)	64742-65-0	Eyes May cause irritation. Skin May cause irritation. May be harmful in contact with skin. Inhalation May cause irritation of respiratory tract. May be harmful if inhaled. Ingestion May be harmful if swallowed. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea. Chronic Effects Limited evidence of a carcinogenic effect.
Sulfur capping compound	Sulfur 55-70% 7704-34-9 Siliceous Flour 30-45% 68131-74-8	H228: Flammable Solid H290: May be corrosive to metals H303: May be harmful if swallowed H316: May cause mild skin irritation H320: May cause eye irritation H335: May cause respiratory irritation

2.2.3 Room 122: Concrete Lab

Electrical hazards: Water is used in this laboratory to condition aggregates and to cure concrete. There are two electrical outlets set in the floor, covered with brass covers that are shut off. Ensure that all water sources do not come into contact with electrical outlets or cords. Ensure that all electrical cords are maintained away from foot-traffic areas and are not frayed, bent, or have contacts missing.

Pinch-Point hazards: Moving mechanical equipment is utilized in this laboratory. Direct physical contact with machinery should be avoided while it is operating. Specific equipment and precautions are listed below:

- Concrete Mixers: There are two types of concrete mixers utilized in this laboratory, four revolving-drum type mixers and one table-top planetary mixer. Both types have pinch points between the mixing apparatus and the frames. Ensure that no person comes into contact with moving components while operating mixers.
- Load frames: There are two load frames used to measure various properties of concrete. The load frames engage very slowly, so the likelihood of pinch point injuries is negligible. However, dropping fixtures and/or samples on feet is a real possibility. Ensure that no open-toed shoes are worn while operating load frames.
- Los Angeles Abrasion machine: The LA Abrasion machine is basically a large rock tumbler with a rotating drum on a fixed frame. This represents a pinch point between the drum and the frame. Ensure that no person comes into contact with moving components while operating the LA Abrasion machine.
- Saws: Two concrete saws are used in this laboratory for research purposes, both utilizing water and a rotating blade. Greatest care should be taken to not come into contact with rotating blades while in operation. Neither saw is approved for student use.

Airborne Particulates hazards:

- The primary source of airborne particulates hazards in this laboratory are from dry sand, cement, fly ash, and ground granulated blast furnace slag being moved about, particularly when introducing them to concrete mixers. Because these materials contain fine silica particles and trace heavy metals in the case of slag and fly ash, an N-95 respirator should be worn when in the presence of airborne particles. A lid should be utilized on mixers until raw materials are sufficiently moistened by water to not become airborne. In addition, the room is equipped with an in-ceiling air exhaust fan that should be engaged when introducing raw materials into the mixers.

- Airborne particulates from sawing operations are controlled by a positive flow of water on the blades. Do not operate the saws if water flow is not present or working.

- A wheel abrasion machine is utilized in this laboratory for testing the abrasion resistance of concrete. Concrete dust is produced during operation. Use of an N-95 respirator is required when operating the wheel abrasion machine.

Trip Hazards:

Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards.

Noise hazards:

The Los Angeles Abrasion machine is the only equipment that is likely to exceed noise level thresholds required for hearing protection. Current practice is to employ hearing protection and move the LA Abrasion machine outdoors during operation.

High Temperature Hazards:

No high temperature hazards are identified in this laboratory.

Chemical Hazards:

The chemicals typically found in this laboratory and their associated hazards are listed below:

Table 3: Chemical Hazards in EMCS 122

Material	CAS#	Hazards
Portland cement	65997-15-1	OVEREXPOSURE TO PORTLAND CEMENT MIXED WITH WATER CAUSES SEVERE SKIN BURNS AND EYE DAMAGE. MAY CAUSE AN ALLERGIC SKIN REACTION. SWALLOWING MAY CAUSE DAMAGE TO MOUTH, THROAT OR INTERNAL ORGANS. INHALATION MAY CAUSE RESPIRATORY IRRITATION. LONG TERM INHALATION MAY DAMAGE LUNGS OR CAUSE CANCER.
Class F Fly Ash	See SDS	Not classified for physical hazards. Skin irritation, Category 3 Eye irritation, Category 2B Specific Target Organ Toxicant, Repeated Exposure, Category 2 Not classified for environmental hazards. Not classified for specific hazards.
Class C Fly Ash	See SDS	Acute: Fly ash may cause irritation to the respiratory tract, eyes, or the skin. Alkaline material; irritation may be aggravated by the addition of moisture (sweat). Chronic: Prolonged inhalation exposure may cause pulmonary fibrosis or chronic bronchitis.
Ground, Granulated Blast Furnace Slag	See SDS	Causes severe skin burns and eye damage May cause cancer (lungs). Causes damage to organs (lungs) through prolonged or repeated exposure.
Silica Fume	69012-64-2	IT CONTAINS MATERIAL WHICH CAN CAUSE CANCER. MAY BE HARMFUL IF INHALED.
Poraver glass beads	See SDS	WHMIS HAZARDOUS INGREDIENTS : None POTENTIAL HEALTH EFFECTS ROUTES OF ENTRY : None expected. Poraver is an expanded glass bead and the ingredients are in a fused crystalline structure. EYES : This product is an eye irritant due to the mechanical abrasion of the crystals. SKIN : This product is a skin irritant due to the mechanical abrasion of the crystals. INGESTION : Small glass particles present in this product may cause injury to the trachea, stomach and intestines. INHALATION : This product is a nuisance dust. OSHA PEL (total particulate, not otherwise

		regulated) 15 mg/m3, (respirable particulate, not otherwise regulated) 5 mg/m3,. ACGIH TLV (nuisance particulates) 10 mg/m3 (inhalable), 5 mg/m3 (respirable). ACUTE HEALTH HAZARDS : None known. CHRONIC HEALTH HAZARDS : Chronic exposure to respirable dust in excess of appropriate exposure limits may cause lung disease. IRRITANCY : This product will irritate the skin through mechanical abrasion of the crystals.
Polycarboxylate Water Reducer Product names: ADVA CAST 575, ADVA 140, Glenium 7500	See SDS	May cause sensitization by skin contact. Inhalation: Causes respiratory tract irritation. Eye Contact: May be slightly irritating to the eyes. Skin Contact: Causes skin irritation.
Lignosulfonate Water Reducer (Product Names: WRDA 64)	See SDS	Inhalation: Causes respiratory tract irritation. If prolonged exposure to vapor or mist occurs, effects maybe more severe resulting in coughing and breathing difficulties. Eye Contact: Eye contact causes irritation. Prolonged eye contact can result in tissue damage. Skin Contact: Acute skin contact is not expected to result in adverse effects. Prolonged skin contact can result in irritation causing redness and itching. May cause sensitization. Skin Absorption: Not expected to be harmful if absorbed through the skin. Ingestion: Harmful if ingested. Effects include: Digestive tract irritation. The following applies to Triethanolamine and associated materials: Triethanolamine has caused blood effects and liver and kidney damage in laboratory animal studies.
Vinsol Resin Air Entrainment (Product Names: MBAE90)	See SDS	Slight irritation only
Synthetic Air Entrainment (Product Names: Micro Air)	See SDS	Inhalation: Harmful Skin: Can cause severe irritation and possible burns Eyes: Corrosive. Can cause severe irritation, redness, tearing, and blurred vision and possible burns and corneal injury Ingestive: Corrosive. Can cause severe and permanent damage to mouth, throat, and stomach
Air Minus	See SDS	Non-Hazardous
Calcium Chloride Flakes	See SDS	Eye Contact: For dust: May cause severe eye irritation. May cause corneal injury. Effects may be slow to heal. Skin Contact: Brief contact is essentially nonirritating to skin. Prolonged contact may cause skin irritation, even a burn. Not classified as corrosive to the skin according to DOT guidelines. May cause more severe response if skin is damp. May cause more severe response if skin is abraded (scratched or cut). May cause more severe response on covered skin (under clothing, gloves). Skin Absorption: Prolonged skin contact is unlikely to result in absorption of harmful amounts.

		Inhalation: Dust may cause irritation to upper respiratory tract (nose and throat). Vapors are unlikely due to physical properties. Ingestion: Low toxicity if swallowed. Small amounts swallowed incidentally as a result of normal handling operations are not likely to cause injury; however, swallowing larger amounts may cause injury. Swallowing may result in gastrointestinal irritation or ulceration. Effects of Repeated Exposure: The data presented are for the following material: Potassium chloride. In animals, effects have been reported on the following organs after ingestion: Gastrointestinal tract. Heart. Kidney. Dose levels producing these effects were many times higher than any dose levels expected from exposure due to use.
Calcium Chloride Solution	10043-52-4	May cause minor irritation to eyes and skin, ingestion may cause nausea
Sodium Chloride Granules	See SDS	See SDS
Silver Nitrate Solution 0.1N	See SDS	See SDS
Sodium Hydroxide Solution	See SDS	See SDS
Sodium Hydroxide Granules	1310-73-2	Potential Acute Health Effects: Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, of inhalation. The amount of tissue damage depends on length of contact. Eye contact can result in corneal damage or blindness. Skin contact can produce inflammation and blistering. Inhalation of dust will produce irritation to gastro-intestinal or respiratory tract, characterized by burning, sneezing and coughing. Severe over-exposure can produce lung damage, choking, unconsciousness or death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering. Potential Chronic Health Effects: CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance is toxic to lungs. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction, or dermatitis. Repeated inhalation of dust can produce varying degree of respiratory irritation or lung damage.

2.2.4 Room 214A: Holmes Concrete Long Term Durability Lab

Housing only computer equipment, desks, tables, chairs, microscopes, and books this laboratory has no known hazards.

2.2.5 SimCenter Fuel Cell Building: Student Projects Lab

Electrical hazards: Water is used in this laboratory to condition aggregates and to cure concrete. Ensure that all water sources do not come into contact with electrical outlets or cords. Ensure that all electrical cords are maintained away from foot-traffic areas and are not frayed, bent, or have contacts missing.

Pinch-Point hazards: Moving mechanical equipment is utilized in this laboratory. Direct physical contact with machinery should be avoided while it is operating. Specific equipment and precautions are listed below:

- Concrete Mixers: There are two types of concrete mixers utilized in this laboratory, four revolving-drum type mixers and one table-top planetary mixer. Both types have pinch points between the mixing apparatus and the frames. Ensure that no person comes into contact with moving components while operating mixers.
- Bench Top Drills and Saws: Ensure that all manufacturer-installed guards are in place, and proper PPE worn when operating. Ensure that no person comes into contact with moving components while using drills and saws.
- Table Saw: Ensure that all manufacturer-installed guards are in place, and proper PPE worn when operating. Ensure that no person comes into contact with moving components while using drills and saws.

Airborne Particulates and Inhalation hazards:

- The primary source of airborne particulates hazards in this laboratory are from dry sand, cement, fly ash, and ground granulated blast furnace slag being moved about, particularly when introducing them to concrete mixers. Because these materials contain fine silica particles and trace heavy metals in the case of slag and fly ash, an N-95 respirator should be worn when in the presence of airborne particles. A lid should be utilized on mixers until raw materials are sufficiently moistened by water to not become airborne.

- Airborne particulates from sawing operations and grinding concrete are a concern. Use of an N-95 respirator is required when using saws or grinding concrete.

- Two-part resins are often used for coating the forms for the concrete canoe before casting. Follow all SDS precautions when using resins. In addition, only apply resins with both the roll-up door and the front door to the building with fans running.

Trip Hazards:

Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards.

Noise hazards:

Saws and grinding operations require hearing protection.

High Temperature Hazards:

No high temperature hazards are identified in this laboratory.

Chemical Hazards:

The chemicals typically found in this laboratory and their associated hazards are listed below:

Table 3: Chemical Hazards in SimCenter Fuel Cell Building

Material	CAS#	Hazards
Portland cement	65997-15-1	OVEREXPOSURE TO PORTLAND CEMENT MIXED WITH WATER CAUSES SEVERE SKIN BURNS AND EYE DAMAGE. MAY CAUSE AN ALLERGIC SKIN REACTION. SWALLOWING MAY CAUSE DAMAGE TO MOUTH, THROAT OR INTERNAL ORGANS. INHALATION MAY CAUSE RESPIRATORY IRRITATION. LONG TERM INHALATION MAY DAMAGE LUNGS OR CAUSE CANCER.
Class F Fly Ash	See SDS	Not classified for physical hazards. Skin irritation, Category 3 Eye irritation, Category 2B Specific Target Organ Toxicant, Repeated Exposure, Category 2 Not classified for environmental hazards. Not classified for specific hazards.
Class C Fly Ash	See SDS	Acute: Fly ash may cause irritation to the respiratory tract, eyes, or the skin. Alkaline material; irritation may be aggravated by the addition of moisture (sweat). Chronic: Prolonged inhalation exposure may cause pulmonary fibrosis or chronic bronchitis.
Ground, Granulated Blast Furnace Slag	See SDS	Causes severe skin burns and eye damage May cause cancer (lungs). Causes damage to organs (lungs) through prolonged or repeated exposure.
Silica Fume	69012-64-2	IT CONTAINS MATERIAL WHICH CAN CAUSE CANCER. MAY BE HARMFUL IF INHALED.
Poraver glass beads	See SDS	WHMIS HAZARDOUS INGREDIENTS : None POTENTIAL HEALTH EFFECTS ROUTES OF ENTRY : None expected. Poraver is an expanded glass bead and the ingredients are in a fused crystalline structure. EYES : This product is an eye irritant due to the mechanical abrasion of the crystals. SKIN : This product is a skin irritant due to the mechanical abrasion of the crystals. INGESTION : Small glass particles present in this product may cause injury to the trachea, stomach and intestines. INHALATION: This product is a nuisance dust. OSHA PEL (total particulate, not otherwise

		regulated) 15 mg/m3, (respirable particulate, not otherwise regulated) 5 mg/m3,. ACGIH TLV (nuisance particulates) 10 mg/m3 (inhalable), 5 mg/m3 (respirable). ACUTE HEALTH HAZARDS : None known. CHRONIC HEALTH HAZARDS : Chronic exposure to respirable dust in excess of appropriate exposure limits may cause lung disease. IRRITANCY: This product will irritate the skin through mechanical abrasion of the crystals.
Polycarboxylate Water Reducer Product names: ADVA CAST 575, ADVA 140, Glenium 7500	See SDS	May cause sensitization by skin contact. Inhalation: Causes respiratory tract irritation. Eye Contact: May be slightly irritating to the eyes. Skin Contact: Causes skin irritation.
Lignosulfonate Water Reducer (Product Names: WRDA 64)	See SDS	Inhalation: Causes respiratory tract irritation. If prolonged exposure to vapor or mist occurs, effects maybe more severe resulting in coughing and breathing difficulties. Eye Contact: Eye contact causes irritation. Prolonged eye contact can result in tissue damage. Skin Contact: Acute skin contact is not expected to result in adverse effects. Prolonged skin contact can result in irritation causing redness and itching. May cause sensitization. Skin Absorption: Not expected to be harmful if absorbed through the skin. Ingestion: Harmful if ingested. Effects include: Digestive tract irritation. The following applies to Triethanolamine and associated materials: Triethanolamine has caused blood effects and liver and kidney damage in laboratory animal studies.
Vinsol Resin Air Entrainment (Product Names: MBAE90)	See SDS	Slight irritation only
Synthetic Air Entrainment (Product Names: Micro Air)	See SDS	Inhalation: Harmful Skin: Can cause severe irritation and possible burns Eyes: Corrosive. Can cause severe irritation, redness, tearing, and blurred vision and possible burns and corneal injury Ingestive: Corrosive. Can cause severe and permanent damage to mouth, throat, and stomach
Air Minus	See SDS	Non-Hazardous
Calcium Chloride Flakes	See SDS	Eye Contact: For dust: May cause severe eye irritation. May cause corneal injury. Effects may be slow to heal. Skin Contact: Brief contact is essentially nonirritating to skin. Prolonged contact may cause skin irritation, even a burn. Not classified as corrosive to the skin according to DOT guidelines. May cause more severe response if skin is damp. May cause more severe response if skin is abraded (scratched or cut). May cause more severe response on covered skin (under clothing, gloves). Skin Absorption: Prolonged skin contact is unlikely to result in absorption of harmful amounts. Inhalation: Dust may cause irritation to upper

		respiratory tract (nose and throat). Vapors are unlikely due to physical properties. Ingestion: Low toxicity if swallowed. Small amounts swallowed incidentally as a result of normal handling operations are not likely to cause injury; however, swallowing larger amounts may cause injury. Swallowing may result in gastrointestinal irritation or ulceration. Effects of Repeated Exposure: The data presented are for the following material: Potassium chloride. In animals, effects have been reported on the following organs after ingestion: Gastrointestinal tract. Heart. Kidney. Dose levels producing these effects were many times higher than any dose levels expected from exposure due to use.
Calcium Chloride Solution	10043-52-4	May cause minor irritation to eyes and skin, ingestion may cause nausea
Sodium Chloride Granules	See SDS	See SDS
Concrete Acid Stain	See SDS	H225 Highly flammable liquid and vapor H313 May be harmful in contact with skin H333 May be harmful if inhaled H336 May cause drowsiness or dizziness
Cure & Seal	See SDS	H226 Flammable liquid and vapor. H304 May be fatal if swallowed and enters airways H315 Causes skin irritation H319 Causes serious eye irritation H331 Toxic if inhaled H335 May cause respiratory irritation H336 May cause drowsiness or dizziness H340 May cause genetic defects H351 Suspected of causing cancer H360 May damage fertility or the unborn child H373 May cause damage to organs (liver, kidney, central nervous system) through prolonged exposure H401 Toxic to aquatic life
Two-Part acrylic resin	See SDS	Heating may cause a fire. Harmful if swallowed. Causes serious eye damage. Causes severe skin burns and eye damage. Harmful if inhaled.

10.3 Computer Science and Engineering Labs:

Computer Science and Engineering
Laboratory Safety Manual

Contents

Part 1 - Introduction and General Information

1.0 Purpose and Scope

The purpose of this Laboratory Safety Manual is to provide guidance to employees, administration, managers, and students with the goal of preventing human injury and environmental damage from hazardous chemicals, equipment, procedures, and testing methods used in the University of Tennessee at Chattanooga Computer Science and Engineering laboratories. These labs include: EMCS 220, EMCS 306, EMCS 312, EMCS 321 and EMCS 323.

1.1 Emergency Services Personnel Contact Information

The UTC Office of Safety and Risk Management is responsible for the safety and environmental concerns at the university. Should guidance be required for a safety or environmental issue, please call the appropriate person below. If an emergency that threatens safety of any student, faculty, or staff is occurring, dial 9-1-1.

UTC Office of Safety & Risk Management:	**423-425-5741**
Robert Mullins, Health and Safety Specialist:	423-425-5820 Robert-Mullins@utc.edu
Bob Jackson, Safety and Risk Management Specialist:	423-425-5949 Bob-Jackson@utc.edu
Joel Wands, Life Safety Technician	423-425-5794 Joel-Wands@utc.edu
Campus Police, Non-Emergency	423-425-4357

***** If health or life is in danger, dial 911 *****

1.2 Faculty Responsible for Computer Laboratories Contact Information

The responsible faculty for all Computer Science and Engineering Departmental laboratories above is Dr. Farah Kandah. He should be contacted via telephone or email should any of the following occur at:

Phone 423-425-4395
Email: Farah-Kandah@utc.edu

1.3 Responsibilities of Faculty for Computer Laboratory Safety

Although there is one faculty appointed to be responsible for all Computer Science and Engineering (CSE) laboratory safety, every faculty is responsible. These responsibilities include but not limited to:

- Knowing current College Laboratory Safety Manual policies and procedures.
- Laboratory Safety Manual compliance.
- Ensuring that each student, student worker, or collaborating researcher understands how to complete each assigned task safely.
- Ensuring Emergency Action Plans are in place and a first aid kit is available.
- Advising management of the safety needs of the labs.
- Encouraging each student and any other lab users to develop safe and healthy work habits.

Part 2 - Procedures and Operations

2.1 Description of Laboratories

2.1.1 Room EMCS 220 Capstone Lab

EMCS Room 220 with 22 computers and dedicated presentation equipment is a dedicated senior capstone and graduate seminar lab. Access is restricted to authorized individuals. Safety posters are up. Also upon access to every machine, a safety use guide screen pops up.

2.1.2 Room EMCS 306 Software Engineering Lab

EMCS Room 306 with 22 computers is used for student in software engineering I and II. It has all current operating systems and software engineering tools. Access is restricted to CSE registered students. Safety guidelines and use policy are activated upon logon on each computer.

2.1.3 Room EMCS 312 General Computing Lab

EMCS Room 312 with 20 machines is a general computing laboratory which every registered CSE student with a MOCs card can access for general lab use. Like in all other labs, a Safety Use Policy pops up upon log on.

2.1.4 Room EMCS 321 – Freshman Computer Lab

EMCS Room 321 with 22 machines is dedicated to CS1 and CS2 Introduction to computer programming which allows access to students in those two classes. Like in all other labs, a Safety Use Policy pops up upon log on.

2.1.5 Room EMCS 323 – UTC InfoSec Lab

EMCS Room 323 is a high security lab with very restricted access. Only students registered in a currently running security course are allowed in the room. Like in all other labs, a Safety Use Policy pops up upon log on.

Acceptable Use Policy for General Purpose Computer Labs

http://www.utc.edu/college-engineering-computer-science/programs/computer-science-engineering/labpolicy.php

- The lab is only for the use of students majoring in Computer Science or Computer Engineering, or who are currently taking one or more CPSC/CPEN classes.
- The lab is for academic use only.
- Doors may not be propped open at any time. Use your Mocs Card for access.
- Students must clean up after themselves.
- No food, drinks, or tobacco products are allowed in the lab.
- Password sharing and logging in for others is prohibited.
- Music should not be audible to others. If you wish to listen to music, please use headphones or earbuds and keep the volume down.
- No pornography, sexually explicit, or potentially offensive material may be viewed or downloaded.
- Files should be stored on personal media and not on the hard drives of the lab computers. Information on the hard drives is subject to being erased at any time, and in the meantime may be viewed by other students who could possibly plagiarize your work.
- Students will not conduct any illegal activities in the lab (including, but not limited to, illegal sharing of copyrighted materials).
- Students may not install or use peer-to-peer applications in the lab.
- Labs may not be used for hacking activities or any type of unauthorized access.
- Lab equipment and/or cables may not be moved, modified, or relocated. This includes chairs.
- Network ports in the computer labs are for lab equipment only.
- Sending/posting harassing or unwanted messages to others is prohibited.
- Be sure to log out from any e-mail accounts, UTC Learn, MyMocsNet, or similar systems when you are finished using them.
- The CSE Department is not responsible for items left in the labs.
- If lost items are found, please give them to the CSE Department Administrative Assistant in EMCS 313.
- Scheduled use of the lab has priority over all other uses. If you need to schedule the use of a lab for an activity other than a class, please see the CSE Department Administrative Assistant. Requests for use of the labs must be approved by the Department Head.
- Be courteous and respectful of others.
- Technical support issues should be e-mailed to CECSTECH@utc.edu.

10.4 Electrical Engineering Labs:

Electrical Engineering
Laboratory Safety Manual

Contents

Part 1 – Introduction and General Information

1.1 Purpose and Scope

The purpose of this Laboratory Safety Manual is to provide guidance to students, faculty, and staff with the goal of preventing human injury and environmental damage from hazardous chemicals, equipment, procedures, and testing methods used in the University of Tennessee at Chattanooga electrical engineering laboratories; specifically, the UTC electrical engineering laboratories.

1.2 Emergency Services Personnel Contact Information

The UTC Office of Safety and Risk Management is responsible for the safety and environmental concerns of the university. Should guidance be required for a safety or environmental issue, please call the appropriate person below. **In the event that an emergency threatens the safety of any student, faculty, or staff dial 911 immediately.**

UTC Office of Safety & Risk Management:	423-425-5741
Robert Mullins, Health and Safety Specialist:	423-425-5820 Robert-Mullins@utc.edu
Bob Jackson, Safety and Risk Management:	423-425-5949 Bob-Jackson@utc.edu
Joel Wands, Life Safety Technician	423-425-5794 Joel-Wands@utc.edu
Campus Police, Non-Emergency	423-425-4357

***** If health or life is in danger, dial 911 *****

1.3 Responsible Laboratory Manager Contact Information

Dr. Raga Ahmed is the responsible laboratory manager for the electrical engineering laboratories. She should be contacted via telephone or email should any of the following occur:

- Student needs to request access after-hours or during weekends/holidays
- Any material from outside the laboratory is brought inside the laboratory. This includes raw materials, chemicals, powders, and any other substance that may be unintentionally inhaled, spilled, or come into contact with human skin. If in doubt about the reportable nature of the material, contact Dr. Ahmed.
- Any time a potentially hazardous material is required for completion of an experiment or project. If in doubt about the reportable nature of the material, contact Dr. Ahmed.
    - Any time a spill occurs.
    - Any time a project will require laboratory space for more than one day.
    - Any time a tool or other piece of equipment not previously used in the laboratory or detailed in this manual is required for completion of an experiment or project.
    - Any time tours are expected to take place where non-UTC students or personnel will be present in the laboratory.

Dr. Ahmed Contact Information: Phone – (423) 425-5456
E-mail: Raga-Ahmed@utc.edu

1.4 Precedence of the University's Chemical Hygiene Plan

The University's Chemical Hygiene Plan is required by OSHA, and is therefore the document governing the activities outlined in this manual. Should any of the policies or procedures outlined in this manual conflict with the University's Chemical Hygiene Plan, the University's Chemical Hygiene Plan shall take precedence. A copy of the University's Chemical Hygiene Plan can be found at: https://www.utc.edu/safety-risk-management/environmental-compliance/index.php

1.5 Responsibilities of the Laboratory Manager

The Laboratory Manager has overall responsibility for implementation and enforcement of safety procedures in the electrical engineering laboratories, including but not limited to:

- Knowing current University policies and procedures as noted in the University Chemical Hygiene Plan, this Laboratory Safety Manual, and any related documents.
- Laboratory Safety Manual compliance.
- Enforcing the University Chemical Hygiene Plan.
- Ensuring that each student, student worker, or collaborating researcher understands how to complete each assigned task safely.
- Ensuring Emergency Action Plans are in place and a first aid kit is available.

- Documenting that the appropriate training has been provided and forwarding training records to the University Office of Safety and Risk Management quarterly.
- Providing regular safety and housekeeping inspections including inspections of emergency equipment.
- Advising management of the safety needs of subordinates.
- Encouraging each employee to develop safe and healthy work habits.

1.6 Training

Users of the laboratories will be trained to perform the following tasks:

- Follow the requirements of this Laboratory Safety Manual, the University Chemical Hygiene Plan, prudent laboratory practices, and other applicable rules.
- Follow oral and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned.
- Plan and conduct each operation in accordance with the Chemical Hygiene Plan, safety plansand prudent laboratory practices.
- Review and understand the hazards of materials and processes in the laboratory prior to conducting work.
- Develop and use good personal hygiene and safety habits.
- Wear all required personal protective equipment/clothing.
- Keep the work areas safe and uncluttered.
- Promptly report accidents to the laboratory supervisor.
- Complete all required health, safety and environmental training.
- Inform the lab supervisor of any work modifications ordered by a physician as a result of medical surveillance, an occupational injury or exposure.

Part 2 – Procedures and Operations

2.1 Description of Laboratories

2.1.1 Room 303: Electrical Communication Laboratory

EMCS Room 303 serves as a teaching and research laboratory for both electrical engineering faculty and students. Only students who have been approved by the Laboratory Manager and have signed the Open Laboratory Policy Acknowledgement Form (Appendix F) are permitted in this lab.

2.1.2 Room 304: Power Electronics laboratory

EMCS Room 304 serves as a teaching laboratory for electrical engineering students. Only students who have been approved by the Laboratory Manager and have signed the Open Laboratory Policy Acknowledgement Form (Appendix F) are permitted in this lab.

2.1.3 Room 305: Robotics Laboratory

EMCS Room 305 serves as a senior capstone design laboratory for CECS students. Only students who have been approved by the Laboratory Manager and have signed the Open Laboratory Policy Acknowledgement Form (Appendix F) are permitted in this lab.

2.1.4 Room 307: EPB Electrical Circuits Laboratory

EMCS Room 307 serves as a teaching laboratory for engineering students. Only students who have been approved by the Laboratory Manager and have signed the Open Laboratory Policy Acknowledgement Form (Appendix F) are permitted in this lab.

2.1.5 Room 308: TVA Power Engineering Laboratory

EMCS Room 308 serves as a teaching laboratory for electrical engineering students. Only students who have been approved by the Laboratory Manager and have signed the Open Laboratory Policy Acknowledgement Form (Appendix F) are permitted in this lab.

2.1.6 Room 310: Instrumentation and Advanced Electronics Laboratory

EMCS Room 310 serves as a senior capstone design laboratory for electrical engineering students. Only students who have been approved by the Laboratory Manager and have signed the Open Laboratory Policy Acknowledgement Form (Appendix F) are permitted in this lab.

2.1.7 Room 322: Linear Controls and Drives Laboratory

EMCS Room 322 serves as a teaching and research laboratory for both electrical engineering faculty and students. It is also support for electrical engineering students capstone projects. Only students who have been approved by the Laboratory Manager and have signed the Open Laboratory Policy Acknowledgement Form (Appendix F) are permitted in this lab.

2.1.8 Room 339: Robotics and Advanced Control Laboratory

EMCS Room 339 serves as a teaching and research laboratory for both electrical engineering faculty and students. Only students who have been approved by the Laboratory Manager and have signed the Open Laboratory Policy Acknowledgement Form (Appendix F) are permitted in this lab.

2.1.9 Room 402: ETAP/TVA Power Simulation Laboratory

EMCS Room 339 serves as a teaching laboratory and classroom for engineering students.

2.1.10 Room 406: Robotics and Advanced Control Laboratory

EMCS Room 406 serves as a teaching and research laboratory for both electrical engineering faculty and students. Only students who have been approved by the Laboratory Manager and

have signed the Open Laboratory Policy Acknowledgement Form (Appendix F) are permitted in this lab.

2.2 Description of Physical, Chemical, and Flammable Hazards

Physical hazards are defined in this manual as those with potential risk of injury or death not associated with chemical exposure. Physical hazards in this manual are divided into the sub-categories of electrical hazards, pinch-point hazards, airborne particulate hazards, trip hazards, noise hazards, and high temperature hazards. Chemical hazards are defined in this manual as being hazardous to humans to the extent that exposure (limited or prolonged) should be avoided, or that require the use of personal protective equipment (PPE). Flammable hazards are defined in this manual as those substances that can catch fire easily, such as petroleum distillates and solvents.

2.2.1 Electrical Hazards

In the laboratory, persons may be exposed to electrical hazards including electric shock, electrocutions, fire, arc blasts, and explosions. Potential exposures to electrical hazards can result from faulty electrical equipments/instrumentation or wiring, damage receptacles and connectors, or unsafe work practices.

Electric Shock

Electric shock occurs when the body becomes part of an electrical circuit. Shocks can happen in three ways.

- A person may come in contact with both conductors in a circuit.
- A person may provide a path between an ungrounded conductor and the ground.
- A person may provide a path between the ground and a conducting material that is in contact with an ungrounded conductor.

The extent of injury accompanying electric shock depends on three factors.

- The amount of current conducted through the body.
- The path of the current through the body.
- The length of time a person is subjected to the current.

Other factors that may affect the severity of the shock are:

- The voltage of the current.
- The presence of moisture in the environment.
- The phase of the heart cycle when the shock occurs.
- The general health of the person prior to the shock.

The amount of the current depends on the potential difference and the resistance. The effects of low current on the human body range from a temporary mild tingling sensation to death. An electric shock can injure a person in either or both of the following.

- A severe shock can stop the heart or the breathing muscles, or both.

- The heating effects of the current can cause severe burns, especially at points where the electricity enters and leaves the body.

Effects can range from a barely perceptible tingle to severe burns and immediate cardiac arrest. Although it is not known the exact injuries that result from any given amperage, the following table demonstrates this general relationship for a 60-cycle, hand-to-foot shock of one second's duration:

Current level	Probable effect on humand body
1 mA	Perception level. Slight tingking sensation. Still dangerous under certain conditions.
5 mA	Slight shock felt; not painful but disturbing. Average individual can let go. However, strong involuntary reactions to shocks in this range may lead to injuries.
6 – 30 mA	Painful shock, muscular control is lost. This is called the freezing current or "let-go" range.
50 – 150 mA	Extreme pain, respiratory arrest, severe muscular contractions. Individual cannot let go. Death is possible.
1000 – 4300 mA	Ventricular vibrillation (the rhythmic pumping action of the heart ceases). Muscular contraction and nerve damage occur. Death is most likely.
10,000 mA	Cardiac arrest, severe burns and probable death.

Wet conditions are common during low-voltage electrocutions. Under dry contions, human skin is very resistant. Wet skin dramatically drops the body's resistance. Dry conditions:

$$\text{Current} = \frac{\text{Volts}}{\text{Ohms}} = \frac{120}{100{,}000} = 1 \text{ mA}$$

A barely perceptible level of current

Wet conditions:

$$\text{Current} = \frac{\text{Volts}}{\text{Ohms}} = \frac{120}{1000} = 120 \text{ mA}$$

Sufficient current to cause ventricular fibrilation

Fire/smoke

Excessive current flowing through a component can cause a smoke or fire hazard. If smoke is detected, immediately turn off the power to the circuit. Locate the problem before applying power to the circuit again. Before applying power to a circuit, double-check the circuit for wiring or design errors. Make sure that the components can handle the designed current.

The following example shows how excessive current can cause problems: **Applying 12VDC to a ½-Watt, 50-Ohm resistor is a bad idea!** Why? 12V/50 Ohms = 240mA. And 12V x 240mA = 2.88 Watts. This resistor is designed to dissipate .5 Watt of power. And 2.88 Watts >> 0.5 Watts. The excess current will cause the resistor to overheat, smoke, and possibly cause a fire.

Explosion

Electrolytic capacitors can explode if their voltage limits are exceeded, or if they are connected with reverse polarity. (Electrolytic capacitors always have a black band with "– " marks on them to indicate the negative connection. They are also marked with the maximum DC voltage they can handle.)

2.2.2 Other Physical Hazards

Pinch-Point hazards

TVA Power Engineering Laboratory (Room 308) utilizes electrical machines and transformers that can be relatively heavy (5-25 lbs. Each). Proper care must be taken when removing them from the station.

Airborne Particulates hazards

No equipment used in the electrical engineering laboratories are suspected to release airborne particular hazards.

Trip Hazards

Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards.

Noise hazards

TVA Power Engineering Laboratory (Room 308) utilizes electrical machines in which during operation might produce noises. Under normal operation, no hearing protection is required asthe noise produced is below the threshold limits.

High Temperature Hazards

No high temperature hazards are identified in electrical engineering laboratories.

Chemical Hazards

No chemicals hazards are identified in electrical engineering laboratories.

10.5 Mechanical Engineering Labs:

Mechanical Engineering
Laboratory Safety Manual

Contents

Part 1 – Introduction and General Information

1.0 Purpose and Scope

The purpose of this Laboratory Safety Manual is to provide guidance to employees, administration, managers, and students with the goal of preventing human injury and environmental damage from hazardous chemicals, equipment, procedures, and testing methods used in The University of Tennessee at Chattanooga mechanical engineering laboratories. Specifically, the UTC mechanical engineering laboratories currently include EMCS 105/106, 107, 114/114A, 108/123/124, and 424. Mechanical Engineering also partly manages projects at the Center of Energy, Transportation and Environment (CETE) located within the Advanced Vehicle Test Facility (AVTF) off-site near the TVA Chickamauga Dam.

1.1 Emergency Services Personnel Contact Information

The UTC Office of Safety and Risk Management is responsible for the safety and environmental concerns at the university. Should guidance be required for a safety or environmental issue, please call the appropriate person below. If an emergency that threatens safety of any student, faculty, or staff is occurring, dial 9-1-1.

UTC Office of Safety & Risk Management:	**423-425-5741**
Robert Mullins, Health and Safety Specialist:	423-425-5820 Robert-Mullins@utc.edu
Bob Jackson, Safety and Risk Management:	423-425-5949 Bob-Jackson@utc.edu
Joel Wands, Life Safety Technician	423-425-5794 Joel-Wands@utc.edu
Campus Police, Non-Emergency	423-425-4357

***** If health or life is in danger, dial 911 *****

1.2 Responsible Laboratory Manager Contact Information

The responsible laboratory manager for the laboratories above is Dr. Gary McDonald. Also, if needed, contact Mechanical Engineering Dept. Head, Dr. James Newman. Both should be contacted by telephone or email should any of the following occur:

- Student needs to request access after-hours or during weekends or holidays.
- Any material from outside the laboratory is brought into the laboratory. This includes raw materials, chemicals, powders, paint, stain, dyes, and any other substance that may be unintentionally inhaled, spilled, or come into contact with human skin. If in doubt about the reportable nature of the material, contact Dr. McDonald.
    - Any time a spill occurs.

- Any time a student or other project will take up laboratory space for more than one day.
- Any time a tool or other piece of equipment not previously used in the laboratory or detailed in this manual is required for completion of a project or experiment.
- Any time tours are expected to take place where non-UTC students or personnel will be present in the laboratory.

Dr. McDonald contact information:

Phone (office):	423-425-4483
Email:	Gary-McDonald@utc.edu

Dr. Newman contact information:

Phone (office)	423-425-4369
Email:	James-Newman@utc.edu

1.3 Manual's Position in reference to the University's Chemical Hygiene Plan

The University's Chemical Hygiene Plan is required by OSHA, and is therefore the document governing the activities outlined in this manual. Should any of the procedures contained in this manual conflict with the University's Chemical Hygiene Plan, the University's Chemical Hygiene Plan shall take precedence. A copy of the University's Chemical Hygiene Plan can be found at: https://www.utc.edu/safety-risk-management/environmental-compliance/index.php

1.4 Responsibilities of the Laboratory Manager

The Laboratory Manager has overall responsibility for implementation and enforcement of safety procedures in the mechanical engineering laboratories, including, but not limited to:

- Knowing current University policies and procedures as noted in the University Chemical Hygiene Plan, this Laboratory Safety Manual, and applicable test methods.
- Laboratory Safety Manual compliance.
- Enforcing the Chemical Hygiene Plan (CHP).
- Ensuring that each student, student worker, or collaborating researcher understands how to complete each assigned task safely.
- Monitoring and enforcing chemical procurement, storage, use, and disposal procedures in the mechanical engineering laboratories.
- Ensuring facilities and training are adequate for any chemical used or stored in their laboratory, and ensuring appropriate training has been provided.
- Being familiar with the training requirements of the University's Hazardous Materials Communication Program, and ensures that all laboratory employees, students, or researchers using or exposed to hazardous materials are trained as required.
- Ensuring laboratory employees who work with or are exposed to materials are provided with the appropriate protective and safety equipment. Ensuring Emergency Action Plans are in place and a first aid kit is available.
- Documenting that the appropriate training has been provided and forwarding training records to the University Office of Safety and Risk Management quarterly.
- Providing regular, formal chemical hygiene, safety, and housekeeping inspections including inspections of emergency equipment.

- Advising management of the safety needs of subordinates.
- Encouraging each employee to develop safe and healthy work habits.

1.5 Training

Users of the laboratories will be trained to perform the following tasks.

- Follow the requirements of this Laboratory Safety Manual, the University Chemical Hygiene Plan, prudent laboratory practices, and other applicable rules.
- Follow oral and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned.
- Plan and conduct each operation in accordance with the chemical hygiene plan, safety plans and prudent laboratory practices.
- Review, understand, and document the hazards of materials, machinery, and processes in the laboratory prior to conducting work.
- Develop and use good personal hygiene and safety habits.
- Wear all required personal protective equipment/clothing.
- Keep the work areas safe and uncluttered.
- Utilize appropriate measures to control identified hazards, including consistent and proper use of engineering controls, personal protective equipment, and administrative controls.
- Understand the capabilities and limitations of personal protective equipment issued to them.
- Gain prior approval from the lab supervisor for the use of any new chemicals introduced to the laboratory.
- Promptly report accidents to the laboratory supervisor.
- Complete all required health, safety and environmental training.
- Inform the lab supervisor of any work modifications ordered by a physician as a result of medical surveillance, an occupational injury or exposure.

1.6 Chemicals requiring approval for use

There are rarely any potentially hazardous chemicals used in the mechanical engineering laboratories. However, should the need arise, the following hazardous chemicals must have prior approval for use before beginning a project or bringing the chemical into the laboratory. The Laboratory Manager will contact the Office of Safety and Risk Management for guidance. In addition, if any chemical beyond the following list is suspected to present a hazard (as identified on the SDS), the Laboratory Manager will contact the Office of Safety and Risk Management for guidance.

Toxic Gas:	Generation of CO from engine test stand (CO monitored alarm)
Acutely Toxic Compounds:	None typically used.
Shock Sensitive Compounds:	None typically used
Highly Corrosive Compounds:	None typically used
Flammable Compounds:	Gasoline
	Oil-automotive
	Propane fuel

1.7 Chemical inventory

A record of the chemicals housed in each laboratory will be maintained, along with their respective SDS, by the laboratory manager. Annually or when requested by the Office of Safety and Risk Management, a chemical inventory will be performed detailing the chemicals and quantities associated with them and the room number in which they reside. See Appendix H for a copy of the chemical inventory form.

1.8 Labeling

All chemicals and materials should be kept in their original, labeled containers when possible. If temporary alternate storage is required, the SDS must be consulted to ensure that the appropriate material (glass, plastic etc.) is chosen for the temporary storage. Temporary storage containers should be clearly labeled. Temporary storage in alternate containers should be avoided whenever possible. In no case should alternate containers be used for long-term (more than 2 weeks) storage.

1.9 Hazardous waste

All hazardous chemical waste will be kept in proper containers which are properly closed and labeled. They will be clearly marked “HAZARDOUS WASTE”. Containers will be stored in satellite collection areas designated in each lab.

Part 2 – Procedures and Operations

2.1 Description of Laboratories

2.1.1 Room 105/106: Fluid Mechanics Laboratory

EMCS Room 105/106 is known as the Fluid Mechanics Laboratory. Its purpose is to allow successful teaching of laboratory techniques involves properties and usage of liquids (mainly water) and gases (mainly air). One experiment uses foodstuffs and other non-toxic fluids. This laboratory supports the Fluid Mechanics course. This lab is not open to students outside of class time but they still must complete the lab safety training. Primary Faculty Member Contact: Dr. Kidambi Sreenivas, Kidambi-Sreenivas@utc.edu, 423-425-5506.

2.1.2 Room 107: Freshman Design Laboratory

EMCS Room 107 is known as the Freshman Design Laboratory. Its purpose is to allow successful teaching, through student group projects that give students experience in applying methodologies of design. There are also experiences in building apparatuses and prototypes for the clients that often sponsor these projects. It should be noted that this shop is a Low Hazard Level shop per the Machine Shop Hazard Matrix Table 2.2.1a on page 75. EMCS 107 is a 24/7 accessible laboratory. The CECS Laboratory Safety Manual and the CECS Training site requires that students be accompanied by at least one other student or faculty member in all laboratories at all times. According to the Machine Shop Hazard Matrix (Table 2.2.1a on page 75), equipment that falls under the category of medium or high hazard level requires specialized training by which a student may be certified as “safety monitor”.

In addition, EMCS 107 lab is locked at all times and students are only allowed swipe card access. Students are not approved for access until they have completed the online lab safety training, passed the quiz, and agreed to abide by all safety requirements. Per the lab safety requirements, students are instructed that non-authorized personnel are not to be in the lab. If this occurs, the authorized student may lose lab access. Primary Faculty Member Contact: Dr. Cecelia Wigal, Cecelia-Wigal@utc.edu, 423-425-4015.

2.1.3 Room 108/123/124: Mechanical Engineering Experimentation Laboratory

EMCS 108/123/124 is known as the Mechanical Engineering Experimentation Laboratory. The laboratory’s purpose is to allow successful teaching of mechanical engineering thermal and machinery experiments that support the curriculum, and introduces the usage of electronic sensors and data acquisition to acquire data for quantifying system performance. This laboratory supports the learning from the Mechanical Engineering Experimentation course. This lab is not open to students outside of class time but they still must complete the lab safety training. Primary Faculty Member Contact: Dr. Charles Margraves, Charles-Margraves@utc.edu, 423-425-4010.

2.1.4 Room 114/114A: BAJA SAE Design Laboratory

EMCS Room 114/114A is known as the Baja SAE Design Lab. Its purpose is to allow successful teaching of the design and construction of the UTC Baja SAE vehicle that competes in the Society of Automotive Engineering (SAE) design competition and events. The Baja vehicle design constraints are derived from the rules of the SAE competition. It should be noted that this shop contains specialized

equipment which requires separate training for use. This equipment is only accessible to those that have completed training and proven competency. EMCS 114/114A is a 24/7 accessible laboratory. The CECS Laboratory Safety Manual and the CECS Training site requires students must be accompanied by at least one other student or faculty member in all laboratories at all times. According to the Machine Shop Hazard Matrix (Table 2.2.1a on page 75), equipment that falls under the category of medium or high hazard level requires specialized training by which a student may be certified as "safety monitor".

In addition, the EMCS 114/114A lab is locked at all times and students are only allowed access using swipe card. Students are not approved for access until they have completed the online lab safety training, passed the quiz, and agreed to abide by all safety requirements. Per the lab safety requirements, students are instructed that non-authorized personnel are not to be in the lab. If this occurs, the authorized student may lose lab access. Primary Faculty Member Contact: Dr. Trevor Elliott, Trevor-Elliott@utc.edu, 423-425-1716.

2.1.5 Room 424: Basic Engineering Science Laboratory

EMCS 424 is known as the Basic Engineering Science Laboratory. The laboratory's purpose is to support the instruction in the Basic Engineering Science course. This laboratory is to allow successful teaching of the Basic Engineering Sciences (physics – mechanics) classical experiments in the measures of force, moments along with the kinematics of displacement, velocity and acceleration, work, energy and momentum. This lab is not open to students outside of class time but they still must complete the lab safety training. Primary Faculty Member Contact: Mr. Ricky Horn, Ricky-Horn@utc.edu, 423-425-2103.

2.1.6 Advanced Vehicle Test Facility (AVTF)

There are also projects that mechanical engineering supports at the Center of Energy, Transportation and Environment (CETE), Advanced Vehicle Test Facility (AVTF). This facility is near TVA's Chickamauga Dam. The director of CETE is Dr. Ignatius Fomunung from Civil Engineering. Drs. Charles Margraves, Trevor Elliott, and Yunye Shi from mechanical engineering have advised student projects at the facility. This facility is locked at all times and authorized students are only allowed access using swipe card. Students are not approved for access until they have completed the online lab safety training, passed the quiz, and agreed to abide by all safety requirements. Primary Faculty Member Contact: Dr. Trevor Elliott, Trevor-Elliott@utc.edu , 423-425-1716.

2.2 Description of Physical, Chemical, and Flammable Hazards

Physical hazards are defined in this manual as those potential risks of injury or death not associated with chemical exposure. Physical hazards in this manual are divided into the sub-categories of electrical hazards, pinch-point hazards, airborne particulate hazards, trip hazards, noise hazards, and high temperature hazards. Chemical hazards are defined in this manual as being hazardous to humans to the extent that exposure (limited or prolonged) should be avoided, or that require the use of personal protective equipment (PPE). Flammable hazards are defined in this manual as those substances that can catch fire easily, such as petroleum distillates and solvents.

2.2.1 Room 105/106: Fluid Mechanics Laboratory

Electrical hazards: Water used in this laboratory is contained in closed circuit pipes, open channel flow

apparatuses. Sometimes foodstuffs and other non-toxic materials are used in viscosity and density measurements. Ensure that all water sources do not come into contact with electrical outlets or cords. Ensure that all electrical cords are maintained away from foot-traffic areas and are not frayed, bent, or have contacts missing.

Pinch-Point hazards: There is some moving mechanical equipment utilized in this laboratory. Direct physical contact with machinery should be avoided while it is operating. The only places in this laboratory where possible pinch points could occur are the low speed wind tunnel blades (have a protective grill to avoid contact), the pumps for the flow bench circuits and open channel flow device, and the propeller experiment, where the test stand is surrounded by a cage during use. All have protective covers to avoid contact with any rotating mechanical parts.

Airborne Particulates hazards:

There are no sources of hazardous airborne particles.

Trip Hazards:

Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards.

Noise hazards:

No equipment used in this laboratory is suspected to meet threshold limits for hearing protection under normal operation.

High Temperature Hazards:

There are no high temperature devices in this laboratory.

Chemical Hazards:

No chemicals requiring protection beyond eye protection are typically utilized in this laboratory. Eye protection will be used in viscosity and density experiments.

2.2.2 Room 107: Freshman Design Laboratory

Airborne Particulates and inhalation hazards:

Airborne particulates are generated when sawing and sanding. Also, there are projects that are spray or hand painted, and the usage of glue and other adhesives. The list of chemicals used in this lab is shown in Appendix H. The lab will be well ventilated using outside air when using paints, adhesives, and coatings.

Trip Hazards:

Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards.

Noise hazards:

Eye and ear protection will always be used when using any power tools, painting, and applying adhesives to the various students' projects.

High Temperature Hazards:

There are no high temperature sources in this laboratory although care should be exercised with the heat generation that is a result of using power tools.

Chemical Hazards:

The list of chemicals used in this lab is shown in the master chemical table, Appendix H.

2.2.3 Room 108/123/124: Mechanical Engineering Experimentation Laboratory

Electrical hazards:

Water is used in this room. The primary source of water usage is the transient heat transfer experiment. For this experiment water is boiled on a hot plate. Care is made to ensure that the hot plate is kept away from all electrical wiring and outlets.

Pinch-Point hazards:

A large metal duct is attached to the refrigeration trainer by slipping one end of the duct over the small duct located on the trainer itself. This creates the possibility of a pinch point. The faculty member responsible for the lab connects the two ducts before any students enter the lab and it is not removed until the students have left.

Airborne Particulates hazards:

The primary source of airborne particulates is from the propane exhaust gases when the Rankine Cycler is used. When in operation a fan is turned on directing the exhaust gases to the exhaust vent located in the ceiling near the equipment. There is also a CO and CO2 sensor located in the lab to alert the faculty if these levels become unsafe. For the Wind Turbine experiment students are required to wear safety glasses to prevent the chance of getting loose debris in their eyes.

Trip Hazards:

Walking areas should be kept free from electrical cords, mechanical components, and other sources of trip hazards.

Noise and eye hazards:

Eye protection will be used when working with the Wind Turbine and Rankine Cycler experiment. Ear protection will be worn when running the wind turbine at high velocities.

High Temperature Hazards:

The usage of boiling water in the transient heat transfer experiment and the propane burner used for the Rankine Cycler are the high temperature hazards in this lab. A top is kept over the boiling water for the transient heat transfer experiment until needed. The exhaust gas and steam from the Rankine cycler are exhausted into the room. A fan is used to direct these toward the exhaust vent located in the ceiling of the room near the experiment. Walkways are kept free of tripping hazards around the equipment.

Chemical Hazards

The list of chemicals used in this lab is shown in the master chemical table, Appendix H.

2.2.4 Room 114/114A BAJA SAE Design Laboratory

Airborne Particulates and inhalation hazards:

Airborne particulates are generated when cutting, grinding, and sanding. There is also need for spray or hand painting, however these are commonly outsourced for larger items or performed outside of the building for smaller items. Welding tasks are performed in this lab and the lab is outfitted with a mobile fume extractor with 95% rated weld fume particulate filter (MERV 15 rated). This is used for TIG/MIG tasks as well as plasma cutting tasks to reduce process originated particulates. Particulate concerns with the benchtop waterjet are addressed using a physical barrier in combination with device control to ensure water submersion to mitigate airborne dispersion. Eye protection will be worn during all cutting, grinding, or sanding activities as well as all fabrication/assembly activities that may result in free flying debris. The list of chemicals used in this lab is shown in Appendix H.

Trip/Fall Hazards:

Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards. The lab has a spill containment area with absorbent technologies appropriate to the lubricates, solid spills, and fluid spills that may occur with commonly used materials.

Noise hazards:

Ear protection will always be used when using any power tools, equipment, or devices that operate above 75 dBA.

High Temperature Hazards:

Appropriate PPE as outlined within each activity area or device location will be worn during activities that result heat or light/arc exposure (such as leathers/auto dark helmet/gloves/etc for welding, gloves for certain cutting/grinding activities, and shield/distancing during plasma table operations).

Chemical Hazards

The list of chemicals used in this lab is shown in the master chemical table, Appendix H.

2.2.5 Room 424: Basic Engineering Laboratory

Electrical hazards:

Water is not normally used in this laboratory. If so, ensure that all water sources do not come into contact with electrical outlets or cords. Ensure that all electrical cords are maintained away from foot-traffic areas and are not frayed, bent, or have contacts missing.

Pinch-Point hazards:

No moving mechanical equipment is utilized in this laboratory. There are weights and balls used to generate force and moment so care should be used to avoid dropping of weights to avoid injury. Steel and/or plastic balls are used in the projectile motion experiment. Proper eye protection will be used to avoid eye contact.

Airborne Particulates and inhalation hazards:

There are no airborne particulates used in this lab.

Trip Hazards:

Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards.

Noise hazards:

There are no noise hazards in this lab.

High Temperature Hazards:

No high temperature hazards are identified in this laboratory.

Chemical Hazards:

There are no chemicals typically found in this laboratory.

2.2.6 Advanced Vehicle Test Facility (AVTF)

Electrical hazards:

The areas utilized by students for project activities are situated at a safe distance from all high voltage systems in use at the facility. There are limited hazards of an electrical nature due to this distancing which are similar to a common office setting. The facility has its own safety and risk management

manual which all student teams are introduced to when they are on site and there is a copy in the conference room on site as well as the primary work space so that the students may consult as needed.

Pinch-Point hazards:

Pinch-point hazards are project dependent and are assessed during project development with the faculty member over the project. Proper safety and mitigation procedures are developed at that time based on the project need.

Airborne Particulates and inhalation hazards:

Airborne particulates are generated when cutting, grinding, and sanding. There is also need for spray or hand painting, however these are commonly outsourced for larger items or performed outside of the building for smaller items. Welding tasks are performed in this facility and location for such activities is the high bay area with both cross flow bay doors open and the air mover on (operating conditions similar to welding outside). This is used for TIG/MIG tasks to reduce process originated particulates. Particulate concerns with the benchtop waterjet are addressed using a physical barrier in combination with device control to insure water submersion to mitigate airborne dispersion. Eye protection will be worn during all cutting, grinding, or sanding activities as well as all fabrication/assembly activities that may result in free flying debris. The list of chemicals used in this lab is shown in Appendix H.

Trip Hazards:

Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards. The lab has a spill containment area with absorbent technologies appropriate to the lubricates, solid spills, and fluid spills that may occur with commonly used materials.

Noise hazards:

Ear protection will always be used when using any power tools, equipment, or devices that operate above 75 dBA.

High Temperature Hazards:

Appropriate PPE as outlined within each activity area or device location will be worn during activities that result heat or light/arc exposure (such as leathers/auto dark helmet/gloves/etc for welding, gloves for certain cutting/grinding activities, and shield/distancing during plasma table operations).

Chemical Hazards

The list of chemicals used in this lab is shown in the master chemical table, Appendix H.

10.6 Machine Shop:

Machine Shop
Laboratory Safety Manual

Contents

Part 1 – Introduction and General Information

1.0 Introduction:

The purpose of this manual is to outline the requirements to minimize/eliminate machine shop related injuries. Specifically, the UTC machine shop, EMCS 111. This manual is developed in accordance with the Occupational Safety and Health Administration (OSHA) regulations and UTC CECS policies.

It is the policy of The University of Tennessee at Chattanooga College of Engineering and Computer Science (UTC CECS) to take precautions to eliminate hazards associated with the use of hand and power tools; and to ensure employees and students are properly trained to utilize these tools in a safe manner related to their use in UTC CECS machine shops. This Machine Shop Safety Manual provides an overview of shop safety.

1.1 Emergency Services Personnel Contact Information

The UTC Office of Safety and Risk Management is responsible for the safety and environmental concerns at the university. Should guidance be required for a safety or environmental issue, please call the appropriate person below. If an emergency that threatens safety of any student, faculty, or staff is occurring, dial 9-1-1.

UTC Office of Safety & Risk Management:	**423-425-5741**
Robert Mullins, Health and Safety Specialist:	423-425-5820 Robert-Mullins@utc.edu
Bob Jackson, Safety and Risk Management:	423-425-5949 Bob-Jackson@utc.edu
Joel Wands, Life Safety Technician	423-425-5794 Joel-Wands@utc.edu
Campus Police, Non-Emergency	423-425-4357

***** If health or life is in danger, dial 911 *****

1.2 Responsible Machine Shop Manager Contact Information

The responsible laboratory manager for the Machine Shop is Ben Swords. Also, if needed, contact Technical Support Supervisor: Karl Fletcher. Both should be contacted by telephone or email should any of the following occur:

- Any material from outside the Machine Shop is brought into the Machine Shop. This includes raw materials, chemicals, powders, paint, stain, dyes, and any other substance that may be unintentionally inhaled, spilled, or come into contact with human skin. If in doubt about thereportable nature of the material, contact Mr. Swords.
    - Any time a spill occurs.
    - Any time a student or other project will take up laboratory space for more than one day.
    - Any time a tool or other piece of equipment not previously used in the laboratory or detailed in this manual is required for completion of a project or experiment.
    - Any time tours are expected to take place where non-UTC students or personnel will be present in the laboratory.

Mr. Swords contact information:

Phone (office):	423-425-2154
Email:	Benjamin-Swords@utc.edu

Karl Fletcher contact information:

Phone (office):	423-425-4306
Email:	Karl-Fletcher@utc.edu

1.3 Manual's Position in reference to the University's Chemical Hygiene Plan

The University's Chemical Hygiene Plan is required by OSHA, and is therefore the document governing the activities outlined in this manual. Should any of the procedures contained in this manual conflict with the University's Chemical Hygiene Plan, the University's Chemical Hygiene Plan shall take precedence. A copy of the University's Chemical Hygiene Plan can be found at: https://www.utc.edu/safety-risk-management/environmental-compliance/index.php

1.4 General Shop Safety Rules

1. Only fully trained and competent personnel are permitted to utilize machine shop equipment and tools. The following general machine shop safety guidelines apply to general shop duties and do not serve as adequate replacement of specific shop equipment training. These guidelines must be implemented to ensure safety and health in machine shops; failure to do so may result in serious injury or death.
    a) Eye protection (i.e., safety glasses, goggles or face shields) is required in all shop areas, whether working or not.
    b) Open toed shoes, or sandals, are prohibited within machine shops. Closed toed shoes are required when in any shop area. Steel toed shoes may be required if working with heavy materials, such as metal.
    c) Adequate hand protection must be worn depending on the materials being handled.
    d) Wear appropriate clothing for the shop and task being completed
    e) Operation of any piece of shop equipment is not permitted unless the user is fully trained on the specific piece of equipment.

f) At least two people should be present in the machine shop when equipment and/ortools are in use.
g) The use of compressed air to clean equipment should be minimized and only used at pressures less than 30 pounds per square inch (psi). Compressed air should never be used for cleaning clothing, hair or aimed at other persons.

1.5 Access Control

1. Machine shops contain tools and equipment, which if used by unauthorized personnel can cause serious injury. Efforts must be made by each shop to ensure access to the shop is controlled.
    a) During business hours, machine shops should be staffed, and a supervisor present, to ensure unauthorized personnel are not permitted within working areas.
    b) During non-business hours machine shops must be locked to limit access by unauthorized personnel.

1.6 Cleaning and general housekeeping

1. Machine shops should be maintained in a clean and orderly manner.
2. Floors should be swept clean at the end of each work shift or class.
3. Equipment/tools should be cleaned after use.
    a. Turn off power to any equipment or tool prior to cleaning. Move chips/shavings away from tool work area and remove any dust/metal collecting container and dispose of water materials properly. Do not overuse compressed air for cleaning equipment. Limit air pressure to less than 30psi.
4. Report any damage or missing parts of tools/equipment to the shop supervisor immediately.
5. At the end of work remove cutting bits and blades and store in a safe manner.
6. Lower saw blades to safe positions for storage.
7. Place storage guards back on tools/equipment after use if applicable.

1.7 Machine Guarding

1. Equipment of tools that present hazards from points of operation, nip points, rotating parts, flying chips and sparks must be properly guarded.
2. Guards should not pose an additional hazard to the worker.
3. At no time should a guard be removed, or changed in any way.
4. Equipment that is missing a guard should be tagged and removed from service. Once the piece of equipment is properly guarded it may be put back into service.

1.8 Visitors

1. Visitors are not permitted to use any of the machine shop tools or equipment without prior approval from the shop supervisor. Approval should include the appropriate level of training for the equipment to be used by the visitor.

Part 2 – Procedures and Operations

2.1 Description of Laboratories

2.1.1 Room 111: Engineering Machine Shop

EMCS Room 111 is known as the Engineering Machine Shop. Its purpose is to assist in the construction of student design projects and faculty in research. It consists of computer controlled and manual machines for both metal and woodworking.

2.2 Description of Physical, Chemical, and Flammable Hazards

Physical hazards are defined in this manual as those potential risks of injury or death not associated with chemical exposure. Physical hazards in this manual are divided into the sub-categories of electrical hazards, pinch-point hazards, airborne particulate hazards, trip hazards, noise hazards, and high temperature hazards. Chemical hazards are defined in this manual as being hazardous to humans to the extent that exposure (limited or prolonged) should be avoided, or that require the use of personal protective equipment (PPE). Flammable hazards are defined in this manual as those substances that can catch fire easily, such as petroleum distillates and solvents.

2.2.1 Machine Shop

Electrical hazards:

There is usually no water in these labs. But, with student projects, if water becomes a part of the project, ensure that all electrical cords are maintained away from foot-traffic areas and are not frayed, bent, or have contacts missing.

Pinch-Point hazards:

The hazards are using power or hand tools in the construction of these student projects. The safety procedures that are stated using our Shop equipment apply to the equipment in this laboratory. All saws, drills and other power tools should be handled with all equipment safety features intact and all cutting, grinding will be done away from any electric cords (or other electric sources) as well as any water sources.

Machine Shop Hazard Matrix - Table 2.2.1a

Hazard Level	Low	Medium	High
General Design	Hand tools (non-powered) Small powered tools Small bench top tools	Larger portable power tools Larger powerful bench top tools Light industrial tools	Large industrial tools and equipment
Common Examples	Belt sander (handheld) Dremel tool Drill (corded/cordless) Hand tools (non-powered) Heat guns Jig saw Laser cutter/engraver Oven Paint booth Palm sander Scroll saw Soldering iron	Angle grinder Belt/disc sander (pedestal) Bench grinder Circular saw Chop/miter saw Drill press (benchtop) Enclosed CNC machine Horizontal band saw Larger than 3/8" drills Manual brake Manual shear Milling machine Planer Reciprocating saw Routers	Band saw (free standing) Cranes and hoists Drill press (free standing) Hydraulic/mechanical press Lathe Milling machine (standing) Open CNC mill Power press brake Power shear Radial arm saw Surface grinder Table saw Vertical band saw Welding (Hot Work)
Shop Monitoring	Equipment use is permitted in designated area of the shop or other pre-approved location. Employees – Direct monitoring is not required for low hazard level tools. Students – Direct safety monitoring is not required, but students shall not work alone with low hazard level tools; student must have prior approval to use equipment.	Equipment use is permitted only in designated areas. Employees – direct monitoring is not required, but worker should not work alone with medium hazard level tools. Students – Safety monitor MUST be present during operation to ensure safe use of equipment.	Equipment use is permitted only in designated areas. Employees – direct monitoring is not required, but worker MUST not work alone; and the monitor/supervisor must be available in the event of an emergency. Students – Safety monitor MUST be present during operation to ensure safe use of equipment
Required Training	1. General Shop information 2. General Shop safety training	1. General shop information 2. General shop safety training 3. Equipment specific safety training	

Airborne Particulates and inhalation hazards:

Airborne particulates are generated when sawing and sanding. Also, there are projects that are spray or hand painted, and the usage of glue and other adhesives. The list of chemicals used in this lab is shown in Appendix H. The lab will be well ventilated using outside air when using paints, adhesives, and coatings.

Trip Hazards:

Walking areas should be kept free from electrical cords, buckets, and other sources of trip hazards.

Noise hazards:

Eye and ear protection will always be used when using any power tools, painting, and applying adhesives to the various students' projects.

High Temperature Hazards:

There are no high temperature sources in this laboratory although care should be exercised with the heat generation that is a result of using power tools.

Chemical Hazards

The list of chemicals used in this lab is shown in the master chemical table, Appendix H.

2.2.2 General Shop Safety Training

Operation of any piece of shop equipment is not permitted unless the user is fully trained on the contents of the UTC CECS Machine Shop Safety Manual and specific equipment training has been completed.

Trainer

Name:
Signature:
Date:

Trainee

Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:
Name:	Signature:	Date:

Specific Shop Tool Training

Equipment-specific training documents: an employee or student has been fully trained to operate certain types of tools/equipment within the shop.

Equipment-specific training must be provided by the shop supervisor or their designee who can demonstrate full competency on the equipment.

The trainer must provide:

- An overview of the equipment
- Hands-on training providing exact use of the equipment
- User must demonstrate competency to become certified to operate the tool/equipment.

Tool	Trainer	Date	Trainee	Signature	Date

APPENDICES

A. Chemical Hygiene Plan

PURPOSE OF CHEMICAL HYGIENE PLAN

(29 CFR 1910. 1450 9(E))
The development and implementation of a written Chemical Hygiene Plan (CHP) is the foundation of compliance required by the Occupational Safety and Health Administration (OSHA) as stated in the publication Occupational Exposure to Hazardous Chemicals in Laboratories (Federal Register, January 31, 1990, pages 3327-3335, part of CFR 1910). These rules have also been adopted by the Tennessee Occupational Safety and Health Administration (TOSHA). Additionally, The University of Tennessee at Chattanooga shall be subject to any rules on this subject adopted by TOSHA at a subsequent time.

This rule and standard applies to all persons, including University employees, students, and visitors, authorized to be present in laboratories maintained by the College of Engineering and Computer Science (CECS). All persons subject to the CHP shall be informed of the locations of the CHP, the availability of Material Safety Data Sheets (SDS), and other pertinent reference materials relating to their health and safety while in the laboratory. Application of the CHP is in compliance with University of Tennessee Policies on Safety and Health, Subject H, Laboratory Safety.

The CHP shall be reviewed and evaluated for its effectiveness annually by the CECS Chemical Hygiene Officer and the Chief Chemical Hygiene Officer for UT Chattanooga.

The University of Tennessee at Chattanooga is committed to providing a safe working environment and believes employees have a right to know about health hazards associated with their work. All employees have access to pertinent safety information through their supervisory staff. When safety concerns arise, employees are encouraged to contact their supervisor.

It is important that employees assume responsibility for laboratory safety. The people who work in a given laboratory are best able to detect potential hazards. So that employees can make knowledgeable decisions about the personal risks of employment, this Chemical Hygiene Plan includes policies, procedures, and responsibilities designed to encourage an awareness of potential hazards in the workplace and to train employees in the development of appropriate, safe working conditions. A training program has been designed for the benefit and protection of all laboratory employees.

STANDARD OPERATING PROCEDURES

General precautions for handling all laboratory chemicals should include minimizing exposure because few laboratory chemicals are without hazard. Any mixture of hazardous chemicals is assumed to be more toxic than the most toxic component.

The following procedures are used when working with chemicals:

1. Accidents and spills: consult the SDS file found in room 445A, EMCS Building.

Eye contact: Promptly flush eyes with water for 15 minutes and seek medical attention. Medical attention should be obtained for body contact with hazardous chemicals.

Ingestion: Consult the SDS (file found in room 445C, EMCS Building) and/or Erlanger Poison Control Center (778-7000). Each chemical affects the body differently. Medical attention should be obtained for ingestion of hazardous chemicals.

Skin contact: Promptly flush the affected area with water and remove contaminated clothing. Use a safety shower if chemical contact is extensive. If symptoms persist after washing, seek medical attention. Medical attention should be obtained for body contact with hazardous chemicals.

Clean-up: Promptly clean up spills, using appropriate protective apparel and equipment. Dispose of clean-up materials properly. If possible, clean-up should be performed by the staff technician. In any situation where there is question as to how to handle a spill safely, contact the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) immediately and consult the appropriate SDS (file found in room 445C, EMCS). In any situation where there are severe health hazards due to a chemical spill contact the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) who will in turn contact the Safety and Risk Management Director (Bob Jackson, 425-5949), when necessary.

Medical attention should be obtained for body contact with hazardous chemicals.

2. Avoid unnecessary exposure to hazardous chemicals

Ensure that appropriate eye protection is worn by all persons, including students and visitors, in areas where chemicals are stored or used.

Wear appropriate gloves when the potential for contact with toxic chemicals exists.

Inspect the gloves before each use, wash before removal, and replace as needed.

Use properly fitted respiratory equipment when air contaminant concentrations are not sufficiently restricted by fume hoods.

Inspect the respirator before each use.

Do not smell or taste chemicals.

Use only those chemicals for which an adequate ventilation system is available.

Apparatus that can discharge toxic chemicals (vacuum pumps, distillation columns, etc.) should be vented into local exhaust devices.

Never eat, drink, smoke, or apply cosmetics in areas where laboratory chemicals are present.

Storing, handling, or consuming food or beverages in a laboratory or chemical storage area is prohibited.

The use of laboratory glassware, utensils, or refrigerators for foodstuff that will be consumed is also prohibited

Do not use mouth suction for pipetting or to start a siphon.

Use protective and emergency apparel and equipment when appropriate.

If contact lenses are worn in the laboratory, inform the supervisor so that special precautions can be taken in the event of eye injury.

Remove laboratory coats immediately upon contamination and dispose of properly.

Wash areas of exposed skin before leaving the laboratory.

3. Follow standard laboratory safety protocols

All chemicals should be properly labeled and stored.

Keep all oxidizing agents stored at least 10 feet away from solvents.

All chemicals should be stored in secure containers within enclosed cabinets, if possible.

Flammables and acids should be stored in authorized, appropriate storage cabinets.

Store flammable solvents and acids separately.

Keep all large quantity containers within appropriate storage cabinets. After removing the needed amount from a large container, return the container to the appropriate storage cabinet.

All chemicals should be monitored monthly to ensure effective status and continued safety measures. For example, picric acid crystals should be kept moist. Immediately request disposal of expired chemicals.

Keep the work area clean and uncluttered; clean up the work area on completion of an operation or at the end of each day.

Do not use damaged glassware. Handle and store laboratory glassware with care to avoid damage.

Dispose of broken or damaged glassware properly. Broken glassware may not be discarded in the regular trash.

Use a hood for operations that might result in the release of toxic chemical vapors or dust.

Use a hood or other local ventilation device when working with any moderately volatile substance with a TLV of less than 50 ppm.

Keep materials stored in hood to a minimum; do not allow materials to block vents or air flow.

Leave hood on if toxic substances are stored in it or if needed to augment laboratory ventilation.

Wear shoes at all times in the laboratory.

Confine long hair or loose clothing.

Horseplay, disorderly conduct, or use of abusive language in the laboratory is prohibited.

Seek information about hazards and plan appropriate protective procedures before beginning a new operation.

Consult the SDS or laboratory manual if in doubt about appropriate procedures for a specific chemical.

In the event of failure of a utility service leave lights on, place an appropriate sign on the door, and notify the CECS Chemical Hygiene Officer.

If questionable hazardous conditions are found immediately notify the supervisor and the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445A, phone 425-2209) before attempting to remedy the problem.

Properly label all chemicals before disposal including a list of all chemicals in each container. Do not mix questionable agents.

The CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) shall be notified of all purchase requests involving a chemical order. The CECS Chemical Hygiene Officer must be aware of all chemicals entering the college so proper handling, monitoring, record keeping, and training can be accomplished in a timely manner.

A current Safety Data Sheet(SDS) manual is maintained in EMCS room 445C.

Review the appropriate SDS in regard to any question concerning how to handle, store, or dispose of a specific chemical.

Be aware of unsafe conditions and see that they are corrected.

No unauthorized persons, children or pets are allowed in laboratories.

HOUSEKEEPING

Floors are cleaned regularly by UTC Building Services. All employees of the housekeeping department are trained in the risks associated with working in the laboratory. Information concerning specific risks in individual laboratories will be relayed by the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) to Mr. Corey McGraw, UTC Building Services (400 Palmetto Street, phone 425-5254). Mr. McGraw is responsible for conveying this information to the Custodial staff.

The housekeeping supervisor conducts a quarterly inspection to assess if:

Trash is deposited in appropriate receptacles and properly removed from the laboratory.

Broken glass must be placed in a separate labeled receptacle.

Chemical spills are promptly reported to the CECS Chemical Hygiene Officer.

Proper storage is maintained to minimize clutter.

Housekeeping personnel are not to clean counter tops. It is the responsibility of the assigned technical personnel to clean all counter tops and upper surfaces in the laboratory area.

Housekeeping personnel are not to clean up any type of spill until approval and instructions are obtained from the assigned technical staff. If technical personnel are not available, contact the CECS Chemical Hygiene Officer for instructions.

CHEMICAL INVENTORY

Current chemical inventory for each laboratory should be maintained and a copy of the inventory provided to the CECS Chemical Hygiene Officer on a quarterly basis. The CECS Chemical Hygiene Officer will provide a complete college chemical inventory to the UTC Chief Chemical Hygiene Officer on an annual basis. The annual inventory will be submitted to the Office of Safety and Risk Management no later than June 1st of each year.

A chemical inventory is performed annually, listing all the hazardous chemicals in the laboratory. Chemicals listed are those classified as hazardous by the Department of

Transportation (DOT), the Environmental Protection Agency (EPA), or displaying a 2 or greater in any section of the National Fire Protection Association (NFPA) diamond.

Chemicals are listed alphabetically along with the average quantity. The NFPA hazard classification, if known, is listed as well as the manufacturer's name and address. A chemical inventory form is provided in Appendix H.

Inventories are computerized whenever possible to provide improved sorting capability. A complete chemical inventory is located in the office of the CECS Chemical Hygiene Officer, the UTC Chief Chemical Hygiene Officer, as well as the local fire department and the State Department of Labor (TOSHA).

When chemical inventories are kept current it serves the purpose of keeping tighter control over chemicals within laboratory areas, prevents excessive stock-piling of chemicals, thereby reducing the hazards involved, as well as saving money by purchasing only needed chemicals.

MATERIAL SAFETY DATA SHEETS

A college SDS file is provided in EMCS room 445C. The SDSs are kept in alphabetical order. The CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) is responsible for updating the SDS file as new materials are purchased.

When a new chemical is introduced into the laboratory, immediately notify the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) so that proper training can be completed prior to the use of the chemical. In most cases this will only involve the review of the SDS to determine the proper handling of the chemical. At this time the CECS Chemical Hygiene Officer will determine if any special protective devices or procedures are required.

CHEMICAL STORAGE

Chemicals can be stored in alphabetical order only if they are in compatible chemical categories.

Special attention must be paid to ensure that oxidizing agents and other reactive chemicals are not stored close to interactive agents.

Chemical storage areas should be minimized. Storage on bench tops and hoods is not desirable. Ventilated cabinets and designated refrigerators are used for chemical storage only. No food is permitted in refrigerators where chemicals are stored.

Highly toxic chemicals, including carcinogens, are stored in ventilated storage areas in unbreakable chemical resistant secondary containers. The containers should be labeled: Caution: High Chronic Toxicity or Cancer Suspect Agent.

A separate inventory list of carcinogens and suspected carcinogens is maintained by the Chemical Hygiene Officer in order to comply with federal and state regulations.

Cylinders of compressed gases will be strapped or chained to a wall or bench top and are capped when not in use.

LABELING

The 29 CFR 1910. 1450 contains specific labeling requirements. Labeling must be done on all hazardous chemicals that are used in the workplace. Labels must not be removed or defaced.

Each hazardous chemical used in the laboratory that is not in its original container must be labeled. These labels must contain the following information:

1. Chemical name
2. Health hazard
3. Physical hazard

ENGINEERING CONTROLS

All biohazard hoods and fume hoods are inspected annually and certified by the Office of Safety and Risk Management (425-2297). Any hood not passing inspection is taken out of service immediately and not used until the hood has passed inspection. It is the responsibility of the employer to purchase the parts and replace the unit in a timely fashion so that the risk to employees is minimized.

Eyewash fountains are inspected every three months by the responsible CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) and records maintained by the Office of Safety and Risk Management (425-2297).

Safety showers are inspected, tested, and flushed annually and records are maintained by the Office of Safety and Risk Management (425-2297).

Fire extinguishers are inspected monthly by the Office of Safety and Risk Management (425-2297).

All chemical hygiene-related equipment is monitored by the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209).

CONTAMINATED WASTE REMOVAL AND DISPOSAL

To assure that minimum harm to people and the environment will result from the disposal of waste laboratory chemicals, a waste disposal program specifies how waste is to be collected,

stored and transported. A copy of the waste disposal plan is on file in the Office of Safety and Risk Management which is located at 400 Palmetto Street.

All disposal is done in accordance with the Tennessee Department of Health and the Environment.

ADMINISTRATIVE CONTROLS

The Custodian of Record is responsible for the safe operation of his/her respective laboratory. All activities and procedures require approval by the CECS Chemical Hygiene Officer before implementation. Environmental monitoring is required in all laboratories that use any of the following chemicals three times per week.

29CFR 1910 Sub part Z
1910.1001 asbestos, tremolite, anthopohyllite, and actinolite
1910.1002 coal tar pitch
1910.1003 4-Nitrobiphenyl
1910.1004 alpha-Naphtylamine
1910.1006 Methyl chloromethyl ether
1910.1007 3, 3'-dichlorobenzidine (and its salts)
1910.1008 bis-chloromethly ether
1910.1009 beta-napthylamine
1910.1010 benzidine
1910.1011 4-aminodiphenyl
1910.1012 ethyleneimine
1910.1013 beta-propriolactone
1910.1014 2-acetylaminofluorene
1910.1015 4-dimethylaminoazobenzene
1910.1016 N-nitrosodimethylamine
1910.1017 vinyl chloride
1910.1018 inorganic arsenic
1910.1025 lead
1910.1028 benzene
1910.1029 coke oven emissions
1910.1043 cotton dust
1910.1044 1, 2-dibromo-3-chloropropane
1910.1045 acrylonitrile
1910.1047 ethylene oxide
1910.1048 formaldehyde
1910.1101 asbestos

All spills are contained according to OSHA guidelines, and appropriate spill kits used. Spill kits are stored in the stockroom for the specific laboratory.

Assessment of significant risk of all operations is made by the Custodian of Record or the person responsible for the Chemical Hygiene Plan. Chemical hygiene and safety policies will be established for each task performed and engineering controls for personal protective equipment assigned.

RECORD KEEPING

Records of environmental monitoring, medical consultations and examinations (including tests and written opinions) for each employee are required.

Accident investigations: Records are written and retained by the Office of Safety and Risk Management (400 Palmetto Street, 425-2297).

Chemical inventory: Records are written and retained by each Custodian of Record and the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) and a copy is supplied to the Office of Safety and Risk Management (400 Palmetto Street, 425-2297).

Environmental monitoring: Records are written and maintained by the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) and the Office of Safety and Risk Management (400 Palmetto Street, 425-2297).

Medical consultation: Records are maintained by the Office of Safety and Risk Management (400 Palmetto Street, 425-2297) and a copy placed in the employee's personnel file.

Training: Records are maintained by the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209) and an annual report is provided to the UTC Chief Chemical Hygiene Officer.

When there is not a designated Chemical Hygiene Officer, full responsibility for all training and record keeping becomes the responsibility of the Custodian of Record.

All records are kept, transferred, and made available in accordance with 29 CFR 1910.20.

PERSONAL PROTECTIVE EQUIPMENT

Eye protection meeting ANSI Standard Z. 87 is required in all laboratories when hazardous chemicals are in use. Students may purchase this type of eye protection in the University Bookstore.

Employees and students are required to wear impervious gloves when there is a potential exposure to blood, hazardous chemicals, or infectious materials.

In areas where chemicals splashes are likely, an impervious apron appropriate for the task is required.

TRAINING

Training is a necessary and important part of the Chemical Hygiene Plan. All employees are trained at the time of the employee's initial assignment to a work in an area where hazardous chemicals are present. Additional training is required if new assignments involve exposure to different risks. All training is documented in writing by attendance records.

Before training can begin, a lesson plan should be developed that outlines the expectations of the program. The lesson plan should include:

I. Objectives. Upon completion of the Chemical Hygiene Training Program the employee will be able to:

A. Locate the potentially hazardous chemicals in the workplace.

B. Recognize the chemical labeling and its meaning.

C. Locate the SDS in the workplace.

D. Locate the health hazard, physical hazard, environmental protection, and special protection sections of the SDS and explain their use.

E. Identify the person responsible for the Chemical Hygiene Plan by name and title.

F. Discuss the major components of the facilities standard labeling system.

G. Identify the appropriate protective clothing for the area and demonstrate its use.

H. Demonstrate emergency procedures in the event of a hazardous chemical spill.

II. Describe the environmental monitoring protocol.

III. Activity Plan.

A. Audiovisuals that will be used
   1. Videotape
   2. Equipment instructions
   3. Handouts

B. An outline of topics to be discussed with approximate time limits.

C. Topics to be covered
   1. Content of lab standard
   2. Location of CHP
   3. Identification of chemical hazards
      a. Location of a chemical

b. Location of SDS
c. Labeling information

4. Procedures for handling hazardous chemicals
    a. Work practices
    b. Proper moving, storing, and use
    c. PEL for specific chemicals used by the employee
    d. Visual appearance of chemicals used by the employee
    e. Environmental monitoring requirements
    f. Signs and symptoms of exposure
    g. Protective equipment used to prevent overexposure
    h. Conditions to avoid
5. Environmental protection
    a. Emergency procedures
    b. Spill containment
    c. Medical consultation procedures

IV. Summary

A. Restate the objectives

B. Restate the main points

C. Answer questions

CHEMICALS REQUIRING APPROVAL FOR USE

There are several potentially hazardous chemicals used in the College of Engineering and Computer Science that require an evaluation of proposed protective procedures before any activity involving the handling of the chemical is commenced. If you plan to work with any of the chemicals in the listing below, you must complete the Permission for Chemical Use form and submit to the CECS Chemical Hygiene Officer (Bradley Harris, EMCS room 445C, phone 425-2209). The CECS Chemical Hygiene Officer then submits a recommendation for approval or rejection to the appropriate Department Head and the Dean (Daniel Pack, 425-2256), who make the final decision. Approval must be obtained in advance before purchase or usage of any chemical listed below. It is the responsibility of the CECS Chemical Hygiene Officer to determine through inventory which chemicals are to be placed on the Acutely Hazardous Chemicals List.

This listing provides some examples of materials categorized as acutely hazardous. The person responsible for the Chemical Hygiene Plan should review the chemical inventory listing and designate the acutely hazardous materials actually present. The listing should be reviewed and updated as necessary.

carbon monoxide
dioxan

arsin86ydrofin
fluorine
plutonium
hydrogen cyanide
cyanide compounds
hydrogen selenite
pesticides
phosphine

Shock Sensitive Compounds, Highly Corrosive Compounds
picramide
benzenesulfonic acid
picric acid
hydorfluoric 86ydrofluoriclycerine (and other nitro- compounds)
methanoic acid
benzoyl peroxide
ethanoyl chloride
acetyl peroxide
benzotrichloride

Extremely Flammable Compounds
carbonyl sulphide
arsine
di-n-propylamine

MEDICAL CONSULTATIONS AND EXAMINATIONS

All employees needing medical attention must use the University Worker's Compensation procedures defined by the University Personnel Office.

The employee is sent for medical evaluation under these circumstances:

1. There are signs and/or symptoms associated with exposure to a hazardous chemical.

2. Environmental monitoring reveals an exposure level above the action level.

3. An event, such as a spill, leak, or explosion, results in a hazardous chemical exposure.

The laboratory provides the following information to the examining physician:

1. Identity of the hazardous chemical(s) to which the employee has been exposed.

2. A description of the conditions under which the exposure occurred, including quantitative exposure data if available.

3. A description of the signs and/or symptoms of exposure.

4. A copy of the SDS for the chemical(s) involved.

Non-University employees and students shall bear the expense for medical surveillance and treatment in the event of an accidental exposure to a hazardous chemical. These individuals must contact the Office of Safety and Risk Management (425-2297) to request information about filing appropriate claims for compensation pursuant to the guidelines set forth by the Tennessee Claims Commission.

CHEMICAL HYGIENE RESPONSIBILITIES

Safety responsibilities for a specific laboratory rest with the Custodian of Record designated by the CECS Chemical Hygiene Officer and approved by the Department Head.

The designated person must:

Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices.

Monitor the procurement, use, and disposal of chemicals in the laboratory.

See that appropriate audits are maintained.

Help project directors develop precautions and adequate facilities.

Know the current legal requirements concerning regulated substances.

Seek ways to improve the chemical hygiene plan.

Certify the performance of protective equipment.

The immediate supervisor has the overall responsibility to:

Ensure that workers

1. Understand and follow the chemical hygiene rules.
2. Have working protective equipment available.
3. Are provided with adequate training.

Provide regular chemical hygiene and housekeeping inspections including routine inspections of emergency equipment.

Know the current legal requirements concerning regulated chemicals.

Determine the need for protective equipment.

The laboratory employee is responsible for:

Planning and conducting each laboratory operation in accordance with the institutional chemical hygiene procedures.

Developing good personal chemical hygiene habits.

UNIVERSITY CHEMICAL HYGIENE OFFICER RESPONSIBILITIES

The University Chemical Hygiene Officer for UTC coordinates the Campus Chemical Hygiene Program within University guidelines and has the responsibility to:

Develop a written hygiene plan to be submitted to the University Safety Office for approval.

Perform periodic reviews, at least annually, of department plans and prepare revisions to keep the campus plan current relative to changes in regulations and University safety policy.

Coordinate the necessary activities required to ensure that an adequate emergency reaction response capability exists within each department.

Coordinate a program to ensure that all hazardous materials information resources required by regulations are available to department employees and that the contents of these materials are current.

Oversee training of departmental employees to ensure compliance with safety regulations. Laboratory employees should have adequate job orientation so that they can protect themselves against the potential adverse effects of exposure to hazardous chemicals.

Coordinate necessary medical consultations to satisfy the requirements of the "medical consultation and medical examination" section of the standard.

Coordinate the arrangements of all required employee monitoring to satisfy the requirements of the "employee exposure determination" of the standard.

Coordinate the implementation of the approval procedure for those substances that are designated as requiring prior approval before use.

Coordinate all other activities that are shown to be necessary to ensure compliance with all aspects of the standard.

In order to assure compliance with the University of Tennessee Safety Policies, the University Chemical Hygiene Officer has the authority to initiate action to close down a laboratory if safety requirements of the UTC Chemical Hygiene Plan are not met.

ADDITIONAL SAFETY REQUIREMENTS OTHER THAN FOR HAZARDOUS CHEMICALS

1. Dispose of glass and sharp objects in designated disposal containers.

2. Non-contaminated waste is to be disposed of in regular trash.

3. Never obstruct exits, fire extinguishers, fire hoses, gas valves, etc.

4. Doors into laboratory areas are to remain closed at all times when not in use. Never prop doors open.

5. Make sure that all equipment is properly grounded and that the wiring of all equipment is in good condition. If cracks in insulation or exposure of the wiring is noticed, immediately unplug the equipment and notify your supervisor and the CECS Chemical Hygiene Officer.

6. In the case of exhaust failure, immediately notify your supervisor and the CECS Chemical Hygiene Officer. If personnel are in danger of contamination by toxic or infectious agents, immediately remove all personnel from the area, closing off the area until the problem has been properly resolved.

7. Chemical storage cabinets are to be placed at least six (6) feet away from laboratory exits.

GLOSSARY

The following terms are used as part of the Chemical Hygiene Plan:

Acute: An adverse effect with symptoms of high severity coming quickly to a crisis.

Carcinogen: A substance capable of causing cancer.

Chemical: A wide variety of fluids that have a high potential for bodily entry by agents various means. Some are more toxic than others and require special measures of control for safety and environmental reasons.

Chronic: An adverse effect with symptoms that develop slowly over a long period of time or that frequently recur.

Combustible: Able to catch on fire and burn.

DOT: Department of Transportation

EPA: Environmental Protection Agency

Flammable: Capable of being easily ignited and burning with extreme rapidity.

Infectious: Sources that cause infections either by inhalation, ingestion, or direct agents contact with the host material.

LC50: The concentration of a substance in air that causes death in 50% of the animals exposed by inhalation. A measure of acute toxicity.

LD50: The dose that causes death in 50% of the animals exposed to a substance through ingestion. A measure of acute toxicity.

SDS: Safety Data Sheet

Mutagen: Capable of changing cells in such a way that future cells are affected. Mutagenic substances are usually considered to be suspected carcinogens.

OSHA: Occupational Safety and Health Administration, the regulatory branch of the Department of Labor concerned with employee safety and health.

PEL: Permissible Exposure Limit. The legally allowed concentration in the workplace that is considered a safe level of exposure for an 8-hour shift, 40 hours per week.

pH: A measure of how acidic or caustic a substance is on a scale of 1 to 14. A pH of 1 indicates that a substance is strongly acidic; a pH of 14 indicated that a substance is strongly basic.

Sensitizers: Agents that can cause an allergic reaction at some point in time following repeated exposures.

Sterility: Changes made in male or female reproductive systems that result in and inability to reproduce.

Teratogens: A substance that causes a deformity in newborns if a significant exposure exists during pregnancy.

TLV: Threshold Limit Value. The amount of exposure allowable for an employee in an 8-hour day.

REFERENCES

THE FOLLOWING SOURCES WERE USED TO PREPARE THIS PLAN:

1. U.S. Department of Labor, final rule part II. Federal Register 29 CFR Part 1910. Occupational Exposure to Hazardous Chemicals in Laboratories, Wednesday, January 31, 1990.

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

3. National Research Council. Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, 1983.

4. A Model Chemical Hygiene Plan for Laboratories, Terry Jo Gile, MT(ASCP), MA Ed. Clinical Laboratory Management Association, Inc. 1990.

RADIATION SAFETY

The purpose of this section of the Chemical Hygiene Plan is to present regulations and recommended procedures for work with radiation sources at the University of Tennessee at Chattanooga in order to protect the individual, prevent the spread of contamination and to assist in fulfilling the responsibilities of the University to its students, its staff, and its neighbors.

Radiation is an invaluable tool in teaching and research and, when properly used, can provide great benefits to mankind with little or no attendant risk. However, improper use can bring risk of radiation exposure resulting in chronic illness, injury, or even death. The known hazards in the order of their importance are the deposition of radioactive materials in the body, external exposure to neutrons, to gamma and x-rays, and to beta radiation.

Use of radiation sources implies acceptance by the user of some increased exposure above the natural background radiation to which man has always been exposed. Common sense dictates that such increase in personnel exposures and contamination levels should be kept to the minimum consistent with reasonable effort and expense. Minimums considerably lower than the so-called Maximum Permissible Levels can be maintained provided the user has adequate knowledge, adequate equipment, and the skill and disposition to use them. Proper disposition means a balanced perspective towards radiation entailing a healthy respect.

This section is designed to help University staff in performing teaching and research with radiation sources in a safe, legal and efficient manner without imposing unnecessary restrictions on anyone's work. Some of the rules come from Federal and State Regulations which, having the force of law, permit no modifications unless specifically permitted by law.

In general, it is the responsibility of the individual radiation user to understand and conduct his operations in an acceptable manner to minimize hazards to himself and others. It is the responsibility of the laboratory supervisor to insure that all personnel, particularly new personnel, in his area are properly instructed with respect to the nature of the radiation hazards and the necessary radiation safety procedures in his laboratory and that they possess

the necessary skills and disposition to cope with radiation safety problems safely. The Radiation Safety staff is responsible for assisting all users and supervisors by providing consultation and certain services in matters of radiation safety.

The Radiation Safety Committee is responsible for establishing policies for the Radiation Safety Program, for reviewing the work of the Radiation Safety staff, and advising both them and the radiation users on particular problems.

Laboratory Procedures

1. The use of radioisotopes is restricted to approved areas.

2. Before using any radioisotope in the laboratory, you must be familiar with limitations placed on this institution regarding isotope use.

3. To prevent accidental entry of radioactive materials into the body, high standards of cleanliness and good housekeeping must be maintained in all laboratories where radioactive material is present.

4. Always use gloves. Remove gloves before leaving the work area. Wear protective clothing (lab coats, masks, shoe covers) as needed.

5. Wash hands and arms thoroughly before handling any object which goes to the mouth, nose, or eyes (e.g., cigarettes, cosmetics, foods). Keep fingernails short and clean.

6. Smoking and eating in radioisotope laboratories is prohibited. No food or drink may be stored in laboratory refrigerators.

7. One or more trial runs with non-radioactive materials are recommended for new procedures and new personnel to test effectiveness of procedures and equipment.

8. Use double containers for storage of working solutions of radioisotopes. For example, if the radioisotope solution is in a liquid scintillation vial, place the vial in a small beaker.

9. Never pipette by mouth. Use rubber bulbs, syringes, or mechanical devices.

10. Clean up minor spills immediately. For major spills follow emergency procedures.

11. Whenever possible, operations with radioactive materials should be conducted in a hood, dry box, or some other type of closed system. Operations with materials susceptible to atmospheric distribution, such as boiling, evaporating, distilling or ashing, must be done in a hood with an air flow of approximately 100 linear feet per minute. Work with activities of more than a few hours half-life should be done over a tray. Work with finely divided powder must be done in a hood or closed system.

12. Table and bench tops should be of a non-porous, chemical resistant material. Working surfaces shall be covered with absorbent paper regardless of the type of surface.

13. When work is completed each person will clean up his own work area and arrange for disposal or proper storage of all radioactive materials and equipment.

14. Vacuum pumps used in systems containing radioisotopes must not be permitted to exhaust into room air or out windows. Use a double trap mechanism on any vacuum system.

15. Exhaust stacks must not be vented near openable windows or building air intake vents.

16. Laboratories shall provide special radioactive waste containers. These shall bear the words Caution, Radioactive Waste and a warning to janitors against handling.

17. Housekeeping should not touch benches and instruments, etc., but are permitted to clean floors and windows only. Laboratory personnel are responsible for the rest of the housekeeping.

18. Repairs such as plumbing, etc., should not be undertaken unless Radiation Safety has been notified.

19. When use and storage of radioactive materials is to be terminated at a facility, notify Radiation Safety which must make a terminal survey before an area can be released for other uses.

Radioactive Waste Management

Researchers must ensure, prior to the procurement of any radioactive materials that a method of disposal of the materials either presently exists or can be worked out to the satisfaction of the Radiation Safety Committee.

1. Each Radioisotope Laboratory Supervisor must maintain accurate records of the types, quantities, and forms of radioisotopes which are placed in the radioactive waste which is released from his/her radioisotope laboratory. Records kept by the Laboratory Supervisor may be based on either calculations or on measurements.

2. Radioactive waste containers should be stored as close to the work area as possible to minimize the probability of spillage during the transfer of the waste to the containers.

3. Waste containers shall not be stored in hallways, stairwells or other uncontrolled areas.

4. Radioactive waste containers should be covered at all times when not in use.

5. Each radioactive waste container shall be labeled with a Caution Radioactive Materials label or sticker.

6. When handling or transferring radioactive waste, the individual should wear a laboratory coat and disposable gloves.

7. Radioactive wastes containing carcinogens, biohazards, or very hazardous chemicals must be inactivated, if possible, and packaged in such a way that they present minimal hazards to people who handle the wastes.

Emergency Procedures

In all emergencies, the Director of Safety and Risk Management (Bob Jackson 425-5949) should be contacted as soon as possible.

Extreme hazards: High radiation levels or the possibility of airborne contamination from dry or volatile radioactive materials.

1. Evacuate the laboratory immediately. Close and lock the door.

2. Summon the University Safety Officer and the Radiation Safety Officer immediately.

3. Remove shoes if contamination is suspected. Do not touch anything unnecessarily.

Other hazards: For example, spills or suspected spills of radioactive materials where the material is not airborne. Keep calm. Assume that you are contaminated until a survey proves otherwise.

1. Confine contamination.
   a. Localize the spill. Right a tipped container then drop absorbent material on the spill. Damp down a dry spill.
   b. Do not track contamination around the laboratory. Call for help if possible.
   c. Close the door to prevent the spread of airborne contamination.
   d. Check shoes before leaving the area after a spill has been cleaned up.

2. Protect personnel.
   a. Remove contaminated clothing and wash contaminated parts of the body with detergent.
   b. Warn other workers.

3. Decontaminate.
   a. If thorough washing does not remove contamination from the body, consult the Director of Safety and Risk Management (Bob Jackson, 425-5949).
   b. Do not spread radioisotopes to clean areas.

Emergency Procedures

1. Cease work as rapidly as possible. If the hood was in use, close the hood door.

2. Evacuate the area immediately. Close and lock the laboratory door. A notice not to enter the room must be placed on the door to prevent entry.

3. Remove contaminated clothing and wash contaminated areas of the body with detergent.

4. Call the Director of Safety and Risk Management (Bob Jackson, 425-5949)

B. Hazard Assessment Form

College of Engineering and Computer Science Risk Assessment									
Date:								Revision:	
		Before Safeguard			Safeguards	After safeguard			
Item #	Potential Hazard	Probability	Severity	Risk		Probability	Severity	Mitigated Risk	Recommended Action

C. Hazardous Material Procurement Form

College of Engineering and Computer Science
Hazardous Chemical Request Form

Requested by:_____ Date Submitted:_____

Department: _____ Date Needed: _____

Phone Number:_____ Total Amount: _____

Item	Quantity	Vendor	Vendor Item Number	Unit Price	Amount
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Description of Chemical Needed, Benefits to College: _____

_____

_____

_____

Courses/Research Supported: _____

Brief narrative of potential hazards, storage plan: _____

_____

_____

_____

_____

_____

_____

Director endorsement: _ Approve _Neutral ___Disapprove

_____

_____

_____

_____

Instructor:_____ Date: _____

Chemical Hygeine Officer:_____ Date: _____

Department Head:_____ Date: _____

Dean:_____ Date: _____

Approved Amount:_____ Account Number: _____

Account Name: _____

Date Ordered:_____ Order Number: _____

Expected Delivery Date:_____

Item	Vendor	Address	Phone	Date Rcvd
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Date Competed:_____

D. Incident Reporting Forms

THE UNIVERSITY OF TENNESSEE
REPORT OF ON-THE-JOB INJURY or ILLNESS

To be used for Workers' Compensation claim reporting.

Initial Information

Injured Employee Name	Social Security #	Date and Time of Incident	Date of Report

Position	Department	Supervisor's Name	Supv. Telephone

Exact Location of Incident (campus building/room or street address of non-campus location)

Description of Incident (work activity employee was engaged in, causes of incident, machinery in use, etc.)

(Use separate page to continue if needed.)

Nature of injury or illness (fracture, cut, allergic reaction, etc.)

Injured Body Part

Witness name	Telephone	Address	Relationship to UT

Witness name	Telephone	Address	Relationship to UT

Complete if incident resulted in medical treatment

Medical Treatment Required:

☐ Yes - First Aid only
☐ Yes - Doctor / Clinic Where?
☐ Yes - Emergency Room Where?

Date of First Treatment

Released to return to work:

☐ At full duty
☐ With restrictions
☐ Not released
☐ Follow-up visit to be scheduled

Any Other Medical Information / Comments:

Supervisor Comments

Could incident have been prevented?

Other comments?

Employee Signature	Date	Supervisor Signature	Date

UT Office of Risk Management, rev. 10/2014

UT Chattanooga

Department of Safety & Risk Management

Report of Unsafe Condition

This form is to be used by University employees to report unsafe conditions on the UTC campus. It is for the use of all employees and is not limited to the immediate work area. You are not required to give your name, department or phone number, however; this information will be kept confidential and **will** greatly assist in follow-up should additional details be needed.

Date: Time of Day:

Location of Unsafe Condition:

Existing Condition Which You Consider Unsafe:

Has This Been Reported to Anyone?:

Other / Comments:

Name: Department: Phone Number:

For use by Department of Safety and Risk Management

Inspection Date: **Work** Order Submitted?:

Existing Condition:

Abatement Date: Follow - up - **YIN:**

Return completed form to:
UTC Department of Safety & Risk Management 425-5209

E. Laboratory Access Log

College of Engineering and Computer Science
Laboratory Access Log

Laboratory Name/Room #: _____

Name (print)	Name (sign)	Mocs ID#	Time In	Time Out	Class #

F. Open Lab Policy Acknowledgement and Training Form

CECS Laboratory/Shop Safety Agreement
and
Student Acknowledgement of Compliance with Open Laboratory/Shop Policy

In consideration of my safety and effective education and that of my classmates, I agree to abide by the following regulations, designed to minimize the hazards inherent in laboratory/shop work. I recognize that an uninformed, unprepared, or merely careless and inconsiderate person hinders the learning process and is a real danger not only to himself or herself, but to all others as well.

1. Safety Equipment and Behavior
   a. Safety glasses, goggles or face shields will be worn at all times as specified in areas of the laboratories and shops, regardless of what is being done.
   b. Hardhats will be worn at all times as specified in areas of laboratories and shops.
   c. Closed toe shoes will be worn in the laboratories/shops at all times. Fitted cotton sleeved shirts and long pants are proper attire. Long hair should be contained behind head.
   d. No horseplay is permitted at any time in the laboratories or shops.
   e. Books, coats, and other personal items should be placed in a safe area of the laboratories and shops. The University is not responsible for personal items left in these facilities.
2. Eating, drinking, smoking or chewing of tobacco is not permitted in the laboratories or shops.
3. The locations of safety equipment (fire extinguisher, safety shower, eye-wash fountain, etc.) and their operation will be learned and committed to memory before any laboratory or shop work is undertaken. Safety shower and eye-wash fountain will be tested on a regular basis.
4. Reports of cuts, burns, fume inhalation, etc., will be made immediately to the instructor or lab/shop manager.
5. Tasting of chemicals is forbidden unless otherwise authorized, and great care will be exercised in noting the odor or fumes. Experiments or work in which noxious or toxic gases may be liberated will be carried out in hoods.
6. Suction bulbs will be used rather than the mouth for filling pipettes.
7. Proper techniques will be observed for routine laboratory/shop operations (boring corks, inserting only lubricated glass into rubber stoppers, etc.).
8. Laboratory/shop bench tops, lockers, balances, reagent shelves, work areas, floors, and hoods will be kept orderly at all times. Those responsible for spillage and scrap will clean it up immediately.
9. No experiment may be performed unless the required study preparation has been completed.
10. Broken or inoperative equipment or apparatus or part will be reported immediately to the instructor and/or shop or lab manager.

I have read, understand, and accept the foregoing as requirements of the course, realizing that failure to adhere strictly to these precautions is sufficient reason for expulsion from the laboratory/shop and possible dropping from the laboratory/shop course.

PRINTED NAME _____

FULL SIGNATURE _____

UTC ID_____ DATE _____

G. Laboratory Inspection Checklist

HEALTH AND SAFETY INSPECTION CHECKLIST

Office of Safety & Risk Management

UT Chattanooga

BUILDING:_____DATE:_____

INSPECTOR(S):_____

EXITS

_____ Panic hardware free of chains, locks, etc.

_____ Exits and other traffic areas free of obstructions.

_____ All exits and exit signs are illuminated.

_____ Panic hardware operates freely and with ease.

FIRE EXTINGUISHERS

_____ Fire extinguishers are accessible and location is clearly designated.

_____ Visually inspect wall-hung fire extinguishers for problems – date and sign inspection card attached to fire extinguisher.

ELECTRICAL

_____ Discontinue use of extension cords in lieu of permanent wiring—write up work request to hard wire.

_____ Wiring, extension cords, and/or power strips are in good condition and protected from damage.

_____ Electrical installations are being maintained in safe condition.

_____ Electrical equipment and wiring is protected from mechanical damage and environmental deterioration.

_____ There is a 36” clearance from all electrical panels.

_____ All covers are in place on electrical outlets and other electrical equipment.

_____ There are covers or barriers on boxes, fittings and enclosures to prevent accidental contact with live parts.

_____ Only qualified persons are working on electrical equipment.

_____ There are insulation covers on all electrical conductors (plugs).

FIRE SEPARATIONS

_____ Fire doors are free of obstructions and alterations.

_____ Closing and latching devices on fire doors are in working order.

_____ Self closing doors are not held open with wedges or by other unapproved means.

_____ Fire walls and draft stops are in good condition.

_____ All attic and scuttle openings are closed.

FIRE PROTECTION INSTALLATIONS

_____ Standpipes and sprinkler control valve is accessible for operations.

_____ Any obstructions, decorations or other items interfering with the proper operation of fire standpipes, hose cabinets and sprinkler systems have been removed.

_____ Obstructions, decorations and other items interfering with proper operation of exit lights have been removed.

COMMENTS: _____

_____

ASBESTOS

_____ Asbestos is being handled by a certified asbestos handler when maintenance, construction, repair, renovation, demolition, salvage, etc.

_____ Prior to work commencing, materials to be disturbed were analyzed for asbestos. Testing was performed by a certified asbestos testing individual.

_____ When a hazardous condition is created by an emergency, potentially affected area(s) are decontaminated prior to resumption of normal operations.

HOUSEKEEPING

_____ Rubbish, waste material and oily rags are kept in approved closed metal containers.

_____ Grease filters and hood and duct systems over cooking appliances are clean.

_____ Waste receptacles are non-combustible.

_____ Combustible waste materials are stored in closed metal waste bins and disposed of daily.

_____ Excessive combustibles (paper) are not stored in work areas.

_____ Electric cords and phone cables are secured to prevent tripping hazards.

_____ Hot plates and coffee makers are properly wired and turned off when not in use.

_____ File cabinet drawers are opened one at a time and closed when work is finished to prevent tipping.

_____ Heaviest materials are stored in bottom drawers of file cabinets.

_____ Spilled materials or liquids are cleaned up immediately.

_____ Work sites are clean and orderly.

_____ There is evidence of insect and rodent damage to carpets, cabinetry, closed/open area.

_____ No damage to furniture or equipment.

_____ No damage to floor coverings that may cause a hazard.

STORAGE

_____ Storage facility is kept in an orderly manner, providing for exiting and fire department access.

_____ Material is stored so it does not create a hazard. Height of piles, stacks and racks is limited to prevent tipping, falling and spreading.

_____ There is an aisle at least 3’ wide in every inside storage room.

_____ Stored materials are kept at least 18” below sprinkler level.

_____ Water heaters are secured to prevent tipping over.

_____ Compressed gas cylinders are secured and identified.

_____ There is at least a 5’ clearance between dumpsters and building openings, combustible walls, or roof eaves.

_____ There is clearance between heating appliances and combustible material.

_____ Boiler rooms, mechanical rooms and electrical panel rooms are not being used for storage of any combustible material or equipment.

COMMENTS: _____

_____

_____

_____

FLAMMABLE & CORROSIVE LIQUIDS

_____ If condition is present, a qualified person will remove flammable liquids not stored in either the original container, metal cans or small glass containers.

_____ If condition is present, a qualified person will remove flammable and combustible liquids not used for maintenance in assembly building and offices.

_____ Flammable liquids are stored away from corridors, main aisles, stairways, doors and exit areas.

_____ If more than 5 gallons of flammable liquid or 10 gallons of combustible liquid are found in the same room, they must be stored in an approved cabinet.

_____ Labeling an injurious substance: the container label will bear either the chemical or common name (not trade name), of injurious substance and signal or warning words. Signal words are “danger”, “warning” and “caution” and “poison” or “poisonous”.

_____ Workers are using appropriate protective equipment when handling corrosive materials.

_____ A deluge shower and emergency eyewash station are provided for workers frequently handling corrosives.

_____ Material Safety Data Sheets (SDS) are posted and made easily available.

BODY PROTECTION

_____ Appropriate clothing is worn for the work to be done.

_____ First Aid Kit is easily accessible, with the necessary supplies available.

_____ Protective equipment is maintained in a sanitary condition and ready for use.

_____ Loose jewelry is not worn while working with or around machinery with moving parts or electrically energized equipment.

HEAD PROTECTION

_____ Head protection is used when exposed to falling or flying objects.

_____ Long hair is kept up or covered if it is long enough to become entangled in moving parts of machinery.

_____ Head protection is worn when exposed to electric current that may cause shocks or burns.

EYE & FACE PROTECTION

_____ Eyes and/or face protection is worn where there is the possibility of injury from flying particles, hazardous substances or harmful light rays.

_____ If an eyewash station or shower is required, insure it flows clear water and at the proper pressure – date and sign inspection card.

HEARING PROTECTION

_____ Hearing conservation is being monitored and proper hearing protection is being worn when extreme equipment noise is present.

COMMENTS: _____

_____

_____

_____

RESPIRATORY PROTECTION

_____ Approved respirators are supplied when exposed to harmful airborne contaminants.

_____ Workers are trained in the need, use, sanitary care and limitations of respiratory equipment.

_____ Respirators are inspected and sanitized after each use and inspected monthly.

HAND PROTECTION

_____ Appropriate hand protection is being worn when hands are exposed to harmful substances.

FOOT PROTECTION

_____ Appropriate foot protection is being worn when feet are exposed to harmful conditions.

HAND & POWER TOOLS

_____ Safety condition of tools and their proper use is being observed.

_____ Power-operated tools are properly grounded or are of the double-insulated type.

_____ Tool and equipment guards are properly designed, substantial and secured in place.

_____ Saws, cutting tools, heads, shears and knives that are part of any machine are kept sharp, properly set up, adjusted and in safe and efficient working condition.

_____ Electrical equipment is de-energized during cleaning, servicing or adjustment.

_____ Before working on de-energized electrical equipment the disconnect is locked in the open position to prevent if from being accidentally energized.

_____ Machinery or equipment is being used with defective parts.

_____ Portable circular saw retracting blade guard is not to be locked open and must be maintained in good condition.

GUARD & DEVICES

_____ Point-of-operation guards are properly:

--preventing placing of hands or fingers in the point of operation

--removing a pinch point between the guard and moving parts

--in place and not removable by the operator

BAND SAWS

_____ Blade is not cracked; if crack occurs, saw will not be used until crack is repaired.

_____ Guides are in proper condition and alignment.

LADDERS

_____ Ladders are maintained in good, useable condition.

COMMENTS: _____

_____

_____

_____

WORKSTATION ERGONOMICS

_____ Wrist supports are present at computer workstations.

_____ Workstations are equipped with anti-glare computer screens.

_____ Working space allows for a full range of work movements.

_____ Mechanical aids and equipment are provided where feasible.

_____ Work surface height is proper and adjustable.

_____ Workstations are designed to minimize or eliminate bending or twisting at the waist, reaching above the shoulder, static muscle loading, extension of the hips and elevation of elbows.

_____ Employee's hands or arms are not subject to pressure from sharp edges on work surfaces.

_____ Armrests and footrests are provided where needed.

_____ Cushioned floor mats are provided for workers where required to stand for long periods.

COMMENTS: _____

_____

_____

_____

Lab_____

Chemical Hygiene Plan:
At location? _____
Reviewed and updated? _____

FUME HOODS

HOOD NUMBER	VELOCITY FT. /MIN.	CONDITION

EMERGENCY SHOWERS

SHOWER NUMBER		CONDITION

EYE WASH STATIONS

STATION NUMBER	CAPS IN PLACE?	CONDITION

Notes:

_____
_____
_____
_____

CERTIFICATION OF ANNUAL REVIEW

This chemical hygiene plan has been reviewed by:

Person responsible for chemical hygiene plan	_____ Signature	_____ Date
UTC Department of Safety and Risk Management	_____ Signature	_____ Date

UT CHATTANOOGA
SAFETY AND RISK MANAGEMENT
BUILDING INSPECTIONS

Building:_____ Date: _____

____Exit Lights

____Fire Protection Equipment

____Egress / Exits

____Electrical / Wiring

____Walking / Working Surface

____Stairs / Egress / Doors

____Lighting / Covers / Bulbs

____Housekeeping

____Fire Drill Records

____OSHA Records

____Date of Last Fire Systems / Sprinkler / Fire Pump Inspections

Other / Comments

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

_____
Signature of Inspector

H. Inventory Control Form

20__ Annual Chemical Inventory

Department:

Room Number(s):

Chemical	CAS#	Room#	Manufacturer	Container Size	Number of Containers	Lot Number	Exp. Date	NFPA Rating Health	NFPA Rating Fire	NFPA Rating Reactivity	NFPA Rating Special

CECS Lab Safety Training Site 21/22

Students enrolled in labs, classes, or organizations that require safety training (provided by each CECS department) are added to the CECS Lab Safety Training Organization in CANVAS by the Walker Teaching Resource Center.

File Message Help Acrobat Tell me what you want to do

Mon 8/9/2021 11:04 AM

AJ James, Andrea

Classes That Require Lab Safety Training for Fall 21-Please Advise by Thurs, 8/12

To Newman, James; Owino, Joseph; Nasab, Ahad; Karrar, Abdel; Pack, Daniel; Danquah, Michael; Wahsheh, Luay; Harris, Bradley

Cc Lomen, Karen; Hunter, Eva; Anderson, Shanae; McWeeney, Mandy; Hunnicutt, Alanna; Waldrep, Christy; Hillman, Irene; Jackson, Sara

You replied to this message on 8/13/2021 11:18 AM.
This message was sent with High importance.

Good morning,
Please review the list below and send me any additions and/or deletions for Fall 2021 by Thurs, Aug 12.
(Student Competition Groups/Organizations can be added as well.)

All I need is the course number.

Faculty/Admins who don't already have access to CANVAS for Lab Safety Site for these classes will have it by Friday, Aug 13. Students enrolled in classes requiring the training will be able to see it on Monday, Aug. 16 and will receive an announcement.

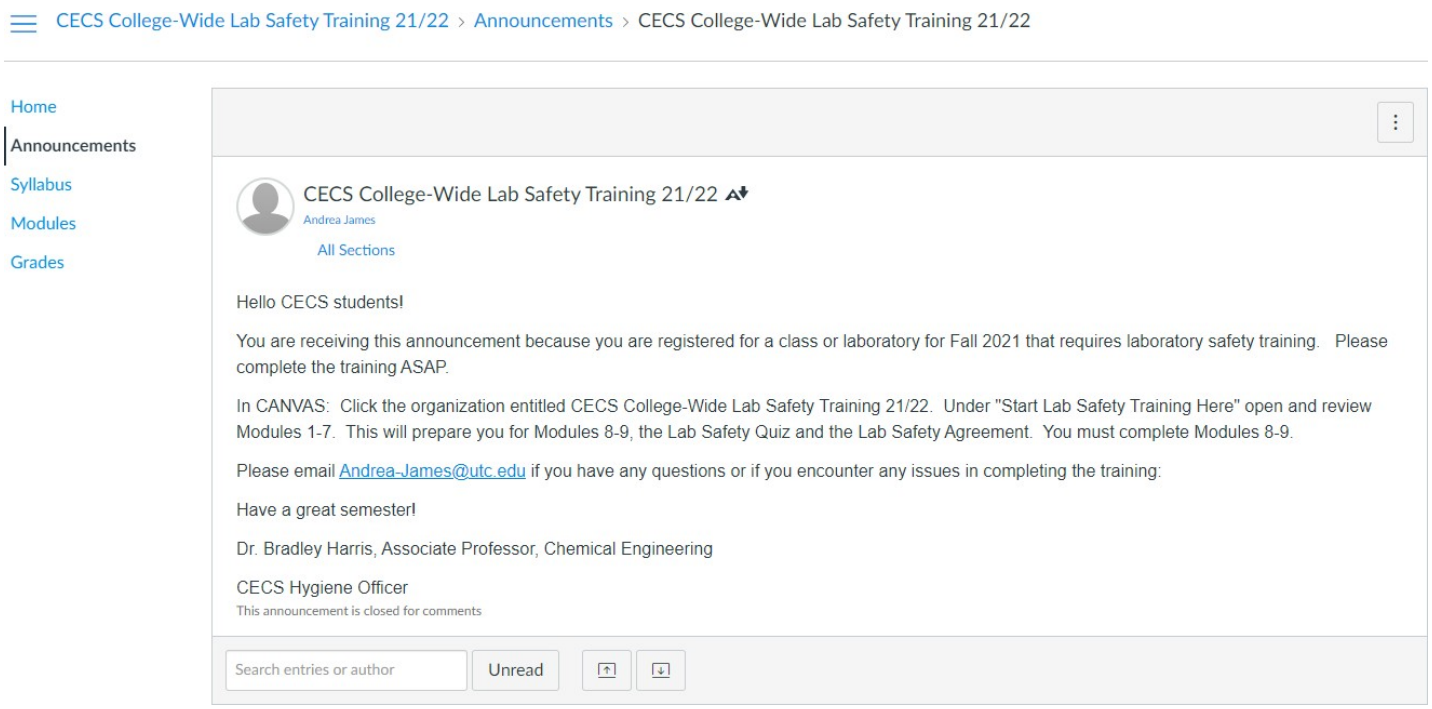
Please let me know if you have questions/concerns.

Thank you!
Andrea

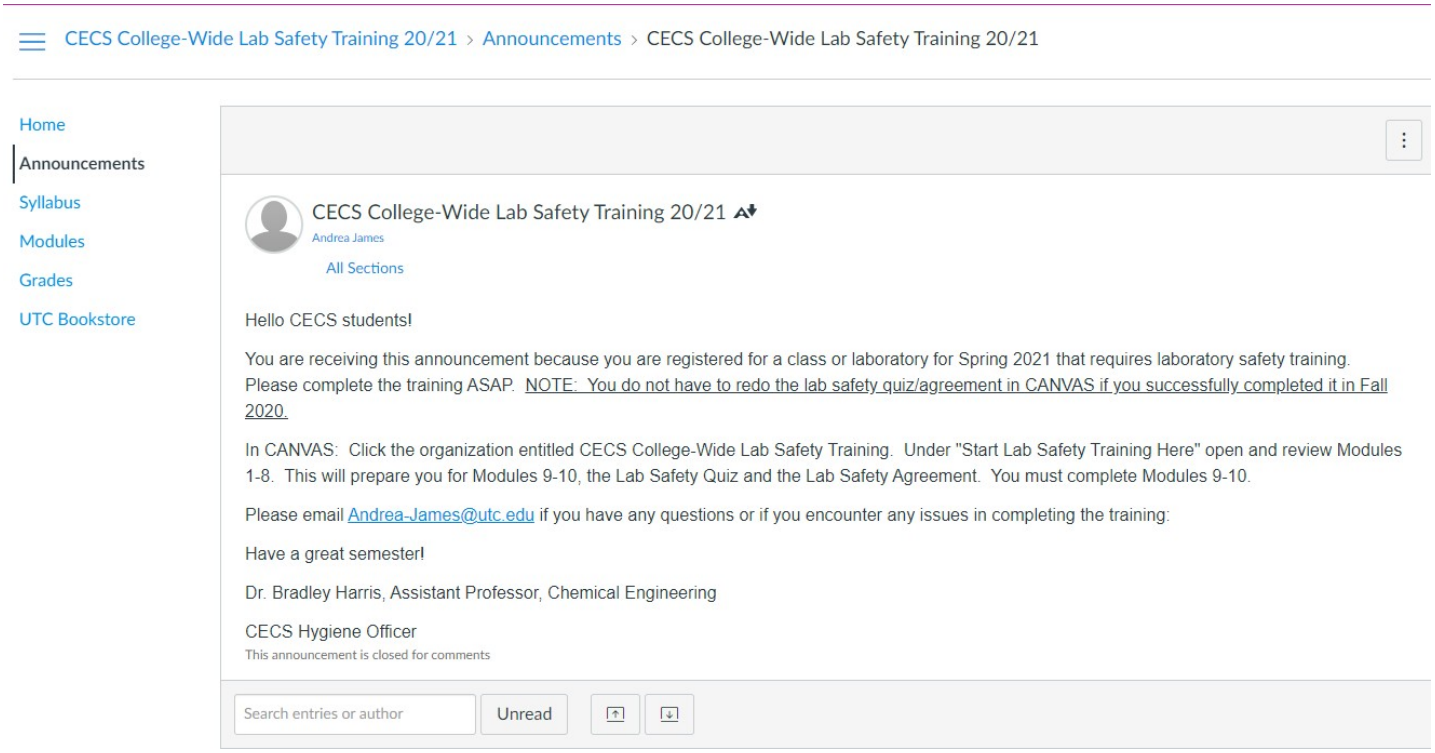
CPEN 3700
CPEN 4700
ENCE 2460L
ENCE 2460L
ENCE 2620L
ENCE 3500L
ENCE 3610L
ENCH 3280L
ENCH 4999 ChemE Car
ENCH 5910R
ENEE 2710L
ENEE 3720L
ENEE 3800
ENEE 3800L
ENEE 4710
ENEE 4790L
ENEE 5910 (Motion Control)
ENME 1030L
ENME 1850
ENME 3070L
ENME 3850
ENME 4470
ENME 4850
ETCM 1740

Lab Safety Training Organization Icon as shown in CANVAS:

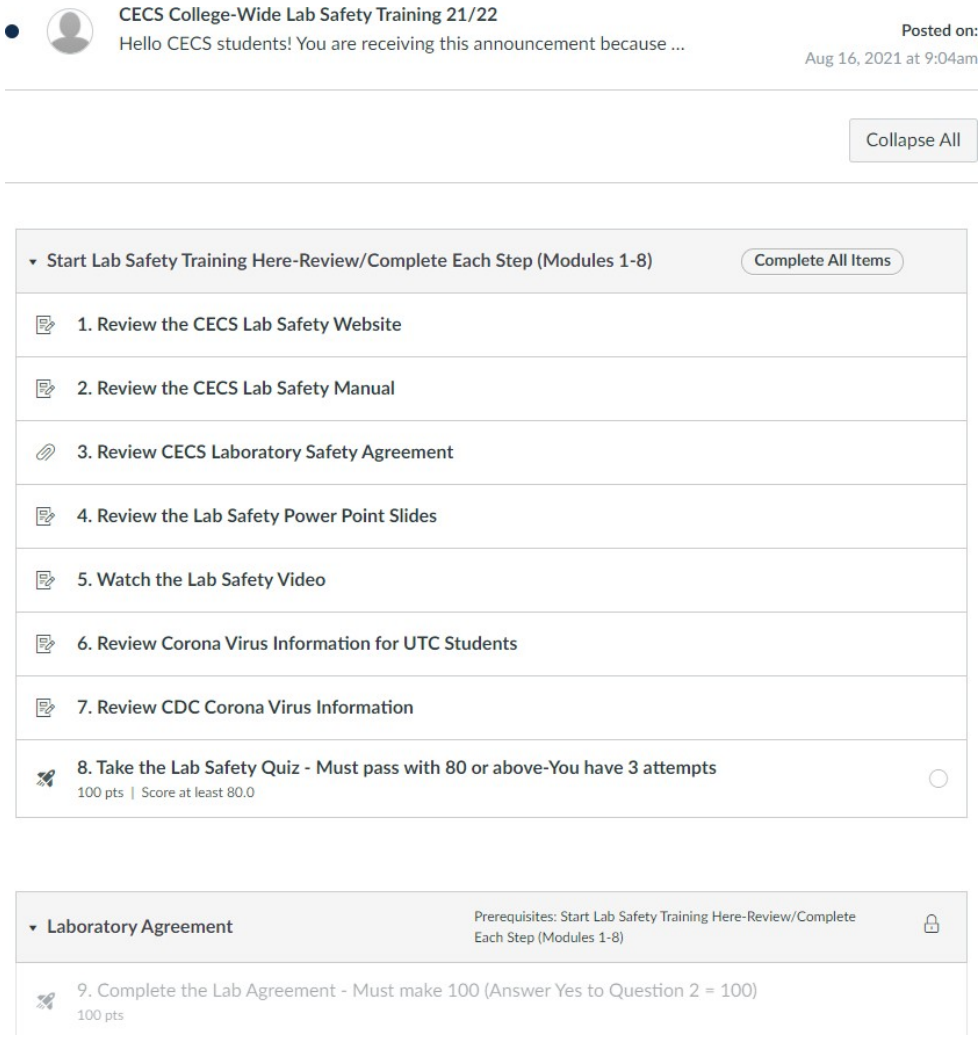
Students receive this announcement on the first day of classes for the Fall semester.



Students are required to complete the training once per each academic year. In Spring & Summer, students will receive an announcement like the one below.



Modules for CECS College-Wide Safety Training

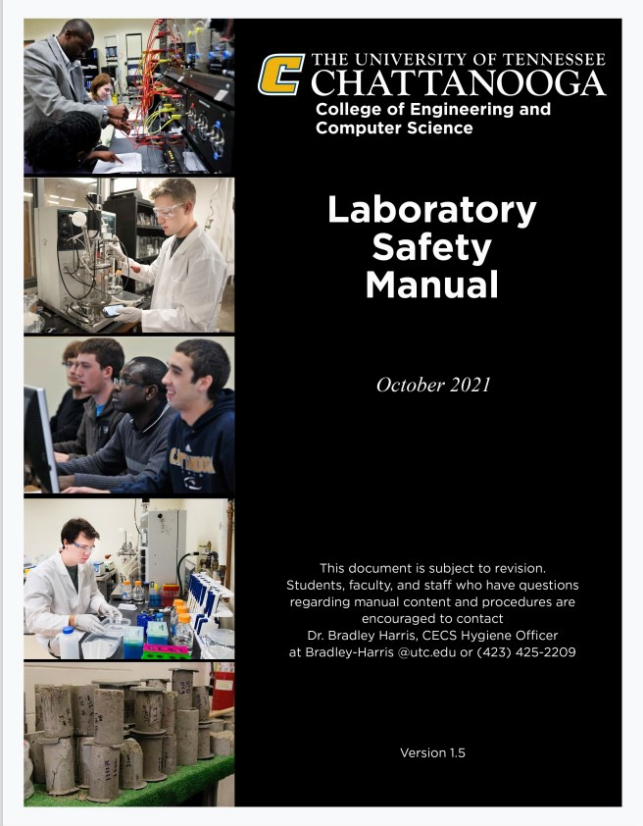


1. Review the CECS Lab Safety Website:

https://www.utc.edu/college-engineering-computer-science/research/laboratories.php

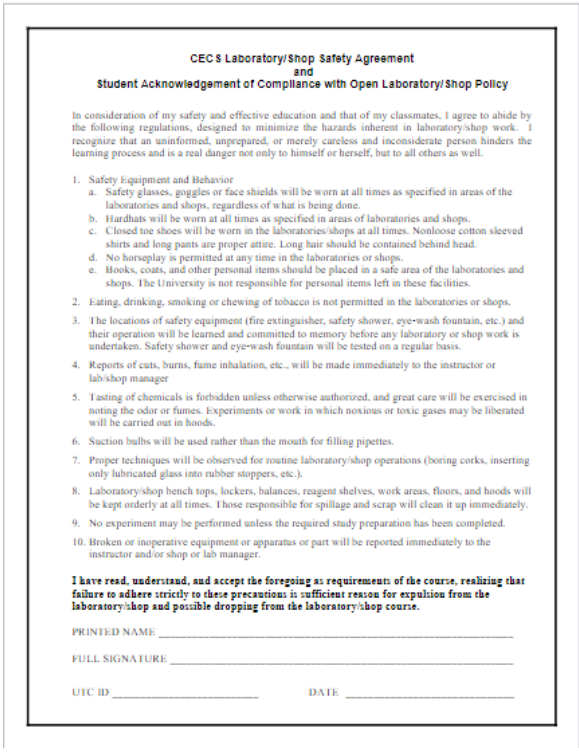
2. Review the CECS Lab Safety Manual:

https://www.utc.edu/sites/default/files/2022-03/CECS-Lab-Manual-Fall-2021.pdf



3. Review the CECS Laboratory Safety Agreement

https://utchattanooga.instructure.com/courses/18469/files/2806000/download?download_frd=1



CECS Laboratory/Shop Safety Agreement
and
Student Acknowledgement of Compliance with Open Laboratory/Shop Policy

In consideration of my safety and effective education and that of my classmates, I agree to abide by the following regulations, designed to minimize the hazards inherent in laboratory/shop work. I recognize that an uninformed, unprepared, or merely careless and inconsiderate person hinders the learning process and is a real danger not only to himself or herself, but to all others as well.

1. Safety Equipment and Behavior
   a. Safety glasses, goggles or face shields will be worn at all times as specified in areas of the laboratories and shops, regardless of what is being done.
   b. Hardhats will be worn at all times as specified in areas of laboratories and shops.
   c. Closed toe shoes will be worn in the laboratories/shops at all times. Nonloose cotton sleeved shirts and long pants are proper attire. Long hair should be contained behind head.
   d. No horseplay is permitted at any time in the laboratories or shops.
   e. Books, coats, and other personal items should be placed in a safe area of the laboratories and shops. The University is not responsible for personal items left in these facilities.
2. Eating, drinking, smoking or chewing of tobacco is not permitted in the laboratories or shops.
3. The locations of safety equipment (fire extinguisher, safety shower, eye-wash fountain, etc.) and their operation will be learned and committed to memory before any laboratory or shop work is undertaken. Safety shower and eye-wash fountain will be tested on a regular basis.
4. Reports of cuts, burns, fume inhalation, etc., will be made immediately to the instructor or lab/shop manager
5. Tasting of chemicals is forbidden unless otherwise authorized, and great care will be exercised in noting the odor or fumes. Experiments or work in which noxious or toxic gases may be liberated will be carried out in hoods.
6. Suction bulbs will be used rather than the mouth for filling pipettes.
7. Proper techniques will be observed for routine laboratory/shop operations (boring corks, inserting only lubricated glass into rubber stoppers, etc.).
8. Laboratory/shop bench tops, lockers, balances, reagent shelves, work areas, floors, and hoods will be kept orderly at all times. Those responsible for spillage and scrap will clean it up immediately.
9. No experiment may be performed unless the required study preparation has been completed.
10. Broken or inoperative equipment or apparatus or part will be reported immediately to the instructor and/or shop or lab manager.

I have read, understand, and accept the foregoing as requirements of the course, realizing that failure to adhere strictly to these precautions is sufficient reason for expulsion from the laboratory/shop and possible dropping from the laboratory/shop course.

PRINTED NAME _____

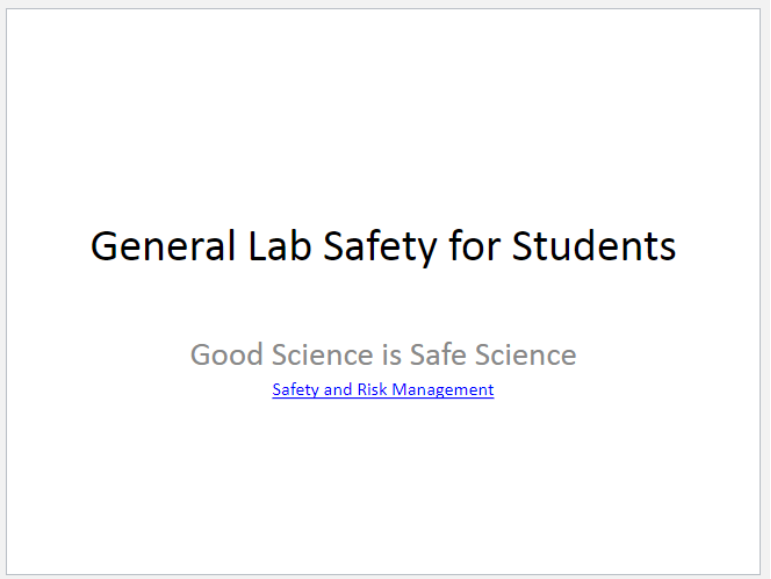
FULL SIGNATURE _____

UTC ID _____ DATE _____

Students will complete this agreement in Module 9, Question 2 of the lab safety training.

4. **Review the Lab Safety Power Point Slides:**

https://utchattanooga.instructure.com/courses/18469/files/2806001?wrap=1

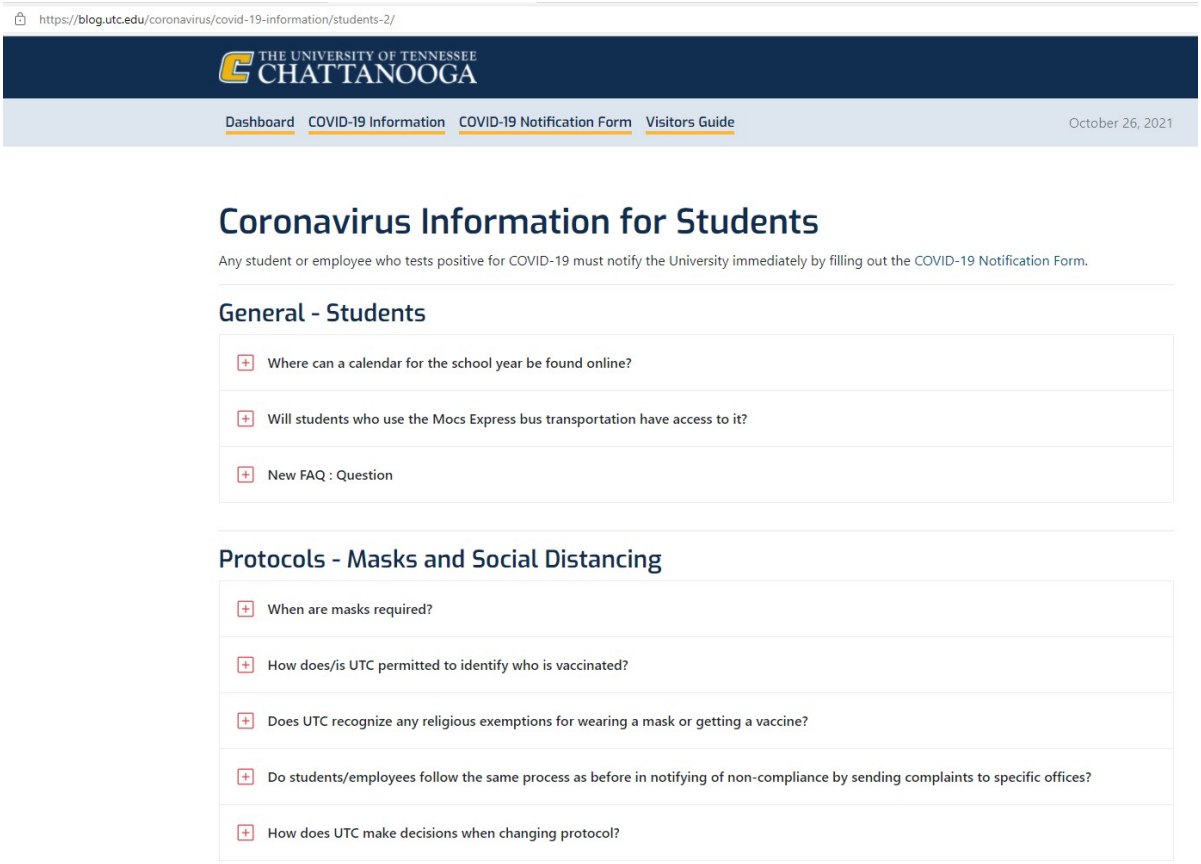


5. **Watch the Lab Safety Video**

https://youtu.be/n7FnntGLaVo

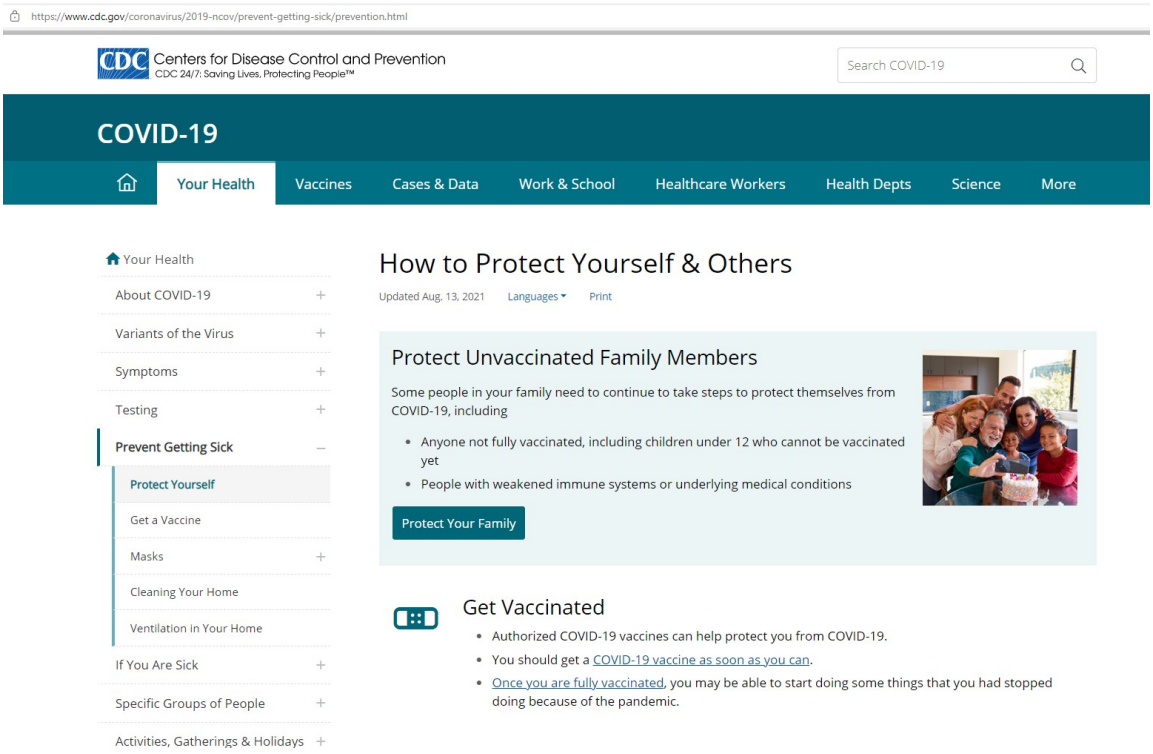
6. Review Corona Virus Information for UTC Students

https://blog.utc.edu/coronavirus/students/



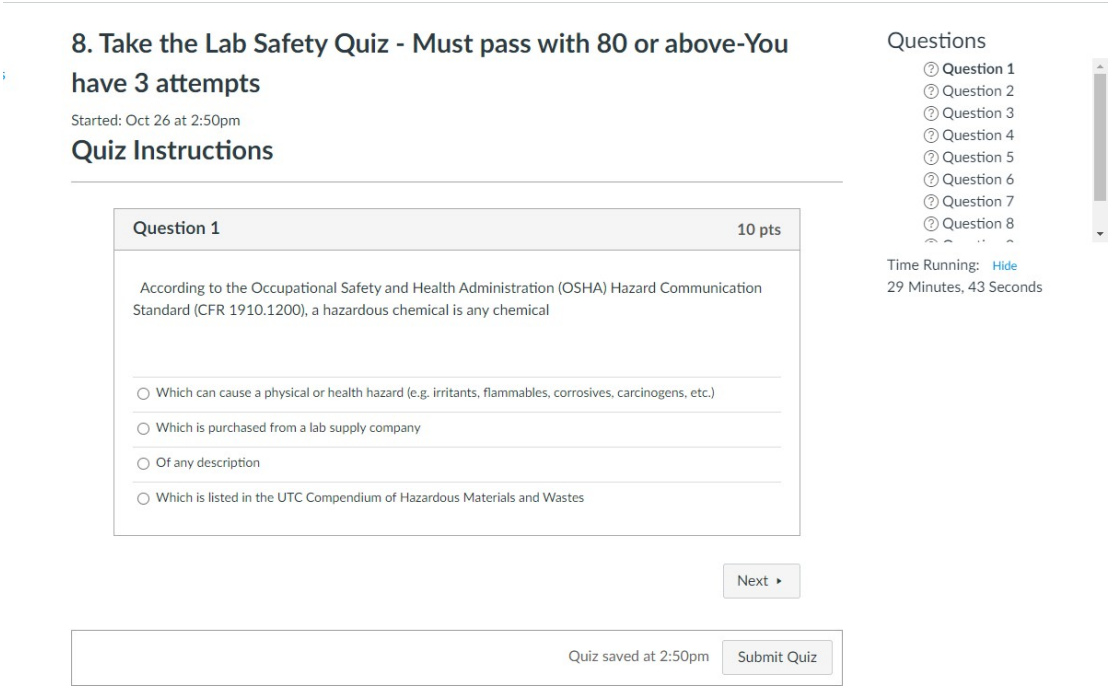
7. Review CDC Corona Virus Information

https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html



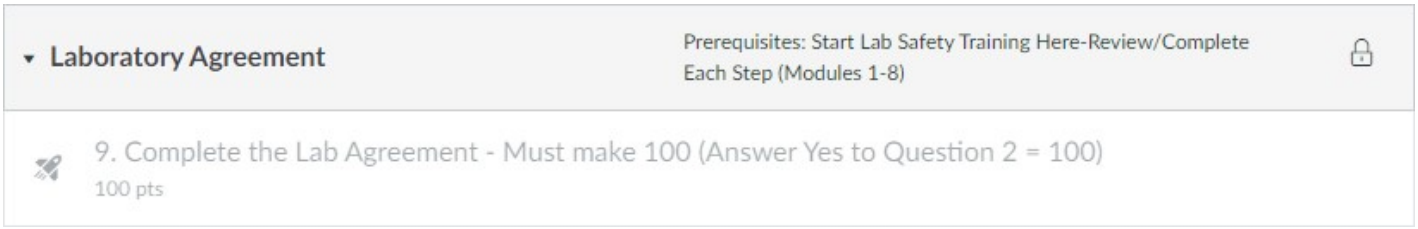
8. Take the Lab Safety Quiz – Must pass with 80 or above—You have 3 attempts (100 pts – score at least 80.0)

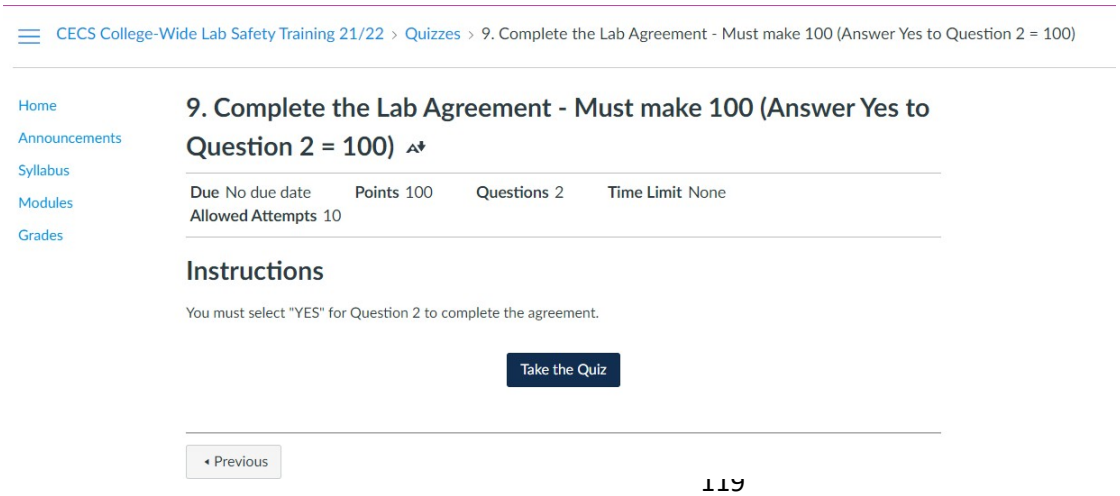
See sample quiz question below (25 questions are randomly presented each time a student takes the quiz).



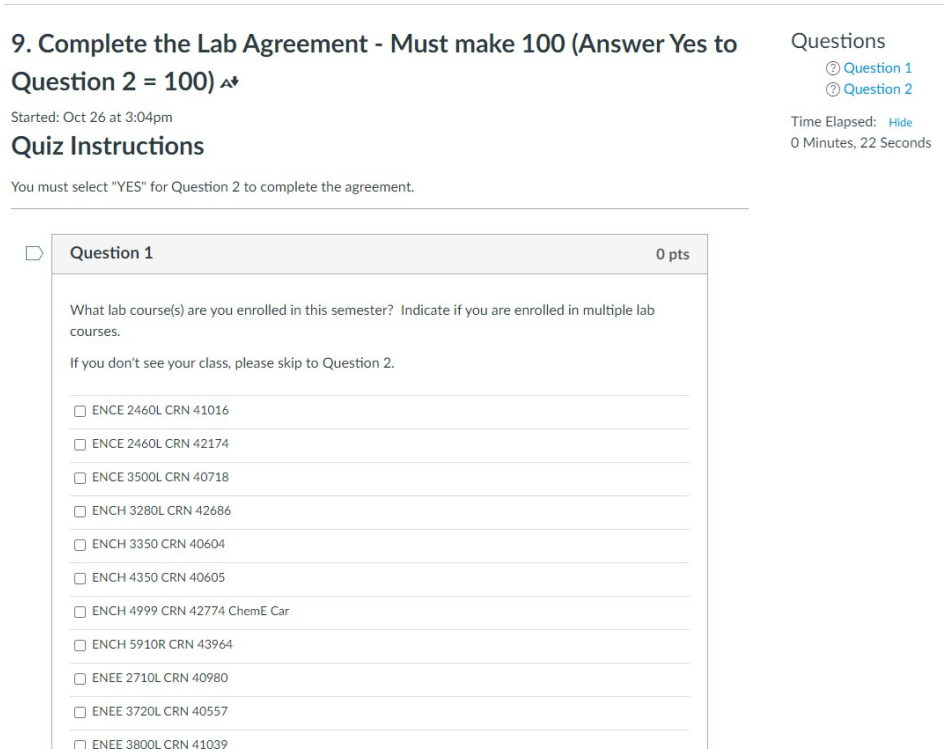
9. Complete the Lab Agreement – Must make 100 (Answer Yes to Question 2 = 100) 100 pts

The Lab Agreement becomes available to students after they pass the Lab Safety Quiz:

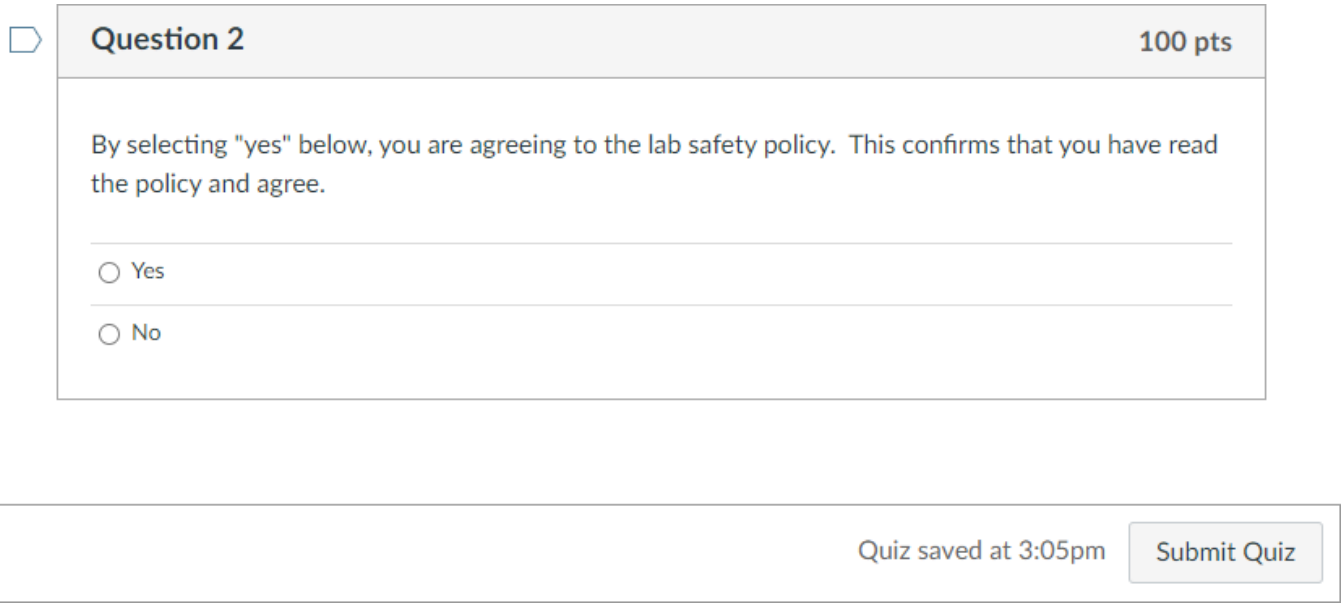




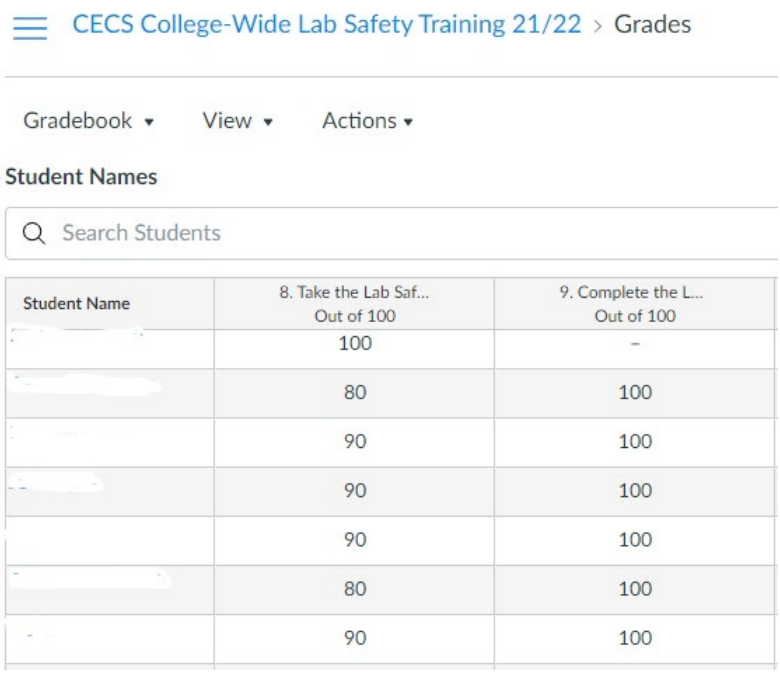
Question 1:



Question 2:

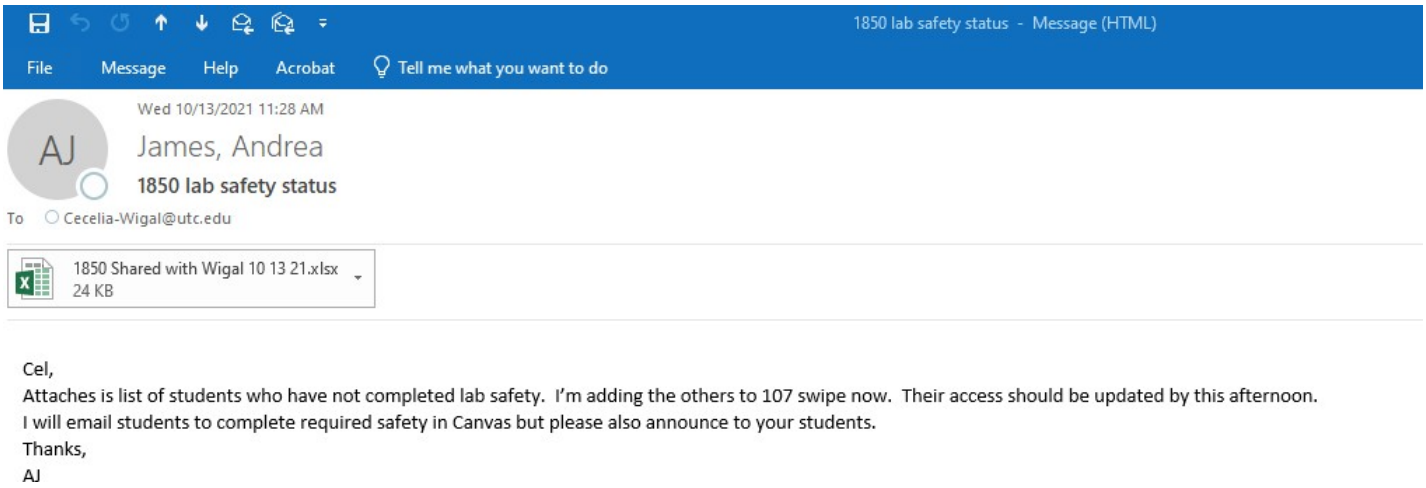


Each department verifies students (in each course it offers that requires lab safety training) have completed the safety training by checking the “gradebook” in the CANVAS Site.



Student Name	8. Take the Lab Saf... Out of 100	9. Complete the L... Out of 100
[redacted]	100	-
[redacted]	80	100
[redacted]	90	100
[redacted]	90	100
[redacted]	90	100
[redacted]	80	100
[redacted]	90	100

Students who have not completed the required training will be contacted by their instructor and/or a department representative. See sample correspondence below.



Reply Reply All 8, Forward
Fri 10/15/2021 4:25 PM

AJ James, Andrea

Q **Complete Lab Safety Training Agreement for Access to EMCS 107 for ENME 1850**

To O James, Andrea
Cc 0Wigal, Cecelia M
QThis message was sent with High importance,

Good afternoon,
You are receiving this message because you have not completed the Lab Safety Agreement required as part of the lab safety training for ENME 1850. Please go to this organization in your CANVAS account: CECS College-Wide lab Safety Training 21/22 and complete the Lab Safety Agreement.You

have completed the quiz already but you have not completed the agreement.

Once you have completed the agreement you will be given swipe card access to EMCS 107.

Please call or email if you have any questions.
Thank you!

Andrea F. James
Mechanical Engineering
UTC College of Engineering and Computer Science
Dept 2502 EMCS 415
615 Mccallie Avenue
Q, tt_a ()()ga,_:rr. c!7_4_0cl:_2_5 !!
Ph. 423-425-5217
Fx. 423-425-5229
Andrea-James@utc.edu

www.utc.edu/mechanicalengineering

/f:;:J UNIVERSITY OF TENNESSEE
CHATTANOOGA
College of Engineering andComputer Science

Reply ReplyAll 8,Forward
Fri 10/15/2021 4:15 PM

AJ James, Andrea

Q **Complete Lab Safety Training for Access to EMCS 107 for ENME 1850**

To :=James, Andrea
Cc O Wigal, Cecelia M
8 This message was sent with High importance.

Good afternoon,
You are receiving this message because you have not completed required lab safety training for ENME1850.Please go to this organization in your CANVAS account: CECS College-Wide lab Safety Training 21/22

Complete the training by reviewing each module, taking the quiz, and completing the agreement (the agreement becomes available after you pass the quiz). Once you

have completed this training, you will be given swipe card access to EMCS 107.

Please call or email if you have any questions.Thank
you!

Andrea F. James Mechanical
Engineering
UTC College of Engineering and Computer Science
Dept 2502 EMCS 415
615 Mccallie Avenue
c;:_h tt_a ()()ga,_:rr. cl7_4_0_3:_2_5 !!
Ph. 423-425-5217
Fx. 423-425-5229
Andrea-James@utc.edu

www.utc.edu/mechanicalengineering

UNIVERSITY OF TE ESSEE
CHATTANOOGA
College of Engineering andComputer Science

From: Wahsheh, Luay
To: James, Andrea
Cc: Hunter, Eva
Subject: Re: Classes That Require Lab Safety Training for Fall 21-Please Advise
Date: Friday, August 13, 2021 11:24:25 AM
Attachments: image001.png

Andrea,

There are no changes to our list.Thank

you.

Luay

Dr. Luay A. Wahsheh Department Head
and Professor

Department of Computer Science and EngineeringEMCS
313, Dept. 2302
College of Engineering and Computer ScienceUniver-
sity of Tennessee at Chattanooga
615 McCallie Avenue
Chattanooga, Tennessee 37403

EMCS 313-D (423)425-
1330
luay-a-wahsheh@utc.edu
https://www.utc.edu/cse

From: James, Andrea <Andrea-James@utc.edu>
Sent: Friday, August 13, 2021 11:18 AM
To: Owino, Joseph <Joseph-Owino@utc.edu>; Karrar, Abdel <abdelrahman-karrar@utc.edu>; Danquah, Michael <michael-danquah@utc.edu>; Wahsheh, Luay <luay-a-wahsheh@utc.edu>; Harris, Bradley <bradley-harris@utc.edu>
Cc: Lomen, Karen <karen-lomen@utc.edu>; Hunter, Eva <eva-hunter@utc.edu>; McWeeney, Mandy <Mandy-McWeeney@utc.edu>
Subject: Classes That Require Lab Safety Training for Fall 21-Please Advise

Just a reminder, please let me know if you have any additions or deletions to the list below for yourFall 2021 classes.
Thanks!
Andrea

CPEN 3700
CPEN 4700
ENCE 2460L
ENCE 2460L
ENCE 2620L
ENCE 3500L
ENCE 3610L
ENCH 3280L
ENCH 4999 ChemE Car
ENCH 5910R
ENEE 2710L
ENEE 3720L
ENEE 3800
ENEE 3800L
ENEE 4710
ENEE 4790L
ENEE 5910 (Motion Control)

From: James, Andrea
Sent: Monday, August 9, 2021 11:04 AM
To: Newman, James <james-newman@utc.edu>; Owino, Joseph <Joseph-Owino@utc.edu>; Nasab, Ahad <ahad-nasab@utc.edu>; Karrar, Abdel <abdelrahman-karrar@utc.edu>; Pack, Daniel <daniel- pack@utc.edu>; Danquah, Michael <michael-danquah@utc.edu>; Wahsheh, Luay <luay-a- wahsheh@utc.edu>; Harris, Bradley <bradley-harris@utc.edu>
Cc: Lomen, Karen <karen-lomen@utc.edu>; Hunter, Eva <eva-hunter@utc.edu>; Anderson, Shanae <shanae-anderson@utc.edu>; McWeeney, Mandy <Mandy-McWeeney@utc.edu>; Hunnicutt, Alanna <Alanna-Hunnicutt@utc.edu>; Waldrep, Christy <christy-waldrep@utc.edu>; Hillman, Irene <Irene-Hillman@utc.edu>; Jackson, Sara <sara-jackson@utc.edu>
Subject: Classes That Require Lab Safety Training for Fall 21-Please Advise by Thurs, 8/12
Importance: High

Good morning,
Please review the list below and send me any additions and/or deletions for Fall 2021 by Thurs, Aug12. (Student Competition Groups/Organizations can be added as well.)All I need is

the course number.

Faculty/Admins who don't already have access to CANVAS for Lab Safety Site for these classes will have it by Friday, Aug 13. Students enrolled in classes requiring the training will be able to see it onMonday, Aug. 16 and will receive an announcement.

Please let me know if you have questions/concerns.

Thank you!
Andrea

Andrea F. James Mechanical Engineering
UTC College of Engineering and Computer ScienceDept
2502 EMCS 430
615 McCallie Avenue
Chattanooga, TN 37403-2598
Ph 423-425-5217
Fx 423-425-5229
Email: andrea-james@utc.edu

From: James, Andrea
To: Howell, Roland; Frishcosy, Christopher; Fomunung, Ignatius; Ayodele, Olumide B; Karrar, Abdel; Kamel, Mariana; McGuire, Felicia; vahid-disfani@utc.edu; Cooper, Preston; Horn, Ricky Horn; Hunter Griffith; Griffith, Bart; Wigal, Cecelia M; Dehay, Jason Robert; Sreenivas, Sree (Sree); Warrington, Don; Margraves, Chuck; McDonald, Gary; Kaplanoglu, Erkan
Cc: Danquah, Michael; Newman, James; Owino, Joseph; Nasab, Ahad; Karrar, Abdel; Wahsheh, Luay; Harris, Bradley; Fletcher, Karl; Waldrep, Christy; Anderson, Shanae; McWeeney, Mandy; Lomen, Karen; Hunter, Eva
Subject: Lab Safety Training and CECS Lab Proactive Maintenance Checklist
Date: Monday, January 10, 2022 4:54:00 PM
Attachments: CECS College-Wide Lab Safety Training 2122 - Updated 11022 1120 AM CECS_LabSafetyTraining21-22.msg
CECS Lab Proactive Maintenance Checklist.docx

Good afternoon CECS Faculty Teaching Lab Courses Spring 2022,
Your Spring 2022 students have been uploaded to the CECS College-Wide Lab Safety Training 21/22Organization in Canvas.

All CECS faculty teaching a lab or a class with a project that requires students to have access to labs will have access to the training site. Students in these classes received an announcement (attached)in Canvas with instructions to complete the training, take the quiz, and indicate their acceptance of the lab agreement. Faculty (and admins) will be able to see who has completed the training and grant card swipe access accordingly.

Please share these procedures with your students the first week of class and refer them to completethe training, on their own, in Canvas:

- Students only have to complete the training in one class per academic year (Fall-Summer).Students must make a score of 80 or above on the quiz and they will have 3 attempts.
- Students must accept the lab agreement to complete the training.

Everyone should use this site for safety training so that student results are listed in one place. If youhave suggestions or concerns, please share.

This is also a reminder to send your completed CECS Lab Proactive Maintenance Checklist (attached) to your department head and copy Dr. Danquah, Karl Fletcher, and Dr. Harris. Thank you,
Andrea

From: James, Andrea
Sent: Friday, December 10, 2021 1:11 PM
To: James, Andrea <Andrea-James@utc.edu>
Subject: Spring 2022 - CECS Lab Proactive Maintenance ChecklistGood after-

noon CECS Faculty Teaching Lab Courses Spring 2022,

**Sent on behalf of Dr. Harris*

Please find attached the CECS Lab Proactive Maintenance Checklist. **This form should be filled out by all instructors teaching a lab course prior to the start of the Spring semester.** We need the support of the Department Heads and Department Lab Managers in ensuring this is carried out.

This is critical for our ABET response, for Chemical Engineering in particular.

Proactive Maintenance Checklist for Teaching Laboratory Equipment

This form is intended to document the routine proactive maintenance of equipment used in teaching laboratories. This routine maintenance takes place two weeks prior to the start of classes each semester, with laboratory instructors inspecting equipment that will be in use that semester to ensure it is in good working order. Any issues should be noted in this form and communicated to affected parties (i.e., department heads, CECS technical staff, UTC facilities planning and management) to initiate the appropriate response.

Name of Equipment: Enter the name of the equipment here. Intended

Use: Briefly describe the intended use of the equipment.

Course(s) Impacted: List the CECS courses impacted.

Briefly describe the steps taken to verify the equipment is in good working order:

Provide a brief description of the procedure used to test the equipment. The following example is provided for the Armfield heat exchanger unit in EMCS 120. "The equipment was turned on, the desktopapplication was loaded, and connection was verified. Availability of house water supply was checked.
Equipment connections were inspected for leaks during operation. Heating element and thermocoupleswere verified to be working properly during operation. Exit line was verified to be draining properly."

Is the equipment in good working order?

☐ Yes ☐ No

If no, describe the issue and what steps will be taken to correct it, with an estimated timeline.

Describe the issue and the plan for addressing it. Using the EMCS 120 heat exchanger unit as an example: "The heating element is not working properly. The Armfield rep has been called and a service technician will be sent out. The issue is minor and should be fixed before the start of classes. If not, the equipment will be taken offline for the first round of lab assignments."

_____ _____ _____

Name of inspector Inspector signature Date

2021 Annual Chemical Inventory

Department - Chemical Engineering	Building - EMCS		Reporting Year 2017			
Product/Chemical	CAS Number or Use	Room#	Manufacturer	Container type	Container Size	Number of Containers
1,2 Dicyanobenzene, 98%	91-15-6	119	Acros		250 g	1
1,2 Dicyanobenzene, 98%	91-15-6	119	Acros		1 kg	5
Aerolite TD Concentrate	Adhesive	119	Arol	Glass bottle	0.5 kg	1
Aluminum (Can Tabs)	7429-90-5	119	Not listed	Plastic bag	N/A	N/A
Aluminum (Granular)	7429-90-5	119	J.T. Baker		1 lb	1
Aluminum Ammonium Sulfate Dodecahydrate	7784-26-1	119	Fisher		500 g	1
Aluminum Potassium Sulfate	7784-24-9	119	Fisher		30 g	2
Ammonium Molybdate Tetrahydrate	12054-85-2	119	Fisher		100 g	1
Bernzomatic	Propane Fuel	119	Map-Pro Gas	Metal bottle	14 oz.	1
Bromothymol Blue	7732-18-5	119	Fisher		10 g	1
Calcium Oxide	1305-78-8	119	Sigma		1 kg	1
Casamino acids	Biological media additive	119	Fisher	Plastic bottle	100 g	1
Carbon, Activated	64365-11-3	119	AquaTech		255 g	3
Copper (Rods)	7440-50-8	119	Not listed	N/A	N/A	N/A
Crystal Violet	548-62-9	119	Fisher		25 g	1
Dextran, Low Fraction	9004-54-0	119	Acros		100 g	1
Ferric Sulfate Dodecahydrate	7783-83-7	119	ChemWay	Plastic bag	N/A	N/A
Glyceryl Tridecanoate	621-71-6	119	Sigma		2 g	1
Iodine-Potassium Iodide Solution	Iodine: 7553-56-2 Potass. Iodide: 7681-11-0	119	Fisher	Plastic bottle	100 mL	1
Iodine tincture	7553-56-2	119	Walgreens		1 oz	1
IONAC Ion Exchange Resin, CP-110	Chromatography	119	Sybron	Plastic bottle	1 kg	1
IONAC Ion Exchange Resin, CP-249	Chromatography	119	Sybron	Plastic	1 kg	1

				bot-tle		
Iron Metal Filings	7439-89-6	119	Educational Innovations		1 lb	3
Iron(III) 2,4-pentanedionate	14024-18-1	119	Alfa Aesar		100 g	2
Iron(III) Chloride	7705-08-0	119	Acros		1 kg	1
Lead (Shot)	7439-92-1	119	Baker and Adamson		5 lb	1
Lithium Chloride	7447-41-8	119	Mallinckrodt		500 g	1
Magnesium (Ribbons)	7439-95-4	119	Home Science Tools		25 g	1
Magnesium (Rods)	7439-95-4	119	Not listed	N/A	N/A	N/A
Manganese Dioxide	1313-13-9	119	Not listed	Plas-tic bag	N/A	N/A
Manganese Dioxide, 80+%	1313-13-9	119	Acros		1 kg	1
Manganese Sulfate Monohydrate	10034-96-5	119	Fisher		500 g	1
Methylene Blue Hydrate	7220-79-3	119	Fisher		100 g	1
Methylene Blue Hydrate	7220-79-3	119	Fluka		100 g	1
Methylene Blue, 1% (w/v) Solution	7220-79-3	119	Online Science Mall		15 mL	1
Nalidixic Acid, 99.5%	389-08-2	119	Acros		25 g	1
n-Heptane	142-82-5	119	Acros		3.5 L	1
Nickel Oxide	1313-99-1	119	Sigma		25 g	3
N-methyl-N-TMS-trifluoroacetamide	24589-78-4	119	Restek			1
Phenolpthalein, 1% (w/v) Indicator Solution	77-09-8	119	Ricca		500 mL	1
Phthalic Anhydride, 99%	85-44-9	119	Acros		250 g	1
Platinum Oxide	1314-15-4	119	Sigma		25 g	2
Polyethyleneimine, 50 wt% Solution	9002-98-6	119	Alfa Aesar		100 g	1
Polyvinylpyrrolidone	9003-39-8	119	Tokyo Chemical		500 g	1
Potassium Bromate, 99+%	7758-01-2	119	Acros		500 g	1
Potassium Hydroxide	1310-58-3	119	Sigma		500 g	1
Potassium Hydroxide	1310-58-3	119	Fluka		1 L	1
Potassium Hydroxide (Pellets)	1310-58-3	119	Chem-Impex		1 kg	1
Potassium Iodide	7681-11-0	119	Acros		500 g	1
Potassium Iodide	7681-11-0	119	Fisher		500 g	1
Potassium Iodide (Granular)	7768-11-0	119	Sigma		500 g	1
Potassium Iodide test solution, 5% (w/v)	7681-11-0	119	Fisher		100 mL	1
Potassium Iodide, 0.5M Solution	7681-11-0	119	Fisher		500 mL	1
Potassium Permanganate, Reagent Grade	7722-64-7	119	Fisher		500 g	1
Potassium Persulfate, 99%	7727-21-1	119	Sigma		100 g	1
Pyridine	110-86-1	119	Aqua		500 mL	1
Silver Nitrate, 0.1 M Solution	7761-88-8	119	LabChem		1 L	1

Sodium Acetate Trihydrate	6131-90-4	119	Fisher		500 g	1
Sodium Acetate Trihydrate	6131-90-4	119	Sigma		1 kg	2
Sodium Bicarbonate (Powder)	144-55-8	119				
Sodium Acetate	127-09-3	119	Sigma		1 kg	1
Sodium Carbonate Anhydrous	497-19-8	119	Sigma		500 g	1
Sodium Hydroxide Anhydrous (Pellets)	1310-73-2	119	Ricca		125 g	2
Sodium Hydroxide Anhydrous (Pellets)	1310-73-2	119	Fisher		1 kg	1
Sodium Hydroxide Anhydrous (Pellets)	1310-73-2	119	Ricca		50 g	1
Sodium Hydroxide Anhydrous (Pellets)	1310-73-2	119	Fisher		1 kg	2
Sodium Hydroxide Lye Beads	497-19-8	119	Bulk Apothecary		2 lbs	4
Sodium Oleate	143-19-1	119	TCI America		500 g	1
Sodium Pyrophosphate Decahydrate, 99+%	13472-36-1	119	Acros		500 g	1
Sodium Thiosulfate	10102-17-7	119	Sigma		1 kg	3
Sodium Thiosulfate	10102-17-7	119	Phot. Form.		1 lb	1
Sodium Thiosulfate Solution, 0.2 N	10102-17-7	119	Fluka		1 L	1
Starch, Soluble	9005-84-9	119	Sigma		500 g	1
Titanium Dioxide	13463-67-7	119	Not listed		500 mL	1
trans-Cinnamaldehyde	14371-10-9	119	Acros		1 kg	1
Trichloroethylene	79-01-6	119	Ricca		500 mL	8
Triiodide	14900-04-0	119				1
Trizma Base	77-86-1	119	Sigma		500 g	1
Universal Indicator Solution	pH Indicator	119	Fisher		1 L	1
Universal Indicator Solution	pH Indicator	119	Online Science Mall		30 mL	1
Urea	57-13-6	119	Fisher		500 g	1
Zinc	7440-66-6	119	Sigma		250 g	1
α-Naptholbenzein	145-50-6	119	Fluka		10 g	1
Acetic Acid Solution, 99.8% (w/v)	64-19-7	120	Acros		2.5 L	2
Acetic Acid Solution, Glacial	64-19-7	120	Acros		2.5 L	1
Acetic Acid Solution, Glacial	64-19-7	120	Fisher		0.5 L	1
Acetone	67-64-1	120	DudaDiesel		950 mL	1
Ammonia	7664-41-7	120	Wal-Mart		4 qts	4
Copper Sulfate Solution, 10% (w/v)	7732-18-5	120	Aqua		4 L	1
Ethanol Solution, 96% (w/v)	64-17-5	120	AlphaTec		1 L	2
Ethanol, 70% (w/v)	64-17-5	120	Fisher		1 L	1
Ethanol, 95% (w/v)	64-17-5	120	Carolina		500 mL	1
Ethyl Acetate Solution	141-78-6	120	Sigma		2 L	1
Ethyl Alcohol, Denatured	64-17-5	120	Chem Crafters		5 gal	3
Ethylene Glycol	107-21-1	120	Fisher		1 L	1

Glutaraldehyde Solution, 25% (w/v)	111-30-8	120	Sigma		1 L	1
Hexachloroplatinic Acid, 10% (w/v)	16941-12-1	120	EMD Millipore		5 mL	1
Hexanes	110-54-3	120	Fisher		500 mL	2
Hydrochloric Acid Solution	7647-01-0	120	Home Depot		3.785 L	2
Hydrochloric Acid, 6M Solution	7647-01-0	120	Carolina		1 L	1
Hydrochloric Acid, N/2 Solution	7647-01-0	120	Fisher		1 L	1
Hydrogen Peroxide Topical Solution	7722-84-1	120	Walgreens		1 qt	5
Hydrogen Peroxide Topical Solution	7722-84-1	120	Fisher		500 mL	1
Isopropyl Alcohol	7732-18-5	120	Fisher		3.785 L	1
Isopropyl Alcohol	7732-18-5	120	Not listed		500 mL	2
Isopropyl Alcohol	7732-18-5	120	Chem Crafters		5 gal	2
Kerosene	64742-47-8	120	Sigma		3.785 L	1
Kerosene	64742-47-8	120	Ricca		3.785 L	3
Lysogeny Broth	Biological media additive	120	Fisher	Plas-tic tub	2 kg	1
Methanol	67-56-1	120	Chem Crafters		5 gal	2
Methyl Red Solution	493-52-7	120	Fluka		100 mL	1
n-Hexane	110-54-3	120	Fisher		1 L	5
n-Hexane	110-54-3	120	Fisher		3.785 L	1
Oleic Acid	112-80-1	120	Alfa Aesar		1 L	1
Potassium Acid Phthalate	7732-18-5	120	Ricca		500 mL	2
Potassium Hydroxide Solution, 0.5 N	1310-58-3	120	Fluka		3 L	1
Potassium Hydroxide Solution, 0.5 N	1310-58-3	120	Ricca		1 L	4
Potassium Hydroxide Solution, 0.5 N	1310-58-3	120	Ricca		1 L	1
Potassium Hydroxide Solution, 0.5 N	1310-58-3	120	Fluka		1 L	3
Sulfuric Acid Solution, 95-98% (w/v)	7664-93-9	120	Sigma		2.5 L	4
Sulfuric Acid Solution, 95-98% (w/v)	7664-93-9	120	Chem Crafters		5 gal	2
Sulfuric Acid Solution	7664-93-9	120	Lowe's		32 oz	1
Tall oil fatty acid with 5% rosin content	61790-12-3	120	Meadwestvaco		1 L	1
Toluene	108-88-3	120	Acros		2.5 L	1
Toluene, 99% (w/v)	108-88-3	120	Acros		2.5 L	1
Triethylene glycol	112-27-6	120	Acros		2.5 L	1
Zinc Sulfate Solution, 10% (w/v)	7732-18-5	120	Ricca		1 L	2

Zinc Sulfate Solution, 10% (w/v)	7732-18-5	120	Ricca		500 mL	1
Expo Cleaner	White Board Wash	120	Newell	Bot-tle	8 oz.	1