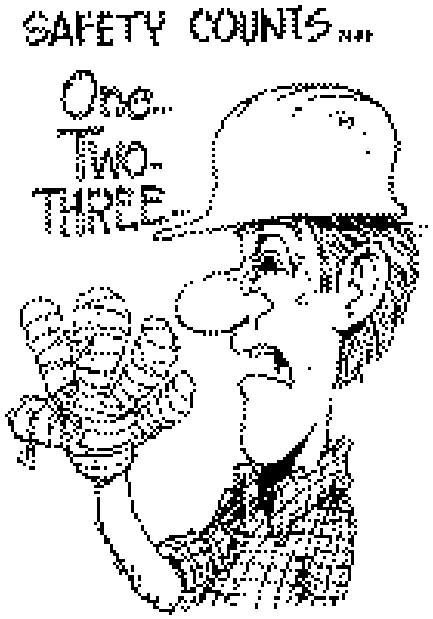
UNC CHARLOTTE

The University of North Carolina at Charlotte
THE WILLIAM STATES LEE COLLEGE OF ENGINEERING

DEPARTMENT OF ENGINEERING TECHNOLOGY & CONSTRUCTION MANAGEMENT

Laboratory Health and Safety Plan



Fall 2016

LABORATORY HEALTH AND SAFETY PLAN

Department of Engineering Technology & Construction Management

Fall 2016

The University of North Carolina at Charlotte
THE WILLIAM STATES LEE COLLEGE OF ENGINEERING
Charlotte, North Carolina

ACKNOWLEDGEMENTS

The Laboratory Health and Safety Plan (LHASP) have been developed through a collaborative process rooted in the review of publicly available health and safety plans from other universities with respect to laboratory safety. The Department of Engineering Technology & Construction Management of the Williams States Lee College of Engineering at the University of North Carolina at Charlotte developed this LHASP to reflect the current state of practice for laboratory safety. Acknowledgement is given to the following universities whose laboratory health and safety plans provided the building blocks for this LHASP (in alphabetical order): New Mexico State University, University of New Hampshire, University of North Carolina at Chapel Hill, University of Massachusetts at Amherst, University of Minnesota, and University of Washington.

PREFACE

It is the policy of University of North Carolina at Charlotte (UNC Charlotte), Department of Engineering Technology & Construction Management (UNC Charlotte-ETCM) to maintain a safe environment for its students, academic appointees, staff, and visitors in an atmosphere that encourages employees, students, and other campus members to communicate occupational safety and environmental health matters without fear of reprisal. UNC Charlotte-ETCM promotes comprehensive safety programs based on applicable health and safety standards promulgated by federal and state agencies, including the Occupational Safety and Health Administration (OSHA) regulation, 29 CFR 1910.1450, titled, "*Occupational Exposures to Hazardous Chemicals in Laboratories*," as well as published standards of nationally recognized professional health and safety groups.

UNC Charlotte-ETCM has written this Laboratory Health and Safety Plan (LHASP) to define administrative responsibilities, accepted safety guidelines and standards, proper laboratory facilities, safety equipment, emergency procedures, training and recordkeeping requirements. UNC Charlotte-ETCM has worked the UNC Charlotte Environmental Health & Safety Office (EHS) to help assure that university policies and state and federal mandates are followed.

The purpose of the LHASP is to provide a framework for recognizing, evaluating, and controlling hazards associated with laboratory operations. This plan sets a minimum standard for laboratory operation and specific research laboratories within the department may require their operations to go "above and beyond" this document and implement additional health and safety protocols. Implementation of the LHASP depends on the cooperation of department chair, program coordinators, faculty, laboratory staff, and all students. The responsibility for safety and health must be shared by all and we must work towards meeting the standards set forth in this LHASP with the common goal of promoting a healthy and safe environment for all employees and students. We recognize that in some situations, proper facilities and equipment may not be available for conducting projects. When this is the case, faculty members should consult with Program Safety Coordinators (PSC) and responsible Laboratory Management (LM) staff for assistance in evaluating hazards and finding ways to conduct work in a safe and healthy manner.

"Nothing Should Be Considered So Important That It Cannot Be Done Safely"

EMERGENCY INFORMATION

	Phone Number	Hours
Environment, Health and Safety (EHS)	7-4291* (704-687-4291)**	8:00 am- 5:00 pm
Work-Related Injuries (normal work hours)	7-4681 (704-687-4681)**	8:00 am - 5:00 pm
Work-Related Injuries (after hours)	7-7400 (704-687-7400)**	After hours
University Police	911 (704-687-2200)**	24 hours
Fire or Smoke	911 (704-687-2200)**	24 hours
Medical Emergencies	911 (704-687-2200)**	24 hours
N.C. Poison Control Center	1-800-84 TOXIN (1-800-848-6946)	24 hours

SPECIAL INCIDENT REPORTING

Gas Leaks or Odors: EHS - 7-4291* (704-687-4291)**

Chemical Spills: EHS - 7-4291* (704-687-4291)**

LABORATORY MANAGERS

Wesley Maxwell – CIET/CM	7-0450 (704-687-0450) ** 8:00 am to 5:00 pm
Richard Graley – ELET	7-5076 (704-687-5076) ** 8:00 am to 5:00 pm
Parks O. Davidson – MET	7-5075 (704-687-5075 ** 8:00 am to 5:00 pm

*University Police contacts EHS during non-business hours.

**Using a non-campus telephone

LIST OF ACRONYMS

Acronym	Definition
ADA	The Americans with Disabilities Act
AWG	American Wire Gauge
CGA	Compressed Gas Association
CHP	Chemical Hygiene Plan
CIET	Civil Engineering Technology
CIL	Chemical Inventory List
CM	Construction Management
COE	College of Engineering
DC	Department Chair
DOT	Department of Transportation
DSC	Departmental Safety Committee
EHS	Environmental Health & Safety Office
ELET	Electrical Engineering Technology
FI	Faculty Instructor
FM	Factory Mutual
FO	Facilities Operations
FRV	Flow Restrictor Cylinder Valve
GFCI	Ground Fault Circuit Interrupters
JSA	Job Safety Analysis
LHASP	Laboratory Health and Safety Plan
LM	Laboratory Managers

LSA	Laboratory Safety Analysis
LSPP	Laboratory Safety Project Plan
MET	Mechanical Engineering Technology
MSDS	Material Safety Data Sheet
NRTL	Nationally Recognized Testing Laboratory
OHSA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limits
PI	Principal Investigator
PC	Program Coordinators
PPE	Personal Protective Equipment
PSC	Program Safety Coordinators
SC	Department Safety Coordinator
SOP	Standard Operating Procedures
TLV	Threshold Limit Value
VAV	Variable Air Volume
UL	Underwriter's Laboratory
UNC Charlotte	University of North Carolina
UNC Charlotte-ETCM	University of North Carolina, Department of Engineering Technology & Construction Management

TABLE OF CONTENTS

Appendices – Laboratory Safety Analyses

1. LABORATORY HEALTH AND SAFETY PLAN

1.1 Scope

The Department of Engineering Technology & Construction Management of the Williams States Lee College of Engineering at the University of North Carolina at Charlotte (UNC Charlotte-ETCM) has developed this Laboratory Health and Safety Plan (LHASP) to provide guidance for conducting laboratory activities related to education and research in a manner that will control the risk to the health and safety of the students, faculty, staff, and the general public working within the UNC Charlotte-ETCM laboratories.
The purpose of this LHASP is to define requirements and designate protocols for protecting students, university personnel, and the general public during laboratory activities associated with the educational process, course delivery, and research within the UNC Charlotte-ETCM laboratories. Applicability extends to all UNC Charlotte-ETCM Faculty and staff, students, and university visitors. The LHASP presented herein is supplemented by a number of Laboratory Safety Analyses (LSAs) intended to detail procedures for the safe conduct of commonly used laboratory equipment within each of the program specific UNC Charlotte-ETCM laboratories.

All laboratory work will be performed in accordance with the UNC Charlotte-ETCM LHASP and policies, and all applicable and appropriate federal, state, local, and university policies and regulations as defined by the UNC Charlotte Environmental Health & Safety Office (EHS) located in the King Building, Room 113, telephone number 704-687-1111. For reference the EHS web address is http://safety.uncc.edu/.

1.2 Overview

The UNC Charlotte-ETCM LHASP is administered as described in Section 1.3 and consists of the following components:

- Laboratory Practices and Safety Equipment, described in Section 2;
- Personal Protective Equipment, described in Section 3;
- Emergencies and Accidents, described in Section 4;
- Laboratory Safety Analysis Program. described in Section 5;
- Training and Information, described in Section 6;
- Record Keeping, described in Section 7;
- Research Laboratory Health and Safety Project Plans, described in Section 8.
- Ventilation Safety, described in Section 9;
- Chemical Safety, described in Section 10;
- Electrical Safety, described in Section 11; and
- Compressed Gases Safety, described in Section 12.

1.3 Administrative Responsibilities

Each individual faculty member is responsible for implementing all UNC Charlotte-ETCM LHASP policies in his/her laboratory. The Department Chair will ensure compliance with existing health and safety policies by designating a Departmental Safety Committee (DSC) consisting of Department Safety Coordinator (SC), Program Safety Coordinators (PSC) representing the program specific disciplines within the department with their program specific Laboratory Managers (LM). EHS is available to provide additional oversight, training, consultation, and technical assistance. Specific responsibilities are outlined below.

1.3.1 Responsibilities of Department Chair (DC) and Program Coordinators (PC)

The DC is responsible for the overall operations of the department and PCs are responsible for the overall operations of the program specific disciplines within the department. The DC and PCs shall also:

- Disseminate and inform faculty, staff, and students of university and department health and safety policies.
- Establish the DSC, designate the SC and each PSC, and ensure retention of proper LM staff.
- Ensure faculty and staff have updated their emergency contact lists and communicated that information to the EHS and DSC.

1.3.2 Responsibilities of the Departmental Safety Committee (DSC)

The DSC consists of the PC, SC, PSC representatives and the LM staff. The LM staff is hired by the university and report directly to the DC or their designee. The DSC shall also:

- Assist each faculty member in implementing university and department LHASP and policies.
- Communicate information on LHASP to faculty and staff, students, and the general public.

1.3.3 Responsibilities of Laboratory Managers (LM)

The LM is responsible for the day-to-day health and safety management of their laboratories and ensuring compliance with the LHASP, federal, state, and local laws. Each LM shall also:

- Develop and implement LSAs for all laboratory activities.
- Develop and implement Standard Operating Procedures (SOPs) that include health and safety considerations for all laboratory experiments.
- Develop and implement applicable health and safety policies for the laboratory.

- Mandate laboratory practices and engineering controls that reduce the potential for exposure to hazards.
- Inform all students of the potential hazards associated with laboratory equipment and experiments.
- Inform laboratory personnel of the proper procedures for dealing with accidents and spills.
- Instruct laboratory personnel on the location and use of safety equipment in the facility.
- Designate at least one person to serve as a safety contact in your absence.
- Post telephone numbers for all emergency response and safety contacts in a noticeable area in the laboratory, preferably near a telephone. Ensure the posting is updated during sabbaticals or other absences.
- Keep emergency telephone call-back lists up-to-date.
- Report accidents and any other safety problems to the DC, DSC, and EHS.
- Conduct periodic safety inspections and ensure problems are remedied.
- Address issues identified by the Laboratory Safety Survey (see Section 2.6, "Laboratory Safety Surveys" and Appendix A for additional information).
- Ensure that pertinent Material Safety Data Sheets (MSDS) are available. EHS provides online MSDS at http://safety.uncc.edu/Safety/HealthManual/Ms_Ds_On_Line.htm.

1.3.4 Responsibilities of Faculty Instructors (FI)

All FIs who are associated with the educational process, course delivery, and research within the UNC Charlotte-ETCM laboratories are required to abide by the minimum requirements set forth in the LHASP as well as any specific LSA. Faculty members shall also:

- Inform all students of the potential hazards associated with laboratory equipment and experiments.
- Supervise students to ensure that safe practices and engineering controls are employed.
- Instruct students and laboratory research personnel on the location and use of safety equipment in the facility.
- Inform students and laboratory research personnel of the proper procedures for dealing with accidents and spills.
- Develop written safety procedures applicable to their research and teaching activities.

1.3.5 Responsibilities of Students, Other University Staff, and Visitors

All students, other university staff, and visitors who use the various UNC Charlotte-ETCM laboratories are required to abide by the minimum requirements set forth in the LHASP as well as any specific LSA. Students, other university staff, and visitors shall also:

- Follow all safety and health procedures specified in the LHASP, LSAs, and by the FI and LM in the laboratory.
- Complete required health and safety training sessions.
- Report accidents, unhealthy and unsafe conditions to the FI and/or LM.
- Notify the FI or LM of any health conditions that could lead to serious health situations in the laboratory.

1.3.6 Responsibilities of the UNC Charlotte Environmental Health & Safety Office (EHS)

EHS is responsible for ensuring the effectiveness and evaluation of the UNC Charlotte-ETCM LHASP. EHS provides support and technical assistance in the safe use, storage, and disposal of materials while conducting laboratory activities at UNC Charlotte specifically within the UNCC-ETCM department. EHS shall also:

- Provide technical guidance on matters of laboratory safety.
- Inspect laboratories to assure compliance with safety and health guidelines and regulations and to assist with remediation of safety issues.*
- Investigate accidents and recommend action to reduce the potential for recurrence. **
- Coordinate clean-up operations in the event of a large chemical or biological spill or if a spill reaches the environment.
- Develop and conduct training programs in laboratory safety.
- Work with state and local officials on matters of codes and enforcement.
- Assist laboratory personnel with evaluating, preventing, and controlling hazards.
- Oversee the adoption and implementation of all university health and safety policies.
- Maintain training and audit documentation.

* EHS will make every attempt to schedule laboratory audits with faculty members. However, if the faculty member is unavailable or is unresponsive, EHS will proceed with the safety audit.

** EHS may conduct unannounced accident investigations. Please be aware that federal, state, and local inspectors may also conduct unannounced inspections.

1.4 Laboratory Construction and Renovation

All design, construction, and modification of laboratory facilities must be reviewed by the DC, DSC, and EHS, whether executed by an outside contractor or internal personnel from Facilities Operations (FO). In order to ensure the safety of new and renovated laboratories, specific design and construction features are required by state and federal codes.

1.5 Americans with Disabilities Act / Reasonable Accommodations

The Americans with Disabilities Act (ADA) requires the UNC Charlotte to make reasonable accommodations for students, staff, and faculty with disabilities as defined by the ADA. If you are a student with a disability and wish to discuss academic accommodations, contact the Office of Disability Services, Fretwell Room 230, telephone number 704-687-4355 (V/TTY), and web address www.ds.uncc.edu. If you are a staff or faculty member with a disability and wish to discuss reasonable accommodations, contact the ADA Compliance Officer in Academic Services, Cato Room 240, telephone number 704-687-7226. The web address for the university ADA policy is http://www.legal.uncc.edu/policies/ps-51.html.

2. LABORATORY PRACTICES AND SAFETY EQUIPMENT

2.1 General Laboratory Safety Procedures

The following general safety practices must be followed in all UNC Charlotte-ETCM laboratories:

- Since the entry way doors to the UNC Charlotte-ETCM laboratories are typically solid (i.e. having no windows) always leave the entry way door open to the hallway so those passing by can see in and check on your safety. However, when a faculty instructor is delivering a laboratory course, it is up to the instructor to choose to close the laboratory door if there are distractions occurring in the hallway which could affect the learning ability of the students.
- Know the hazardous properties of the materials you are working with (e.g., physical, mechanical, chemical, and electrical): Refer to the written LSAs, SOPs and review the MSDS for chemicals. Consider the toxicity of materials, the health and safety hazards of each procedure, the knowledge and experience of laboratory personnel and the safety equipment that is available.
- Know the location of safety equipment and emergency and exit procedures.
- Always wear appropriate clothing (e.g., pants, shirts, shoes) and personal protective equipment (e.g., safety glasses, lab coats, gloves) in the laboratory. Open sandals, clogs, crocs, and similar footwear are prohibited; shorts and skirts are not recommended.
- Remove personal protective equipment (PPE) before leaving the laboratory and store properly.
- If hazardous operations are conducted in the laboratory, arrangements should be made to have another person present (see Section 2.5, "Working Alone in the Laboratory," for additional information).
- Use a properly operating fume hood when working with hazardous materials.
- Do not eat, smoke, drink, prepare food, or apply cosmetics in the laboratory.
- Keep work areas clean and uncluttered at all times.
- Unauthorized individuals are prohibited from entering any laboratory without the presence of a FI or LM.

2.2 Food and Beverages in the Laboratory

In order to reduce potential exposures and to ensure compliance with prudent laboratory operations, regulations, and other best management practices, UNC Charlotte prohibits the storage and consumption of food and drink in all UNC Charlotte-ETCM laboratories where hazardous materials are used and stored. The only exception is for food and beverages used in research and teaching projects. These materials must be labeled, "Not for Human Consumption."

In order to prevent potential exposure to hazardous materials:

- Do not eat, drink, smoke, chew gum, apply cosmetics, or take medicine in laboratories where hazardous materials are handled or stored.
- Do not store food, beverages, cups, or other drinking and eating utensils in areas where hazardous materials are handled or stored.
- Do not use glassware for laboratory operations to prepare or consume food or beverages.
- Do not use laboratory refrigerators, ice chests, cold rooms, and ovens for food storage or preparation.
- Do not use laboratory water sources or deionized laboratory water for drinking water.

Important: Food and beverages must never be stored in any laboratory refrigerator in which chemicals and biological materials are kept unless they have been labeled, "Not for Human Consumption."

2.3 Security

Laboratory security is an integral part of an effective safety program. Follow these steps to ensure a secure working environment in your laboratory:

- Keep laboratory doors closed and locked when unoccupied.
- Keep stocks of hazardous chemicals locked when the laboratory is unoccupied.
- Keep an accurate record of chemicals, stocks, project materials, and those items that support project activities.
- Notify UNC Charlotte police if materials are damaged or missing from laboratories.
- Inspect all packages arriving into the laboratory.
- When research is completed for the day, ensure that chemicals and biological materials have been stored properly and securely.
- Ask strangers (someone you do not recognize) to exit the laboratory if they are not authorized to be there, if resistance occurs contact the campus police at 911 from a campus phone or (704) 687-2200 from a cell phone.

2.4 Laboratory Design and Equipment

The following safety devices/equipment is available for students and all university personnel that have potential risk of being exposed to hazardous materials.

2.4.1. Drench Showers

Drench showers and other emergency wash systems are used in an emergency to flush chemicals that have accidentally come in contact with students and university personnel. In order to wash

the body properly, clothing should be removed as water is applied. The drench shower can be used to extinguish a clothing fire, but this is **not recommended** if the shower is more than a couple of feet away. The best method of extinguishing a clothing fire is to **"Stop, Drop, and Roll,"** and then remove clothing.

In order to ensure adequate access to the shower, at least three feet of space in each direction is required beneath the shower and this area must be kept free of all obstacles. Drench showers should be inspected annually by UNC Charlotte FO personnel for proper flow and operation. A **"DO NOT USE"** notice must be placed on the unit if the shower is not properly functioning.

2.4.2. Eye and Face Washes

The best treatment for chemical splashes of the eye and face is immediate flushing with copious amounts of water for 15 minutes. Eye and face washes are equipped with a stay-open valve. All plumbed eye and face washes should be flushed by LMs on a **weekly basis** by allowing the water to flow for approximately 3 minutes to remove stagnant water from the pipes. Plastic eye wash bottles are not recommended**.**

In general, the emergency eyewash equipment should be installed within 10 seconds walking time from the location of a hazard. The equipment must be installed on the same level as the hazard (accessing the equipment should not require going up or down stairs or ramps). In addition, the path of travel from the hazard to the equipment should be free of obstructions and as straight as possible.

2.4.3. Fire Extinguishers

Fire extinguishers are placed in or just outside laboratories depending on the hazards. A dry chemical (e.g., BC, ABC) type extinguisher is located in laboratory facilities where flammable liquids are used and a carbon dioxide (CO_2) type extinguisher is located in laboratories with computer and electrical equipment (i.e., mass spectrometers, gas chromatographs and NMR facilities). Metal-X extinguishing agent, a graphite material, is used to smother a Class D (flammable solids) fire and should be distributed to laboratories when appropriate. University personnel who plan to attempt extinguishing small fires must be trained in extinguisher operation. For more information about fire extinguishers, contact EHS.

2.4.4. Open Floor Drains and Sink Traps

In order to reduce odors in buildings, sink traps and floor drains should be filled weekly with one to two liters of water. Laboratories that are not used for long periods should be checked regularly by LMs to assure that floor drains and sink traps are filled. No equipment should be placed over floor drains to obstruct this routine maintenance.

2.4.5. Door Postings and Other Signs

All exit doors must be posted "EXIT" on the interior of each laboratory. Any non exit doors (i.e. closets, internal hallways, etc.) must be posted as "Not an EXIT' or "No Exit". A hazard and emergency information sign should be posted on the laboratory door exterior, facing the corridor. Response personnel will use the hazard and emergency information sign during an emergency. The sign identifies hazards within the facility, the responsible faculty member, and other personnel to be contacted in the event of an emergency. In the event of an accident, chemical spill, fire, or personal injury, assistance from a person familiar with the laboratory may be requested. EHS should be consulted about other door postings and signs (e.g., radioactive materials, biohazards) that may be required. The DSC should review signs at least annually or in the event that pertinent information changes. Contact EHS to request a new sign.

2.4.6. Laboratory Safety Information

Material Safety Data Sheets (MSDS), emergency procedures, safety manuals, and other references must be readily available for all students and laboratory personnel. In each of the UNC Charlotte-ETCM laboratories there is a standalone computer work station which has direct electronic access to the MSDS online database. EHS provides the MSDS online database at the following web address http://safety.uncc.edu/Safety/HealthManual/Ms_Ds_On_Line.htm.

2.4.7. First Aid Kits

OSHA standard 1910.151 (b) states an employer or public institution must have "adequate first aid supplies...readily available". Each LM will maintain a first aid kit meeting the minimum guidelines provided by American National Standards Institute (ANSI), ANSI Z308.1-2003. These first aid kits will be available for use by students and laboratory personnel by the LMs. In addition, specific laboratories may have very limited first aid supplies consisting of Band-Aids and antiseptic pads for minor scratches and scrapes located in designated areas within the laboratory. The minimum requirements for the first aid kits are as follows:

Item and Minimum Size or Volume	Minimum Quantity
Absorbent compress, 32 square inches (No side smaller than 4")	1
Adhesive bandages, 1" x 3"	16
Adhesive tape, 5 yards	1
Antiseptic, 0.5 gram application	10
Ice packs	2

Medical exam gloves (disposable)	2 pair
Sterile pads, 3" x 3"	4
Triangular bandage, 40" x 40" x 56"	1

These items are intended to be the minimum for a laboratory first aid kit. Depending on the potential for injury, a more complete kit may be necessary.

2.4.8. Placement of Safety Equipment

In newly constructed and renovated laboratories, drench showers, eyewashes, and fire extinguishers shall be located next to the main door of the facility for occupant safety. A hazard (i.e., chemical, fire or personal injury) should not come between you and your safe egress from the laboratory. In addition to the aforementioned safety equipment, emergency gas shut-offs and electric panels should also be located next to the main door. Depending on the work, additional controls and equipment may be needed for protection of laboratory workers.

2.5 Working Alone in the Laboratory

All faculty, staff, students, and visitors working in a laboratory where exposure to hazards (i.e. chemical, environmental, physical, etc.) may exist, must have knowledge of the following:

- Emergency Contacts;
- Emergency Response Procedures;
- Evacuation Routes;
- First Aid Procedures;
- Health and Safety Training Requirements;
- Personal Protective Equipment Requirements;
- Procedures to Report Unhealthy and Unsafe Conditions;
- Safety Policies and Procedures; and
- Spill Response Equipment and Procedures.

All personnel working alone*** in a laboratory where such hazards exist shall:

- Obtain written permission (e.g., e-mail, letter) from the FI or Principal Investigator (PI) with a copy provided to the specific LM, in order to work alone in the laboratory ; and

- Ensure that a means to contact emergency response personnel is available when working alone in the laboratory.

***According to the National Safety Council, the term "alone" means that a person is beyond the visual or auditory range of any other individual for more than a few minutes at a time.

2.6 Laboratory Safety Surveys

EHS will inspect each laboratory at least once a year. The safety inspection includes an evaluation of the fume hood operation, laboratory techniques, emergency and safety equipment, chemical storage, electrical safety, and general housekeeping. EHS also inspects buildings and fire protection equipment to assure compliance with all appropriate state building and fire prevention codes.

Following the laboratory safety survey, (an example survey is presented in Appendix A), a report listing the safety concerns (deficiencies) will be sent to the DC and LM responsible for the laboratory. The LM with support of the PSC is responsible for correcting the operational hazards. (UNC Charlotte is responsible for correcting all infrastructure deficiencies.) If the LM fails to correct the hazard, a second notice is sent to the DC and forwarded to the DSC, with a copy to the LM so the proper action can be taken to correct the deficiency. Follow-up surveys are conducted in laboratories with extremely hazardous conditions and/or numerous violations.

In addition to these annual laboratory safety surveys, it is the responsibility of each of the ETCM department LMs to update the chemical inventory and periodically conduct their own safety inspections.

3. PERSONAL PROTECTIVE EQUIPMENT

3.1 Personal Protective Equipment (PPE) Policy

Students are required to purchase safety glasses with side shields (available at the various campus bookstores or local hardware stores) for use during all laboratory activities. Safety glasses must be worn at all times during experiments when mechanical laboratory equipment is in operation and /or chemicals are used. Students will be penalized for not having and wearing safety glasses during laboratory activities. The penalty will be determined by your FI and discussed in your course syllabus. The penalty may involve you being asked to leave the laboratory for that particular laboratory session/activity.

Closed-toed shoes are required to be worn during all laboratory activities. **Open toed-shoes, sandals, flip-flops, clogs, crocs, etc. are prohibited from being worn in any of the UNCC-ETCM non-computer laboratories.** Students should also be aware of potential thermal, chemical, and electric hazards and take necessary precautions to protect themselves and others from injury.

PPE must be made available to students and university personnel who are working with mechanical equipment and/or hazardous materials. PPE will be provided to all paid university personnel at no cost. Laboratories must provide PPE (i.e., safety glasses, protective gloves, laboratory coat, hearing protection, respiratory protection) for visitors and must post a sign indicating that eye protection is required where mechanical equipment and/or hazardous materials are in use.

3.2 Eye and Face Protection

Eye and face protection must be worn in the laboratory when there is a potential for contact with hazardous chemicals or other agents (i.e. flying particles/dust.). Please note that all protective eye and face wear should meet the ANSI Z87.1 standard. Sun glasses are **not** acceptable for any laboratory procedures. Safety glasses **must still** be worn over conventional eyeglasses, unless the lenses of the eyeglasses are prescription safety lenses and the eyeglass frames incorporate side shields.

The type of protection needed depends on the hazard (e.g., chemical, impact). For instance, when laboratory chemicals are used, approved eye protection is mandatory and chemical splash goggles are recommended. Goggles should be worn over eyeglasses or prescription safety glasses with side shields should be worn. Ordinary prescription glasses do not meet these standards. Face shields should be worn when working with an agent that may adversely affect the skin on the face and/or when proper eye protection is not enough.

3.3 Shoes, Gloves, and other Protective Clothing

Closed-toed shoes are required to be worn during all laboratory activities. **Open toed-shoes, sandals, flip-flops, clogs, crocs, etc. are prohibited, accept in computer laboratories**. Depending on the type of work, additional personal protective equipment, such as laboratory coats, gloves and aprons may be necessary. Coats, aprons, and gloves should be removed when leaving the laboratory. Gloves should be replaced immediately if they are contaminated or torn.

In situations when one is working with any equipment where rotation is involved (i.e. drill press, mill wrights, lathes, saws, mixers, etc.) the use of gloves is prohibited. In situations involving extremely or particularly hazardous substances, double gloves are recommended. Gloves should be carefully selected for their degradation and permeation characteristics to provide proper protection. The thin, latex, vinyl, or nitrile gloves, popular for their dexterity, are not appropriate for highly toxic chemicals or solvents. When using chemicals, consult the chemical compatibility information that is provided in the MSDS and manufacturer's catalogs to help select proper personal protective equipment, including gloves and respirators. More information on specific types and uses of personal protective apparel is available from EHS.

4. EMERGENCIES AND ACCIDENTS

4.1 Emergency Assistance

Dial 911 from a campus phone or (704) 687-2200 from a cell phone to request emergency assistance (e.g., fire, police, ambulance) on campus. In all emergencies and accidents, the first consideration is your safety and the safety of those around you. For additional information and guidance please visit the following web addresses: http://safety.uncc.edu/Safety/HealthManual/Chemical_Program/EMERGENCY_RESPONSE_FACT_SHEET.pdf for the UNC Charlotte Emergency Response Procedure Fact Sheet and http://safety.uncc.edu/Safety/Emergency_Procedures_Guide/EmergencyProcedureManual.pdf for the UNC Charlotte Emergency Procedure Manual.

4.2 Preparation

In order to be prepared for an emergency, know the hazards to which you are exposed (i.e. mechanical, chemical, thermal, electrical, etc.). Assess the risks before using any laboratory equipment. When working with chemicals and other hazardous materials, consider the following criteria before working:

- Toxicity, reactivity, and flammability of the compound.
- The amounts involved.
- The expected duration of your exposure to the compound.
- Potential routes of entry for the chemical (i.e., inhalation, ingestion, injection, skin contact).

Refer to the following EHS web address for additional information concerning chemical safety at http://safety.uncc.edu/Safety/HealthManual/Chemical_Program/ChemicalSafety.htm.

4.3 Chemical Spills

Chemical spills can be a common occurrence in academic and research laboratories. Controlling the extent of a chemical spill requires planning and a prompt response. Using shatter resistant containers (e.g., primary, secondary) can help to prevent many chemical spills. The cleanup and disposal of hazardous chemicals is very expensive. For additional guidance please refer to the EHA "SPILL RESPONSE GUIDE" provided at the following web address http://safety.uncc.edu/Safety/HealthManual/Chemical_Program/UNC_Charlotte_Spill_Emergency_Procedures.pdf.

Small spills involving chemicals that laboratory personnel are familiar with can be safely handled within the laboratory. All spilled material must be collected, labeled, and stored for disposal by authorized individuals from EHS. All spills must be reported to EHS.

Every laboratory which regularly uses hazardous chemicals must have a readily-accessible spill kit containing at a minimum:

Material	**Quantity**
Inert absorbent powder	32 oz.
Inert absorbent pads	10
4-mm polyethylene bags	10
5 gallon pail with lid	1
Chemical-resistant scoop	1
Chemical-resistant broom	1
Nitrile/Silver Shield combination gloves	4 pair
Splash goggles	2 pair
Chemical waste labels	10

Each LM will maintain a spill kit for use as needed. In the event of a large chemical spill:

- Alert all persons nearby.
- Avoid breathing aerosols of the spilled material.
- If flammables are spilled and your safety is assured, turn off any potential sources of ignition (e.g., lights, motors, Bunsen burners).
- Evacuate the area and close the door to the laboratory.
- Secure the area to prevent others from entering.
- Immediately notify your EHS and LM of the incident.
- During regular work hours (Monday through Friday, 8 a.m. to 5 p.m.), contact EHS at 704-687-4291. On weekends, holidays and after 5 p.m., contact UNC Charlotte Police Department at 911 from a campus phone or (704) 687-2200 from a cell phone for advice and assistance. Be prepared to provide the identity, amount and location of the spill, as well as your location and a phone number where you can be reached (not your lab phone, since you should not remain in the lab after the spill).

4.4 First Aid

Follow these first aid procedures in the event of contamination:

- Go to the nearest eyewash station or safety shower.
- Flush the contaminated area with large volumes of water.
- While flushing, remove any clothing that may have been contaminated.
- Continue flushing until emergency responders arrive.
- Provide the MSDS of the spilled chemical to emergency response personnel.

4.5 Mercury Spills

Mercury has been typically found in the UNC Charlotte-ETCM laboratories in thermometers, thermostats, and certain laboratory devices. From time to time accidents may occur which require the cleanup of liquid mercury.

4.5.1. Mercury Spill Kits

Rooms containing liquid mercury or mercury-containing devices must have a special spill kit present. Each LM will maintain a mercury spill kit for use as needed. At a minimum, the spill kit should contain the following:

- Nitrile gloves
- Safety glasses
- Shoe covers
- Tweezers
- Flashlight
- Several pieces of stiff, non-corrugated cardboard
- Paper towels
- Eyedropper
- Duct tape
- Sheets of plastic or garbage bags
- Sealable plastic bags
- 5 gallon bucket with a lid
- Spray bottle
- Chemical amalgam (or other commercially available product)

4.5.2. Preparing to Clean a Mercury Spill

Before cleaning a mercury spill:

- Do not use a standard vacuum cleaner to clean up mercury. The vacuum filter is not capable of containing mercury and will spray small droplets and vapor into the air. Once a vacuum has been used to clean up mercury it is permanently contaminated and must be discarded.
- Do not use a broom to clean up mercury. The broom will break the mercury into smaller droplets and spread the contamination.
- Do not pour liquid mercury down the drain. Mercury will contaminate the drain and the local water treatment plant. Mercury is highly hazardous to the environment.
- Do not attempt to clean mercury from fabric, upholstery, or carpet. It is impossible to remove all mercury contamination from these materials. In general, discard fabrics and carpet contaminated with mercury. If the item has sentimental or research value, contact EHS for advice on decontamination.
- Do not wash mercury-contaminated clothing in a washing machine or dryer. All contaminated clothing must be disposed of as hazardous waste.

4.5.3. Cleaning a Small Mercury Spill

Follow these procedures when cleaning up a small amount of mercury (e.g., thermometer spill).

- **Evacuate the spill area.** Make sure anyone with contaminated clothing or shoes leaves these articles behind before they leave. These items should be placed in a sealable plastic bag for disposal.
- **Lower the temperature** in the area, whenever possible. Mercury is a liquid at room temperature but at higher temperature can easily become a vapor which may then be inhaled.
- **Isolate the ventilation** in the affected area. Contact the Facilities Support Center to shut down HVAC equipment, whenever possible. Ventilation grates in the spill area should be covered with plastic to prevent mercury vapors from traveling to other parts of the building.
- **Open the windows,** if they are operable. Allow any mercury vapors to escape outside
- **Protect yourself.** Make sure you are dressed in clothing which completely covers your arms and legs. Put on gloves, shoe covers, and safety glasses. Remove all metal jewelry before attempting to clean up mercury. Mercury will bond to metal jewelry.
- **Contain the spill.** Protect environmental receptors such as sinks or floor drains.

  <u>Spills on Hard, Smooth Surfaces</u>

  - Use two pieces of stiff cardboard to push debris and beads of mercury together and then scoop them up. Place the collected material and the pieces of cardboard in the plastic container.

- Pick up pieces of broken glass with tweezers and place in the plastic container.
- Use the eyedropper to suck up small beads of mercury that cannot be gathered using the cardboard. If you need to expel the eyedropper, gently do so onto a wet paper towel placed inside the plastic container. Discard the eyedropper in the plastic container when finished. Alternatively, you can use the duct tape to pick up very small droplets of mercury only. Discard the tape in the plastic container.
- Turn on the flashlight and shine it over the spill area. Light will reflect off broken glass and bead of mercury. This will help in locating any remaining spilled materials.

Spills on Carpets, Rugs, or Fabric

- If the spill is on an area rug, roll the area rug up. Wrap the rug in two layers of plastic sheeting and proceed to the disposal section of this document.
- If the spill is on wall-to-wall carpeting, do not attempt to cut out the affected area yourself. Cutting and tugging actions can disperse additional mercury into the indoor environment. Isolate the affected room and contact OEHS for assistance.
- If the spill is on upholstery, contact EHS for disposal.

Mercury Spilled in Water

- If the liquid mercury fell into a sink full of water, recover the mercury beads using an eyedropper.
- Expel the eyedropper into a sealable container.
- Once complete the remaining water can be flushed to the sewer as mercury is not soluble in water.
- Proceed to the disposal section of this document.

Mercury Spilled Down the Drain

- If the liquid mercury went down a sink drain, contact EHS immediately for assistance.

- **Sprinkle the chemical amalgam powder over the spill site.** This material will bind any remaining mercury from the spill. Chemical amalgam powder may be sprinkled on wall-to-wall carpeting or upholstery in anticipation of disposal to prevent further mercury vapor generation.

- **Lightly mist the area** with water to prevent dust generation during cleanup.
- **Collect the powder** with a moist paper towel and dispose in the plastic bucket.
- **Dispose of all materials** used in the spill cleanup as mercury waste. If any clothing came into contact with mercury, dispose of this clothing as mercury-contaminated waste.
- **Seal all bags and containers of waste.** The plastic bucket should be taped around the seal. Label the material as hazardous waste and call the Office of Environmental Health and Safety to schedule a pickup.
- **Wash your hands** when finished.
- **Contact EHS** at telephone number 704-687-4291with any questions or concerns about the spill.

4.6 Environmental Chemical Releases

If a spill reaches the environment (e.g., floor drain, sink drain), immediately contact the campus police at 911 from a campus phone or (704) 687-2200 from a cell phone, then contact EHS at 704-687-4291. Attempt to stop or contain the spill/release at the source without endangering yourself and others by following these procedures:

- Extinguish all sources of ignition.
- Isolate all potential environmental receptors (e.g. drains, sumps, soil).
- Immediately report the spill/release to EHS.
- Wait for EHS to arrive on the scene.

4.7 Fires and Explosions

All building occupants must exit the building during all fire alarms. Failure to leave a building is illegal and may result in disciplinary action from the UNC Charlotte Police Department at 911 from a campus phone or (704) 687-2200 from a cell phone or other university academic or administrative unit.

Whenever a fire alarm is activated:

- Shut off all open flames.
- Safety store hazardous materials.
- Leave the work area.
- Shut all doors on the way out of the laboratory.
- Evacuate through the nearest fire exit.
- Do not use elevators.

4.8 Accidents and Injuries

There are several steps that must be taken following an accident or injury at UNC Charlotte.

Follow these procedures immediately after an accident or injury:

- Call 911 from a campus phone or (704) 687-2200 from a cell phone if the incident requires an ambulance or other form of emergency response.
- Verbally alert your FI and/or LM, DC, and EHS of the incident.
- Follow the "SAFETY - Accident Reporting/Investigation Procedures" provided by EHS at the following web address http://hr.uncc.edu/Policies/PIM26.htm .

A medical care provider should assess all injuries. During regular business hours non-critical injuries may be evaluated at UNC Charlotte Student Health Center located on the corner of Cameron Blvd. & Mary Alexander Rd., telephone number 704-687-7400, and web address http://studenthealth.uncc.edu/index.htm. For critical injures go to the emergency room at Carolinas Medical Center-University located at 8800 N. Tryon Street, Charlotte, North Carolina, telephone number 704-863-6000.

Accidents and injuries should be reported as soon as possible, but no later than two days post occurrence. For a chemical exposure, medical personnel should be given the following information:

- Identity of chemical(s).
- Conditions under which exposures occurred.
- Signs and symptoms of exposure.

Whenever possible, a MSDS should be provided. In addition, the LM or FI shall forward a written report describing the incident or injury within two days to the DC and to EHS.

4.9 Power Outages or Service Interruptions

Although some buildings have emergency power, it is only designed for essential services, and not for continued operations in the laboratory. If the power should be interrupted:

- Immediately stop all work.
- Close all chemical containers.
- Shut-off or unplug equipment.
- Lower chemical fume hood sashes.

Take special care with potentially unstable chemicals or reactions that require cooling water and with any work involving water reactive chemicals or temperature sensitive chemicals.

5. LABORATORY SAFETY ANALYSIS PROGRAM

5.1 Introduction

Though the UNC Charlotte-ETCM LHASP provides the basic guidelines for safe laboratory policies and procedures, it is not designed to provide the specific details for the safe operation of all of the test equipment within the UNC Charlotte-ETCM laboratories. In order to provide the specific safe operating procedures for all of the individual types of laboratory equipment which have potential safety hazardous associated with their operation, are provide by the department's Laboratory Safety Analysis (LSA) program. This program is an ongoing effort to provide specific guidelines for the safe operation of each piece of test equipment which can cause harm to the operator or surroundings (i.e. other students, laboratory staff, other equipment, etc.).

5.2 Laboratory Safety Analysis (LSA) Program

The LSA program is an integral part of the LHASP and the individual LSAs developed for each piece of test equipment are provided as Appendices to the LHASP. The LSA Appendices are organized by each of the program within the UNC Charlotte-ETCM department as follows:

- Appendix B – CIET/CM LSAs
- Appendix C – ELET LSAs
- Appendix D – MET LSAs

The LSA program is based on the industry standard Job Safety Analysis (JSA) program standardized by OSHA. A JSA identifies the task, the hazards, and the control which should be used to allow the safe operation of a specific piece of equipment. JSAs are used extensively in all industries to help prevent serious accidents from occurring in a work place or at a job site. UNC Charlotte-ETCM department recognizes the importance for exposing our students to using JSAs similar to those that they may encounter in a future place of work. However, the use of the terminology of JSAs in an academic environment, especially an undergraduate student laboratory potentially implies the students are employees of the university. When in actuality they are the consumers of the university. With that said, the primary difference between a JSA and a LSA is the fact that the LSA is written at the student level recognizing the fact that most students have very little to no experience in using the various types of test equipment within the UNC Charlotte-ETCM laboratories. From that perspective, a JSA assumes some level of operational experience that a worker within a particular field of work has all ready gained practical experience.

The LSAs are designed to be read and used by the students as part of their laboratory experience. LSAs are developed by the LM who is responsible for the laboratory activities within the specific program discipline laboratory. Each LSA is reviewed at the ETCM department level and are assigned a specific LSA reference number. The LSA reference number consists of a 3 to 4 letter

prefix followed by a three digit sequential number. For example a LSA developed by the CIET/CM program would be numbered as CIET001, where as an ELET program LSA would be ELET001 and a MET program LSA would be MET001.

Each LSA will be reviewed on an annual basis and any required revisions will be reflected in a revised LSA having an updated revision number and revision date maintained on each LSA. By using this revision system, it prevents the use of an out of date LSA. All current LSAs will be maintained on UNC Charlotte-ETCM department's web site located at the following web address http://et.uncc.edu/ for easy access by students, FIs, LMs, and other laboratory staff. In each of the UNC Charlotte-ETCM laboratories there is a standalone computer work station which has direct electronic access to this web address for easy up-to-date access. A hard copy of each current LSA will be maintained in each laboratory and posted at a location for easy reference at the specific test device.

5.3 Course Integration

The LHASP and LSAs will be integrated into all applicable UNC Charlotte-ETCM laboratory courses through the inclusion within each course syllabus and referenced laboratory procedures. During the first laboratory class meeting, each FI or LM instructor will review with the students the key points of the LHASP and discuss the importance of the use of specific LSAs when conducting their laboratory activities. Some form of challenge (i.e. quiz, homework assignment, etc.) of the students' knowledge and understanding of the importance of laboratory safety and the use of the LHASP and LSAs will be conducted. The method of challenge will be determined by the FI and will be incorporated as part of the required training for each laboratory course.

All laboratories procedures will make reference to the proper LSAs which should be followed by each student when conducting their assigned laboratory activity. Each laboratory instructor will provide access to the specific LSAs that will be used throughout the laboratory course either through hard copy, use of the UNC Charlotte-ETCM web site or the preferred method of using Moodle, the online course communication system of UNC Charlotte.

5.3.1 Example Course Syllabus Information

Some suggested standardized wording that should be included in each laboratory course syllabus is provided in this section. It is up to the FI or LM to decide how the following information is presented to the students taking the laboratory course. At a minimum the syllabus should include a section entitled Laboratory Safety and include the following discussion topics:

- Introduce the LHASP
- Discuss the use of LSAs

- Introduce the location of the UNC Charlotte-ETCM laboratory safety information (i.e. UNC Charlotte-ETCM web site, stand alone workstations in laboratories, Moodle, etc.)
- Stress the importance of having and using safety glasses and any related penalties
- Stress the importance of wearing closed-toed-shoes
- Stress the importance of "Safety First"

Example wording: "*The University Of North Carolina Department Of Engineering Technology & Construction Management has established a Laboratory Health and Safety program which has been incorporated into all laboratory activities within the department. The program consists of a Laboratory Health and Safety Plan (LHASP) and Laboratory Safety Analyses (LSAs). The LHASP and related LSAs must be followed when conducting all laboratory testing related to course work and research. The LSAs have been developed to provide the specific safe operating procedures for all of the individual types of laboratory equipment which have potential safety hazardous associated with their operation.*

It is the responsibility of each student to be aware of and understand the policies and procedures stated within the LHASP and related LSAs. The LHASP and LSAs are located on the Department of Engineering Technology & Construction Management web site at the following web address http://et.uncc.edu/laboratory-health-a-safety.html. *This information is also available within each laboratory in hard copy form, on a stand-alone computer workstation with direct electronic access to the above web address and may be provided on Moodle, the online course communication system of UNC Charlotte.*

Students are required to purchase safety glasses meeting the ANSI Z87.1 standard (available at the various campus bookstores or local hardware stores) and must be worn while conducting all laboratory functions in all non-computer laboratories. Safety glasses must be worn at all times during experiments. Failure to do so could result penalties which could affect your grade for the course as outlined in the LHASP. Closed-toed shoes should also be worn to every laboratory class. Students should also be aware of potential thermal, chemical, and electric hazards and take necessary precautions to protect themselves and others from injury. It is important to keep "Safety First" when conducting all aspects of laboratory activities"

5.4 Student Responsibility

The responsibility of each student is recognize the importance of "Safety First" by taking an active role in the UNC Charlotte-ETCM laboratory Health and Safety program by reading and utilizing the LHSAP and following all of the LSAs used during their laboratory activities. Students who do not follow the required safety guidelines as outlined in the LHASP, LSAs and/ or as directed by

the FI and/or LM will be asked to leave the laboratory class activity and will receive a zero for the class activity. Continued willful offenders of the laboratory safety policies will receive a failing grade for the laboratory course or will be administratively removed from the class.

5.5 Faculty Responsibility

The responsibility of UNC Charlotte-ETCM Faculty is to stress the importance of "Safety First" by incorporating the UNC Charlotte-ETCM laboratory Health and Safety program into each of the related laboratory courses by utilizing the LHSAP and the LSAs in all of their laboratory activities.

6. TRAINING AND INFORMATION

6.1 Training and Information Policy

FIs and LMs are responsible for insuring that their students and other laboratory staff receive proper training as stipulated in this LHASP**.**

EHS provides many training programs as described at the following web address http://safety.uncc.edu/Safety/Training/TrainingMain.htm. Training may be required for faculty, staff, students, and other personnel. Descriptions of each of the training programs are available online. A full list of training programs offered by EHS is available at the following web address http://safety.uncc.edu/Safety/Training/Training_Program_Descriptions.pdf. One-on-one training sessions are available. Please contact EHS at (704) 687-4291 to request any of the above-listed trainings or for additional information.

6.2 Laboratory Safety Training

Laboratory safety training is available to all students, faculty, and staff. Typical training sessions that are available include:

- Details, location, and availability of UNC Charlotte-ETCM LHASP
- Basic toxicology including routes of entry and occupational exposure limits (Permissible Exposure Limits (PELs), Threshold Limit Value (TLVs))
- General information on physical and health hazards of hazardous chemicals, signs and symptoms of exposure, and measures students can take to protect themselves
- Location and availability of additional reference material
- Methods that may be used to detect the presence or release of a hazardous chemical
- General information on safety equipment and personal protective equipment
- Proper use of laboratory fume hoods

Specific types of training that are available from EHS can be found at the following web address http://safety.uncc.edu/Safety/Training/Regulatory_Training_Guide.pdf.

6.3 Machine Shop Safety Training

In order to utilize the various machine tools located in the UNC Charlotte-ETCM Machine Shop laboratory (Smith 128 A/B), students and instructors must follow safety procedures (LSAs) for each specific piece of equipment. Specify, students who wish to use the equipment must enroll and pass ETME 2156L – Machine Shop Practices Laboratory. For access to the machines in Smith 128 A/B, contact the Mechanical Engineering Technology laboratory manager in Smith 130A at

telephone number (704) 687-5075 for safety and operation training before machine tools can be used. Retraining will be required and the specific LSA training record updated, before students are allowed to use the machine tools for work related to their senior design projects (ETME 3232-001, et.al).

6.3.1 General Safety Procedures

- Safety glasses with side shields are required to be worn in the shop area at all times. Full face shields, welding goggles, welding masks and fixed safety shields on shop equipment are also available in the shop and must be used as the job at hand requires. Face shields do not provide unlimited protection from flying objects and splashes. Face shields must be worn with one of the following eye protective devices; a) Safety glasses or goggles where impact hazard exits. b) proper splash goggles where chemical splash hazard exists.
- Remove rings, watches, bracelets, pendants and neckties, which may be caught in moving machinery. Roll up your long sleeves and secure long hair for the same reason.
- No shorts or open-toed shoes are permitted.
- Do not operate ANY shop equipment unless you are authorized to do so by the LM or FI. If you are uncertain of any shop procedure, ask the LM for assistance.
- Never work alone in the machine shop. Always bring a colleague along to help you in case of injury. Report all injuries (and near misses), no matter how small, to departmental safety personnel.
- Always clean up the work area before you leave.
- The use of extension cords is prohibited.
- Never use compressed air to remove particles from clothing.
- Compressed air used for cleaning work pieces must be regulated to 30 psi or less. Use the proper safety nozzle.

6.4 Supplemental Training

FIs and LMs will provide training to supplement laboratory safety training. This will include specific information on:

- Location of the LSAs
- Personal protective equipment required
- Location of MSDS

7. RECORD KEEPING

7.1 Training Records

At a minimum, LSA training records and other laboratory safety training records must include the following information:

- Date of training session.
- Contents or summary of the training.
- Name of person(s) attending the training.
- Name of person(s) conducting the training.

Records for the specific LSA training are maintained in each of the UNC Charlotte-ETCM laboratories where the laboratory equipment resides. An example of a LSA Training Record is provided in Appendix E. For administrative purposes, copies of the training records will be forwarded to the DC and EHS, upon request. Records for additional safety training required by the UNC Charlotte-ETCM department or individual FIs are kept in department offices or by the responsible FI.

7.2 Archiving of Records

Training records will be maintained in each laboratory for a complete academic year. At the completion of each academic year, the training records will be maintained for additional four (4) years in each of the responsible LM's offices. At the completion of each five (5) year cycle the related training records will be destroyed.

8. RESEARCH LABORATORY HEALTH AND SAFETY PROJECT PLANS

8.1 Laboratory Safety Checklists

The UNC Charlotte-ETCM LHASP provides a general outline of laboratory policies and procedures. This plan should be adopted by each faculty member who is involved in laboratory research activities as the basis for the development of their research specific Laboratory Safety Project Plan (LSPP). In order to meet the specific needs in his/her laboratory, a specific LSPP should be developed for each research project. The LSPP and the LHASP should be made available to all students and laboratory staff who are involved with the specific research as well as the DSC. The LSPP should reference the LHASP but contain additional safety and health policies and procedures related specifically to the research to be performed as specified by the PI or FI and should include the applicable list of information as suggested below:

- Hazardous Materials Used in the Laboratory
- Required Training
- Medical Monitoring
- Registrations/Notifications/Permits
- List of Laboratory Personnel
- Special Emergency Procedures
- Individual Laboratory Procedures
- Departmental Policies and Procedures

8.2 Laboratory Safety Project Plan (LSPP) Sample

LSPP for individual laboratories are required by the OSHA regulation 29 CFR 1910.1450, "Occupational Exposures to Hazardous Chemicals in Laboratories," commonly referred to as the OSHA Laboratory Standard. A complete copy of this regulation is provided in Appendix F. This standard requires a written plan that sets forth procedures, equipment, personal protective equipment and work practices capable of protecting students and laboratory staff from health hazards presented by the chemicals used in the laboratory. For UNC Charlotte-ETCM research laboratories the complete research laboratory project specific safety plan should consist of two components:

- the LHASP, which covers general safety procedures for UNC Charlotte-ETCM laboratories, and
- a LSPP prepared by the PI to address hazards and precautions specific to a given laboratory and research project.

The LSPP:

- Identifies the hazards in the laboratory,
- Describes specific handling procedures and precautions for special hazards, and

- Outlines emergency safety procedures in the event of a fire or chemical spill.

The LHASP and LSPP must be available to all students and laboratory staff in the laboratory involved with the laboratory research; the contents of these documents must be discussed with each person when he or she begins working on the laboratory research project and annually thereafter. Documentation of this training must be maintained by the PI or assignee and become part of the research record.

An example of a LSPP is given in Appendix G.

9. VENTILATION SAFETY

9.1 Laboratory Ventilation Policy

The UNC Charlotte-ETCM Fume Hood Program was developed to help ensure that chemical fume hoods are functioning properly and are adequately maintained. All work with hazardous materials must be conducted in a certified fume hood, gas cabinet, glove box, biological safety cabinet, or other approved local exhaust ventilation system.

General room ventilation does not provide adequate protection against hazardous gases, vapors, and aerosols. All work with corrosive, flammable, odoriferous, toxic or other dangerous materials shall be conducted only in a properly operating chemical fume hood, gas cabinet, or glove box.

Ductless and filtering chemical fume hoods may not be used in UNC Charlotte-ETCM laboratories. Chemical fume hoods and other specialty ventilation devices must be located away from supply air (e.g., air conditioners, ducts), doors, and other openings that interfere with their operation. In addition, the exhaust stacks (on the roof) must have ductwork that extends at least ten feet above the roof line.

9.2 Fume Hood

Fume hoods are checked annually by EHS. The velocity of the air at the face of the hood is measured with the sash half-open and the results are posted on a sticker, which is attached to the chemical fume hood. Variable Air Volume (VAV) hoods maintain a constant face velocity at different sash heights. Researchers should close the sash as much as possible when conducting experiments.

Hoods that do not meet the minimum exhaust requirements during EHS inspections are posted with a “DO NOT USE” sign and FO is notified about the need for repairs. Once repairs have been made, EHS will test the fume hood for proper operation.

9.2.1. Procedures for Proper Use of Fume Hoods

Before using the hood, make sure air is entering the hood and hood is functioning properly. Report any problems to FO at telephone number (704) 687-2155. Do not block baffle openings or place bulky items in the hood that will prevent air from entering the baffle opening.

- Ensure that air is entering the unit.
- Ensure the baffle openings are not blocked and air is flowing properly.
- Conduct work at least six inches from the edge of the hood.
- Lower the sash to protect yourself from dangerous reactions.
- Keep hood clean and uncluttered. Wipe up spills immediately.

- Be aware that drafts from open windows, open doors, fans, air conditioners, high traffic walkways may interfere with normal hood exhaust.
- Use perchloric acid only in a special perchloric acid hood. (See Section 8.2.3 - Perchloric Acid Hoods below and consult EHS regarding perchloric acid use.)

9.2.2. Fume Hood Alarms

Fume hood alarms indicate substandard operation of fume hoods. They are installed on every new fume hood system and on those which have been upgraded. The fume hood alarm (i.e., audio/visual) will indicate an exhaust flow malfunction by an audio and visual alarm. If the fume hood alarm sounds, close the sash and notify FO. Do not use the fume hood, until repairs have been made and EHS has removed the "Do Not Use" sign.

9.2.3. Perchloric Acid Hoods

Regular fume hoods must never be used for perchloric acid. Special perchloric acid hoods must be used. The hood must be labeled clearly and used only for perchloric acid or other mineral acids, such as nitric, hydrochloric and hydrofluoric. No organic solvents should be stored or used in a perchloric acid hood. When perchloric acid is heated above ambient temperature, vapor is formed which can condense in the ductwork and form explosive perchlorates. The hood and ductwork should be washed down after each use.

9.3 Glove Boxes

Glove boxes can be used for work with particularly hazardous substances including select carcinogens, reproductive toxins, air reactive chemicals, and substances, which have a high degree of acute or chronic toxicity. When correctly used, these units prevent vapors, gases, and particulates from escaping into the laboratory.

10. CHEMICAL SAFETY

10.1 Chemical Hygiene in the Laboratory

In order to help ensure the protection of faculty, staff, students, and visitors in UNC Charlotte-ETCM laboratories, OSHA 29 CFR 1910.1450 requires the development and implementation of a written Chemical Hygiene Plan (CHP) that is "capable of protecting employees from health hazards associated with hazardous chemicals used in the laboratory" (see Appendix F). EHS has developed and implemented a CHP to meet the requirements of this regulation that sets forth procedures, equipment, personal protective equipment, and work practices which are capable of protecting employees from the health hazards presented by hazardous chemicals used in campus laboratories. The campus wide CHP is can be found at the following web address http://safety.uncc.edu/Safety/HealthManual/Chemical_Program/ChemicalHygienePlan.pdf.

In addition to the responsibilities as outlined in Section 1.3 – Administrative Responsibilities, each FI and LM must ensure that everyone under their direct supervision possess the requisite knowledge, training, and education to safely handle hazardous chemicals in the laboratory. All students and laboratory personnel are responsible for following appropriate work practices when using hazardous chemicals.

10.2 Use of Hazardous Chemicals

Hazardous chemicals may only be used in laboratory facilities or areas specifically designed and engineered for such work. Hazardous chemicals may only be used in areas intended for such use. The capabilities of a laboratory to handle the hazardous chemicals must be assessed by the PI/FI and LM in conjunction with EHS and FO. Hazardous chemicals should never be used in areas lacking the appropriate infrastructure and proper means of ventilation. For example, hazardous chemicals should not be used in offices, dormitories, apartments, or other residential environments. Hazardous chemicals must never be used or stored in carpeted areas. Hazardous chemicals may not be removed from UNC Charlotte property.

Chemical exposures to laboratory personnel must not exceed the PELs established by OSHA. Laboratory operations conducted in a properly operating fume hood, or similar containment device, are unlikely to result in excessive airborne exposures. EHS should be consulted if:

- The chemical to be used can cause severe acute or lethal effects upon exposure by any route of entry to quantities of 5 mg/kg or less based upon available LD50 data.
- The chemical has the potential to create an atmosphere that poses an immediate threat to life.
- The chemical will react violently when exposed to air, water, or humidity.
- The chemical is temperature or shock sensitive.

- The chemical has an unknown composition.
- The chemical may generate by-products that may overcome standard control measures or penetrate personal protective equipment to cause severe acute or lethal injuries.
- The laboratory operations produce conditions that may exceed OSHA PELs.

It is prudent to minimize all chemical exposures. Never deliberately taste or smell chemicals. Do not mouth-pipette hazardous chemicals. Food, drinks, cosmetics, and medication for consumption or use are prohibited inside laboratories where hazardous chemicals are used or stored.

10.3 Chemical Inventory

The OSHA Hazard Communication Standard and the Charlotte Fire Department requires the university to maintain an inventory (e.g., chemical inventory list (CIL)) of hazardous chemicals. The university wide CIL is maintained by EHS. A hazardous chemical is defined as any liquid, solid, or gas that could present a physical or health hazard to an employee or student. All hazardous chemicals used at UNC Charlotte must be registered with EHS. The Charlotte Fire Department and other emergency responders use this master list maintained by EHS when responding to an emergency. In addition, EHS requires that any chemical with a MSDS be included in the CIL.

10.4 Material Safety Data Sheets

The MSDS is a summary of safety information for a hazardous substance or material. OSHA requires manufacturers and importers of chemicals to develop a MSDS for these materials. The MSDS must include the chemical and common names of all ingredients that have been determined to be health hazards if they constitute 1% or greater of the product's composition or 0.1% for carcinogens. The MSDS typically includes information about a chemical's toxicity, health hazards, physical properties, fire and reactivity data, as well as storage, spill and handling precautions. EHS provides MSDS online at the following web address http://safety.uncc.edu/Safety/HealthManual/Ms_Ds_On_Line.htm. In each of the UNC Charlotte-ETCM laboratories there is a standalone computer work station which has direct electronic access to the MSDS online database. The database is comprehensive of all of the registered MSDS information for the entire UNC Charlotte campus. The database is setup so one can query specifically to the laboratory they are working in to get the current and historical history of all of the MSDS information for the laboratory. Also each UNC Charlotte-ETCM laboratory will maintain a MSDS binder that contains a hard copy of each of the current MSDS forms related to the specific laboratory.

10.5 Housekeeping

Good housekeeping is mandatory in all laboratories, especially in laboratories using or storing hazardous chemicals. Ensure that all chemical spills are cleaned up promptly and safely. Dispose of old chemicals, mixtures, and solutions routinely (e.g., after each semester). Keep exit routes clear and never block access to emergency equipment (e.g., eyewash station, deluge shower, fire extinguisher). Keep clutter to a minimum in chemical fume hoods, safety cabinets, benches, tabletops, and on the floor. Ensure trash, broken glass, sharps, recyclables, and chemical wastes are properly disposed.

10.6 Chemical Storage

The number and amounts of chemicals in laboratories should be reduced to an absolute minimum. Chemicals should be stored based on their compatibility; compatible chemicals can be stored alphabetically. Incompatible chemicals must be physically segregated during storage. Corrosives, flammable liquids, oxidizers, and highly reactive chemicals must be separated and stored properly to avoid an unwanted chemical reaction. Additional information on incompatible chemicals and hazardous materials are available from EHS at the following web address http://safety.uncc.edu/Safety/HealthManual/Chemical_Program/CHP_Supplement_A.pdf.
Specially designed cabinets should be used to store hazardous chemicals. Hazardous chemicals should not be stored under sinks. Chemically-compatible bins should be used as secondary containment and to segregate incompatible materials. Proper chemical storage also includes the following:

- Storage areas should be well ventilated.
- Large containers of reagents should be stored on low shelving, preferably in trays to contain all leaks and spills.
- Chemicals should not be stored on the floor, on bench tops, or inside fume hoods.
- Inventories of storage areas should be conducted on an ongoing basis, and at least annually reported to EHS
- Odiferous chemicals must be stored inside vented cabinets or fume hoods.
- Flammable and combustible liquids requiring refrigeration must be stored in units designed for flammable material storage. Typical domestic refrigerators and freezers are not approved for flammable material storage and may result in fire and explosion hazards.

11. ELECTRICAL SAFETY

11.1 Introduction

The purpose of this section is to inform students and laboratory occupants to remediate electrical hazards when possible and develop appropriate work procedures for electrical safety.

Electrical hazards for students and laboratory staff usually include shock, burn, or fire hazards. Electrical shocks occur when a part of the body becomes part of the electrical circuit. One way this can occur is by contacting a metallic part of a piece of equipment that has become energized by contact with an electrical conductor. The severity of the electrical shock depends on the following:

- The amount of the current (measured in Amperes or Amps);
- The pathway through the body;
- The duration of the exposure; and
- Whether the skin is wet or dry.

11.2 Roles and Responsibilities

The UNC Charlotte FO specifies electrical design standards for UNC Charlotte. The FO oversees the design of electrical systems in new buildings as well as renovations and changes to existing buildings. FO is responsible for responding to maintenance requests made by ETCM department and fulfilling those requests in a manner that meets the UNC Charlotte design guidelines which as available at the following web address http://facilities.uncc.edu/FileManager/files/Planning/DesignManual5-18- 2006_040909.pdf.

Students and Laboratory staff are responsible for their electrical equipment. FO personnel may only perform design changes to the building's electrical infrastructure. Specific changes may be required when converting a dry laboratory to a wet environment or when a change in the electrical load exceeds the capacity in a given area (such as after a new laboratory is established in an existing space). Laboratory personnel and students are responsible for ensuring that electrical equipment connected to the building power system is in good condition.

EHS provides electrical safety guidance for the University community at the following web address http://safety.uncc.edu/Safety/Electrical_Safety/ElectricSafetyMain.htm. EHS will respond to technical questions and provide individual assistance on electrical safety issues. EHS inspects laboratories for electrical safety compliance and investigates all accidents resulting from electrical exposure. Any electrical accident of a serious nature would also be investigated by the State Fire Marshal and the State Electrical Inspector.

11.3 General Requirements

Students and Laboratory staff typically encounter electricity in the form of hard-wired equipment (e.g., specialty microscopes, generators), plug-and-cord equipment (e.g., refrigeration, centrifuges, heating baths, other electrical devices), extension cords, and outlets. The following requirements must be followed to ensure electrical safety:

- All electrical equipment used by laboratories must be listed by a nationally recognized testing laboratory (NRTL), with a label showing its approval. It must be used in accordance with the instructions on the listing or labeling. Two examples of NRTLs include Underwriter's Laboratory (UL) and Factory Mutual (FM). A full listing of approved NRTLs can be found on the OSHA website at: http://www.osha.gov/dts/otpca/nrtl/index.html.
- Only an electrician that is properly licensed in the State of North Carolina may work on electrical utilization systems. Under no circumstances may students or laboratory staff undertake changes to the building electrical service.
- Students and Laboratory staff must always disconnect the power source to any electrical equipment before attempting non-electrical service or repair.
- Live parts of electrical equipment operating at 50 volts or more must be guarded against accidental contact.
- A minimum 36-inch clearance must be maintained around electrical controls, panels and disconnects at all times. Greater clearance distances may be required when the equipment voltage is greater than 150V in conjunction with certain workplace conditions. Contact EHS for more information at telephone number (704) 687-4291.
- When unplugging a device, be sure to pull from the plug to prevent wiring damage.
- Never override electrical safety equipment such as guards or electrical interlocks.

11.4 Use of Extension Cords

In general, extension cords are not appropriate where a permanent wiring solution is available, regardless of convenience. Extension cords should be used only for temporary purposes and replaced with surge protectors if needed for longer periods of time. When extension cords are used, the following restrictions apply:

- Use only extension cords that are listed and labeled by a NRTL.
- Use only extension cords that are rated for hard or extra hard usage. The rating must be denoted not only on the original package but also printed on the extension cord insulating jacket. Review the capacity of the extension cord to ensure that you are staying within the cord's power rating.

- Use only extension cords with a minimum conductor size of 12 American Wire Gauge (AWG) and only cords with a grounding pin. Never remove the grounding pin to make a three prong cord fit in a two-prong outlet.
- Extension cords may not be run through doors, windows, walls, or ceilings and may not be attached to building surfaces (i.e., walls, ceilings) by staples or other means.
- Extension cords must be protected from damage (i.e. the use of duct tape on the entire extension cord to secure the extension cord to the floor is an acceptable practice) providing that it is done in such a way that they do not create a tripping hazard.
- Extension cords may not be plugged in end-to-end or "daisy-chained."
- Extension cords must be inspected regularly for wear, as it is especially likely around the plug. Worn or frayed cords must be removed from service and replaced. Cracks in extension cords may not be repaired with electrical tape.

11.5 Use of Power Strips

Power strips permit more products to be plugged into the same outlet. While power strips may be convenient, they may also create safety hazards when used incorrectly. Power strips do not increase the amount of power available to a location, but rather more access to the same electrical source. A heavy reliance on power strips generally indicates that additional wall outlets are needed. Follow these procedures when using power strips:

- Use only NRTL tested power strips, and be sure they are used only as intended by their NRTL listing.
- Select power strips that are properly rated for the application. For example, in a wet chemistry laboratory the power strip must be rated for corrosive and indoor wet locations.
- Read and understand the manufacturer's instructions and limitations on the power strip. For example, the on/off switch on the power strip may not be designed to interrupt the power of the devices plugged into the strip during normal applications.
- Do not overload the circuit. Review the capacity of the circuit and the power requirements of all of the items plugged into it. This includes not only the items plugged into the power strip but also other devices plugged into wall outlets along the same circuit.

11.6 Ground Fault Circuit Interrupters

Ground Fault Circuit Interrupters, or GFCIs, are designed to protect the end user from electrical shock. GFCIs are not required on all circuits in laboratories. Best management practices in laboratory safety call for all outlets within 6-feet of a water source (such as a sink) or in a wet environment to have GFCI protection. All maintenance requests and renovation designs must

include a provision for GFCI protection under these circumstances. Older buildings may be "grandfathered" and exempt from this requirement.

If a laboratory currently has outlets with GFCI protection, they should be tested at least once per month. LMs are responsible for testing the GFCI. To test the receptacle GFCI, first plug a lamp into the outlet and turn it on. Next, press the "TEST" button on the GFCI. Under properly functioning conditions, the GFCI's "RESET" button should pop out and the light will turn off. Press the "RESET" button to restore power to the outlet. If the "RESET" button pops out but the light does not go out, the GFCI has been improperly wired. Contact FO at the following telephone number (704) 687-2155 to correct the wiring errors. If the "RESET" button does not pop out, the GFCI is defective and should be replaced.

11.7 Damaged or Defective Equipment

Any of the following circumstances requires that the user immediately take the equipment out of service:

- Experiencing shocks, even mild shocks, when the equipment is touched;
- Abnormal heat generation; and
- Arcing, sparking, or smoking from the equipment.

Laboratory staff must tag the equipment, "Do Not Use" and should arrange for equipment repair either through the equipment manufacturer or through FO as appropriate.

11.8 Special Considerations

Follow these guidelines when working with electrical equipment or devices:

- LM frequently construct equipment such as lighting fixtures or housings for use in specialty applications. All electrical equipment constructed by UNC Charlotte employees or students must be inspected prior to use by North Carolina licensed electrician or qualified electrical engineer. All electrical equipment must be constructed in accordance with the requirements of the current National Electric Code.
- If flammables are used, electrical equipment with motors must be rated for Class I Division II environments. This requirement is waived if the motor is permanently housed in a fume hood or fitted with special local exhaust ventilations designed to prevent flammable concentrations of gases or vapors from reaching the motor.
- The manufacturer must certify refrigerators used to store flammable chemicals.
- Install GFCI outlets within 6 feet of a water source.
- Electrophoresis devices should be evaluated for electrical safety concerns.

12. COMPRESSED GASES SAFETY

12.1 Handling Compressed Gas and Gas Regulators

Compressed gas cylinders are manufactured and charged under regulations set by the Department of Transportation. These cylinders must not be filled or altered in any way except as specified by the cylinder manufacturer. Cylinders leased under regulations set up by the Department of Transportation (DOT) should never be used to mix gases or be used as a container for anything other than the designated gas. A compressed gas is any material or mixture having in the container an absolute pressure exceeding 40 pounds per square inch at 70°F, or regardless of the pressure at 70°F, having an absolute pressure exceeding 104 pounds per square inch at 130°F; or any liquid flammable material having a vapor pressure exceeding 40 pounds per square inch absolute at 100°F.

Cylinder storage areas must be conspicuously placarded with the names of gases being stored. Know the contents of a cylinder and be familiar with the properties of that gas. Never use a cylinder which cannot be positively identified; cylinder color coding varies among gas vendors and is an unreliable identifier of cylinder contents.

Gas cylinders are equipped with a pressure safety device. There are three types: rupture disks, pop valves and fusible metal plugs. These devices are used separately or in combination on all cylinders. Know the type and location of the relief devices on any cylinder brought into the laboratory. Fusible metal plugs are designed to melt between 158 and 194°F. Thus, cylinders should not be placed near radiators of heat or in any location where they may become overheated. Cylinders are designed for safe use up to 122°F.

Each experimental apparatus employing compressed gas cylinders should be checked for proper pressure relief with the LM. The cylinder regulator maximum discharge pressure should not exceed the pressure rating of the downstream apparatus. Be sure all downstream apparatus is at zero gauge pressure before disassembly. Federal law requires that cylinders of oxidizing gas have a 20-foot minimum separation from cylinders of flammable gas and that they be securely anchored at all times. Cylinders will not be stored or left unattended in hallways, corridors, stairways, or other areas of access and/or egress. Always store cylinders in a ventilated area away from heat or ignition sources. When installing a new cylinder, complete the cylinder information tag, and attach it to the valve stem. Remove the tag and give it to the LM when the empty cylinder is returned to the vendor.

Use cylinders only with matched connectors and proper Compressed Gas Association (CGA) regulator. Never install cylinder adapters on a regulator. Teflon tape must NEVER be used on any CGA cylinder valve fitting. Section 11.4 – Regulator Inspection, describes the regulator inspection program details. Gas cylinder regulators are designed uniquely such that each will

only fit a specific cylinder gas type. Left handed threads are found on cylinders containing combustible gases. Oxygen regulators should be used only on oxygen tanks. Contamination of oxygen regulators with the oil present in other gases can result in a serious explosion hazard when the regulator is again used for oxygen. After regulator is connected to the cylinder, the pressure-reducing valve shall be closed before allowing gas to enter the regulator. Gas must not be permitted to enter the regulator suddenly. Leak-test all connections to a cylinder with a soap solution. CAUTION! Any gas, regardless of its health hazard, may cause asphyxiation by displacing oxygen. When removing a regulator from a cylinder, the cylinder valve is closed first, and then the pressure is released from the regulator.

The number of cylinders of flammable gases and oxygen is limited to a maximum of three per laboratory. Connect all cylinders containing flammable gases to an earth ground, and use metallic tubing when connecting these gases to other equipment. Cylinders of all gases having a health rating of 3 or 4 and cylinders of gases having a health hazard rating of 2 with no physiological warning properties shall be kept in a continuously mechanically ventilated enclosure. There will be no more than three cylinders of these hazard ratings per hood or other continuously mechanically ventilated enclosure per laboratory.

Compressed gas cylinders must be firmly secured at all times by a bench or wall mounted cylinder clamp or chain. Pressure-relief devices protecting equipment attached to cylinders of flammable, toxic, or otherwise hazardous gases should be vented to an exhaust duct or fume hood. Regulators with vented bonnets are required when toxic or corrosive gases are used. Securely clamp plastic tubing to the bonnet vent and also at the exhaust duct where the tubing vents, see OSHA 29 CFR 1910.101 (2) (b). When not in use, the regulators on cylinders should be depressurized. If the cylinder is not to be used for a long time, the regulator must be removed and the valve cover screwed into place. Never leave partly assembled apparatus attached to gas cylinders. Never attempt to refill a cylinder. When storing or moving a cylinder, always attach the safety cap securely to protect the valve stem, and transport only on a wheeled cart specifically designed for gas cylinders of Size 2 or larger.

Any UNC Charlotte elevator is a confined space demanding special precautions when transporting compressed gases. People and compressed gas cylinders are disallowed on the elevator simultaneously. Sudden release of gas (e.g., valve breakage, ruptured disk blow-out, etc.) could cause death by asphyxiation. Therefore, when transporting a cylinder in the elevator, send it up on a secure cylinder dolly unescorted; and walk up the stairs to meet it at the destination. Those encountering a cylinder on the elevator must not enter until it is off-loaded.

Cylinders should be located in the lab so that the cylinder valve is accessible at all times. The main cylinder valve should be closed as soon as it is no longer necessary that it be open (i.e., it should never be left open when the equipment is unattended or not operating). When storing or

moving a cylinder, have the cap in place to protect the valve stem and NEVER expose cylinders to temperatures higher than 50 degrees Centigrade (120 degrees Fahrenheit). Cylinders of compressed gases must be handled as high energy sources and, therefore, as potential explosives. Cylinder valves should be opened slowly; the valve on an unregulated cylinder should never be "cracked." It is never necessary to open the main cylinder valve all the way; the resulting flow will be much greater than one would ever want. It is safe practice to open the main valve only to the extent necessary. Never tamper with any part of a valve, such as the safety or packing nuts.

A cylinder should never be emptied to a pressure lower than (20 psig); leave a slight pressure to keep contaminants out, and notify the vendor with a note if draw-down occurs. Empty cylinders should not be refilled by anyone except the gas supplier. Remove the empty cylinder regulator, replace the valve cap, mark the cylinder "Empty," and return it to the loading dock storage area for pickup by the gas vendor. Do not store empty and full cylinders together under one chain. Cylinder discharge lines should be equipped with approved check valves to prevent inadvertent contamination of cylinders that are connected to a closed system where the possibility of flow reversal exists. Sucking back is particularly troublesome in the case of gases used as reactants in a closed system. If there is a possibility that a cylinder has been contaminated, it should be so labeled and returned to the supplier.

When ordering toxic or flammable gases, always request a Flow Restrictor Cylinder Valve (FRV). The FRV orifice considerably reduces the full-open leak rate in event of a major leak (e.g., regulator diaphragm failure).

12.2 Hydrogen Storage

Any hydrogen storage location must be permanently placarded as follows: "**HYDROGEN--FLAMMABLE GAS--NO SMOKING--NO OPEN FLAMES**", or equivalent. Each mobile hydrogen supply unit used as part of a hydrogen system must be readily accessible, and must be protected against physical damage and against tampering. Hydrogen systems of less than 3,000 CF when located inside buildings and exposed to other occupancies must be situated in the building so that the system will be as follows:

- In an adequately ventilated area as in subparagraph (b) (3) (ii) (b) of 29 CFR 1910.103.
- Twenty feet from stored flammable materials or oxidizing gases.
- Twenty five feet from open flames, ordinary electrical equipment or other sources of ignition.
- Fifty feet from intakes of ventilation or air-conditioning equipment and air compressors.
- Twenty five feet from concentrations of people.
- Fifty feet from other flammable gas storage.
- Protected against damage or injury due to falling objects or working activity in the area.

- More than one system of 3,000 CF or less may be installed in the same room provided the systems are separated by at least fifty feet. Each system shall meet all of the requirements of this paragraph as described in OSHA 29 CFR 1910.103.

12.3 Regulator Inspection

All regulators used with toxic or corrosive gas service require a bonnet vent connected to a fume hood or to an operating exhaust duct. Regulators without a bonnet vent must be sent to the vendor for modification. A preventative maintenance program is now required for all gas regulators. Corrosive gas service regulators need to be removed from service at semiannual intervals (6 months) for overhaul. Toxic gas regulators are to be sent out for annual overhaul. Anytime a regulator shows gauge pressure discrepancies, bubbles upon leak testing or other abnormal characteristics, it will be removed from service and factory-overhauled. The responsible LM dates new and rebuilt regulators, records inspection dates and notifies regulator users of inspection-due dates. Inspections are performed annually.

APPENDIX A

Laboratory Safety Survey

UNC CHARLOTTE

Department of Engineering Technology & Construction Management

	Laboratory Safety Survey			
	This checklist can be used in evaluating the safety of procedures and equipment in the laboratory. It can be further developed to meet the needs of specific research laboratories.			
Room Reviewed _____ Date _____		YES	NO	N/A
Doors				
	The Laboratory Safety Information Card is up to date			
	Other appropriate signs are present (i.e. Radioactive Materials, X-rays etc.)			
	The "Vision Panel" (window) in the door is unobstructed for emergencies			
Safety Equipment				
	The safety equipment located in close proximity to the main door of the lab			
	Drench Shower is unobstructed (at least 3sq.ft.)			
	All persons in the laboratory are trained to use the Drench Shower			
	A Fire Extinguisher is located within 50' of the laboratory door			
	Fire Extinguisher has not been discharged or tampered with			
	Occupants in the laboratory know how to use the Fire Extinguisher			
	An Eyewash Station is available? (Bottled eyewashes are not acceptable)			
	The Eyewash Station is accessible			
	The Eyewash Station is being "flushed" weekly,(at least 3 minutes)			
	A First Aid Kit is available			
	The First Aid Kit is "mounted" next to the main laboratory door			
	The kit contains clean, sterile bandages, pads, Band-Aids, tape, ice packs			
Procedures				
	Housekeeping is clean, neat and orderly			

	Beverages and foods are not consumed and cosmetics are not applied in the laboratory			
	Aisles and corridors are free of obstruction and tripping hazards			
	A Laboratory Safety Coordinator has been identified **(If so, please identify)**			
	All doors from the laboratory are unobstructed, in case of emergency			
	Combustible storage (boxes and paper) is kept to an absolute minimum			
	The trash containers are noncombustible and emptied regularly			
	Communicating doors to offices/other labs are closed at night and weekends			
Personal Protective Equipment				
	All laboratory occupants wear the appropriate Eye/Face Protection			
	The protective eyewear meets ANSI standard, Z87.1, as required			
	All laboratory occupants wear the appropriate Laboratory coats/aprons			
	All laboratory occupants wear the appropriate gloves			
	Shorts & open-toed shoes are prohibited in the laboratory			
	Loose clothing & long hair do not come in contact with equipment			
	Laboratory visitors are required to wear Personal Protective Equipment			
Chemical Safety				
	All hazardous/odiferous/toxic chemicals are used in an approved fume hood			
	All chemicals are stored compatibly			
	Flammable Liquid Storage is kept to an absolute minimum			
	Flammable Liquids are stored in approved safety cans, flammable storage cabinets, or flammable storage refrigerators			
	Chemicals are inventoried regularly to reduce unwanted/outdated material			
	Chemicals are not placed or stored on the floor			

	All chemicals and containers are properly labeled			
	Hazardous chemicals are not stored across from the hood			
	Acutely hazardous chemicals are used in an approved glove box			
Chemical Waste				
	Chemical Waste is located in an area, which has been properly identified			
	Each chemical waste container identifies each and every chemical within			
	Each chemical waste container identifies hazards (i.e. Flammable, Toxic)			
	All chemical waste containers are capped at all times			
	Satellite drums (if applicable) are dated, initialed weekly, or after adding to			
Fume Hoods/Exhaust Systems				
	The fume hood is being used at proper sash height			
	Occupants in the laboratory do not to use the fume hood for storage			
	Occupants know to contact EHS, if they suspect a fume hood problem			
	The Bio Safety Cabinets (if applicable) are inspected yearly			
Gas Cylinders				
Refrigerators	Gas cylinders are stored compatibly			
	All gas cylinders are properly capped or regulated			
	All gas cylinders are secured to a stationary bench or wall			
	All flammable gas cylinders are been located away from doors			
	All gas cylinders are located away from electric panels/outlets			
	Extremely Poisonous gases are used in approved gas cylinder cabinets			
	Gas cylinders are transported on appropriate carts with straps/chains			

	Flammable Liquids are not stored in household refrigerators (internal lights/temperature control switch)			
	Food and beverages are not stored in the laboratory refrigerator			
	All chemicals and containers are properly labeled			
	All chemicals are inventoried regularly, disposed of, if not needed			
	Refrigerators are cleaned and maintained			
Electrical Safety				
	Equipment is properly grounded			
	All electrical cords are in good condition, without splice or defect			
	Electrical outlets are prohibited within the fume hood			
	The electric panel breakers and fuses are properly labeled			
	Electrical cords do not pass through ceilings, doors or walls			
	Electrical cords are not draped across the floor of the lab			
	Flammable Liquids do not come into close contact with electric ignition sources			
	Acids do not come into close contact with electric ignition sources			
	Guards have been provided for all moving parts (i.e. Vacuum pumps)			
Emergency Procedures				
	Occupants of the laboratory know the Campus Emergency Number, 911			
	Occupants know what to do in case of Chemical Spill/Fire/Injury			
	There is a telephone w/ 911 sticker attached, in the laboratory*			
For further information	Contact the Environmental Health and Safety at telephone number 704-687-4291			

APPENDIX B

CIET/CM LSAs

List of CIET/CM LSAs

LSA No.	LSA Title	Revision No.	Revision Date
CIET001	Operating a Conventional Oven	1	August 2010
CIET002	Operating a Concrete Mixer	1	August 2010
CIET003	Operating a Concrete Testing Machine	1	August 2010
CIET004	Operating a Concrete Saw	1	August 2010
CIET005	Using A Sulfur Mortar Capping System	1	August 2010
CIET006	Operating a Marshall Compactor	1	August 2010
CIET007	Operating a Marshall Tester	1	August 2010
CIET008	Operating a Hot Water Bath	1	August 2010
CIET009	Operating a Microwave Oven	1	August 2010
CIET010	Operating a Sample Splitter	1	August 2010
CIET011	Operating a Sample Mixer	1	August 2010
CIET012	Operating a Sieve Shaker	1	August 2010
CIET013	Conducting Soil Compaction	1	August 2010
CIET014	Operating a Sample Extruder	1	August 2010
CIET015	Conducting Soil Compression	1	August 2010
CIET016	Conducting Soil Consolidation	1	August 2010
CIET017	Conducting Soil Direct Shear	1	August 2010
CIET018	Operating a Soil Mixer	1	August 2010
CIET019	Operating a Metal Lathe	1	August 2010
CIET020	Operating a Vertical Knee Mill	1	August 2010
CIET021	Operating Wood/Metal Cutting Saw	2	June 2016
CIET022	Operating a Horizontal Band Saw	1	August 2010
CIET023	Operating the Instron 5582 Universal Testing Maching	1	August 2010
CIET024	Operating the Double Pipe Heat Exchanger	1	August 2010
CIET025	Operating the HVAC Trainer	1	August 2010
CIET026	Operating the Armfield Fluids Bench	1	August 2010
CIET027	Operating the Flume	1	August 2010

APPENDIX C

ELET LSAs

List of ELET LSAs

LSA No.	LSA Title	Revision No.	Revision Date
ELET001	Operating a Soldering Iron	1	August 2010
ELET002	Operating a Drill Press	1	August 2010
ELET003	Operating Cutting/Stripping Wire Cutters	1	August 2010
ELET004	Operating a Digital Multimeter	1	September 2010
ELET005	Operating a Function Generator	1	September 2010
ELET006	Operating a Digital/Analog Trainer	1	September 2010
ELET007	Operating a Power Supply	1	September 2010
ELET008	Operating an AC Power Supply	1	September 2010
ELET009	Operating an Oscilloscope	1	September 2010

APPENDIX D

MET LSAs

List of MET LSAs

LSA No.	LSA Title	Revision No.	Revision Date
MET001	Operating a Pedestal Grinder	1	August 2010
MET002	Operating a Disc Sander	1	August 2010
MET003	Operating a TIG/Stick Welder	1	August 2010
MET004	Operating a Metal Lathe	1	August 2010
MET005	Operating a Vertical Knee Mill	1	August 2010
MET006	Operating a MIG Welder	1	August 2010
MET007	6-8 Foot Step Ladder	1	August 2010
MET008	Operating a Vertical Band Saw	1	August 2010
MET009	Operating a Horizontal Band Saw	1	August 2010
			August 2010
MET011	Operating a Metal Shear	1	August 2010
MET012	Operating a Finger Brake	1	August 2010
MET013	Operating the BST 768 3D Printer	1	August 2010
MET014	Operating the SST 1200es 3D Printer	1	August 2010
MET015	Operating the Clean Station Soluble Support Remover	1	August 2010
MET016	Operating the Instron 5582 Universal Testing Machine	1	August 2010
MET017	Operating the Satec Impact Tester	1	August 2010
MET018	Operating the Blue M Heat Treat Furnace	1	August 2010
MET019	Operating the Parr Bomb Calorimeter	1	August 2010
MET020	Operating the Double Pipe Heat Exchanger	1	August 2010
MET021	Operating the HVAC Trainer	1	August 2010
MET022	Operating the Steam Turbine	1	August 2010
MET023	Operating the Megatech Visible Engine	1	August 2010
MET024	Operating the Armfield Fluids Bench	1	August 2010
MET025	Operating the Armfield Pelton Turbine	1	August 2010
MET026	Operating the Hampden Fluid Circuits Experiment	1	August 2010
MET027	Operating the TQ Reciprocating Compressor Experiment	1	August 2010
MET028	Operating the Flume	1	August 2010

APPENDIX E

Example LSA Training Record

UNC CHARLOTTE

DEPARTMENT OF ENGINEERING TECHNOLOGY

LABORATORY SAFETY ANALYSIS TRAINING RECORD

_____

[NAME OF EQUIPMENT]

MY SIGNATURE INDICATES THAT I HAVE READ, UNDERSTAND AND WILL ABIDE BY THE LSA REQUIREMENTS. IT IS MY RESPONSIBILITY TO OBTAIN AUTHORIZATION FROM MY LABORATORY MANAGER OR INSTRUCTOR AND REVIEW THE LSA REQUIREMENTS BEFORE USING THIS EQUIPMENT.

NAME **(PRINT)**	SIGNATURE	DEPARTMENT	DATE	LAB MANAGER / INSTRUCTOR SIGNATURE

Record No. _____

APPENDIX F

OSHA Laboratory Standard
29 CFR 1910.1450

ATTACHMENT 1
OSHA Laboratory Standard
29 CFR 1910.1450

PART 1910-OCCUPATIONAL SAFETY AND HEALTH STANDARDS

1. The authority citation for part 1910, subpart Z is amended by adding the following citation at the end. (Citation which precedes asterisk indicates general rulemaking authority.)

Authority: Secs. 6 and 8, Occupational Safety and Health Act, 29 U.S.C. 655, 657; Secretary of Labor's Orders Nos. 12-71 (36 FR 8754), 8-76 (41 FR 25059), or 9-83 (48 FR 35736), as applicable; and 29 CFR part 1911.
* * * Section 1910.1450 is also issued under sec. 6(b), 8(c) and 8(g)(2), Pub.L. 91-596, 84 Stat. 1593, 1599, 1600; 29 U.S.C. 655, 657.

2. Section 1910.1450 is added to subpart Z, part 1910 to read as follows:

191.1450 Occupational exposure to hazardous chemicals in laboratories.

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

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

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

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

(iii) Where the action level (or in the absence of action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements, paragraphs (d0 and (g)(1)(ii) of this section shall apply.

(3) This section shall not apply to:

(i) Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart 2, even if such occurs in a laboratory.

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

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

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

(b) *Definitions*-

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

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

"Carcinogen" (see "select carcinogen").

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

"Chemical Hygiene Plan" means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

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

"Compressed Gas" means"

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

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

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

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

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

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

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

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

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

(ii) *"Gas, flammable"* means:

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

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

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

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

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

(i) Tagliabue Closed Tester (See American National Standard for Flash Point by Tag Closed Tester, Z11.7-1979 (STM D93-79))-for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 °F (37.8 °C), than do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))-for liquids with a

viscosity equal to or greater than 45SUS at 100 °F (37.8 °C), or that contain suspended solids, or that have a tendency to form a surface fulm under test; or

(iii)Setaflash Closed Tester (see American National standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D3278-78)).

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

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

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

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

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

"*Laboratory-type hood"* means a device located in a laboratory, enclosure on five sides with a moveable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure with out insertion of any portion of the employee's body other than hands and arms.

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

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

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

(ii)Multiple chemical procedures or chemicals are used;

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(c) *Permissible exposure limits.* For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 26 CFR par 1910, subpart Z.

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

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

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

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

(e)*Chemical hygiene plan-General.* (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan). (1) Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

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

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

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

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

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

(ii) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular

attention shall be given to the selection of control measure for chemicals that are known to be extremely hazardous;

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

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

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

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

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

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

(A) Establishment of a designated area;

(B) Use of containment devices such as fume hood or glove boxes;

(C) Procedures for safe removal of contaminated waste; and

(D) Decontamination procedures.

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

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

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

(3) *Information.* Employees shall be informed of:

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

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

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

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

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

(4) *Training.* (I) Employee training shall include:

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

(B) The physical and health hazards of chemicals in the work area; and

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

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

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

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

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

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

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

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

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

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

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

(4) *Physician's written opinion.* (i) For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

(A) Any recommendation for further medical follow-up;

(B) The results of the medical examination and any associated tests;

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

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

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

(h) *Hazard identification.* (1) With respect to labels and material safety data sheets:

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

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

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

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

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

(iii) If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (26 CFR 1910.1200) including requirements for preparation of material safety data sheets and labeling.

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

(j) *Recordkeeping.* (1) The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any

medical consultation and examinations including test or written opinions required by this standard.

(2) The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.20.

(k) *Dates*-(1) *Effective date.* This section shall become effective May 1, 1990.

(2) *Start-up dates.* (i) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.

(ii) Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

(l) *Appendices.* The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

Appendix A to 1910.1450-National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory)

Table of Contents

Foreword

As guidance for each employer's development of an appropriate laboratory Chemical Hygiene Plan, the following non-mandatory recommendations are provided. They were extracted from "Prudent Practices for handling Hazardous Chemical in Laboratories" (referred to below as "Prudent Practices"), which was published in 1981 by the National Research Council and is available from the National Academy Press, 2101 Constitution Ave., NW., Washington DC 20418.

"Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will modify any requirements of the laboratory standard. This Appendix merely presents pertinent recommendations from "Prudent Practices", organized into a form convenient for quick reference during operation of a laboratory facility and during development and application of a Chemical Hygiene Plan. Users of this appendix should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

"Prudent Practices" deals with both safety and chemical hazards while the laboratory standard is concerned primarily with chemical hazards. Therefore, only those recommendation directed primarily toward control of toxic exposures are cited in this appendix, with the term "chemical hygiene" being substituted for the word "safety". However, since conditions producing or threatening physical injury often pose toxic risks as well, page references concerning major categories of safety hazards in the laboratory are given in section F.

The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized, and headings have been added. However, their sense has not been changed.

Corresponding Sections of the Standard and this Appendix

The following table is given for the convenience of those who are developing a Chemical Hygiene Plan which will satisfy the requirements of paragraph (e) of the standard. It indicates those sections of this appendix which are most pertinent to each of the sections of paragraph (e) and related paragraphs.

Paragraph and topic in laboratory standard	Relevant appendix section
(e)(3)(i) Standard operating procedures for handling toxic chemicals.	C, D, E
(e)(3)(ii) Criteria to be used for implementation of measures to reduce exposure.	D
(e)(3)(iii) Fume hood performance	C4b
(e)(3)(iv) Employee information and training (including emergency procedures).	D10, D9
(e)(3)(v) Requirements for prior approval of laboratory activities.	E2b, E4b
(e)(3)(vi) Medical consultation and medical examinations	D5, E4f
(e)(3)(vii) Chemical hygiene responsibilities.	B
(e)(3)(viii) Special precautions for work with particularly hazardous substances.	E2, E3, E4

In this appendix, those recommendations directed primarily at administrators and supervisors are given in sections A-D. Those recommendations of primary concern to employees who are actually handling laboratory chemical are given in section E. (Reference to page numbers in "Prudent Practices" are given in parentheses.)

A. General Principles for Work with Laboratory Chemicals

In addition to the more detailed recommendations listed below in sections B-E, "Prudent Practices" expresses certain general principles, including the following:

1. *It is prudent to minimize all chemical exposures.* Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals (2, 10). Skin contact with chemicals should be avoided as a cardinal rule (198).

2. *Avoid underestimation of risk.* Even for substances of no known significant hazard, exposure should be minimized; for work with special precautions should be taken 910, 37, 38). One should

assume that any mixture will be more toxic than its most toxic component (30,103) and that all substances of unknown toxicity are toxic (3, 34).

3. *Provide adequate ventilation.* The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices (32, 198).

4. *Institute a chemical hygiene program.* A mandatory chemical hygiene program designed to minimize exposures is needed; it should be a regular, continuing effort, not merely a standby or short-term activity (6, 11). Its recommendations should be followed in academic teaching laboratories as ell as by full-time laboratory workers (13).

5. *Observe the PELs, TLVs*. The Permissible Exposure Limits of OSHA and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists should not be exceeded (13).

B. Chemical Hygiene Responsibilities

Responsibility for chemical hygiene rest at all levels (6, 11, 21) including the:

1. *Chief executive officer*, who has ultimate responsibility for chemical hygiene within the institution, and must with other administrators, provide continuing support for institutional chemical hygiene (7, 11).

2. *Supervisor of the department or other administrative unit*, who is responsible for chemical hygiene in that unit (7).

3. *Chemical hygiene officer(s),* whose appointment is essential (7) and who must:

(a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices (7);

(b) Monitor procurement, use, and disposal of chemicals used in the lab (8);

(c) See that appropriate audits are maintained (8);

(d) Help project directors develop precautions and adequate facilities (10);

(e) Know the current legal requirements concerning regulated substances (50); and

(f) Seek ways to improve the chemical hygiene program (8, 11).

4. *Laboratory supervisor*, who has overall responsibility for chemical hygiene in the laboratory (21) including responsibility to:

(a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided (21, 22);

(b) Provide regular, formal chemical hygiene and housekeeping inspections including routine inspections of emergency equipment (21, 171);

(c) Know the current legal requirements concerning regulated substances (50, 231);

(d) Determine the required levels of protective apparel and equipment (156, 160, 162); and

(e) ensure that facilities and training for use of any material being ordered are adequate (215).

5. *Project director or director of other specific operation,* who has primary responsibility for chemical hygiene procedures for that operation (7).

6. *Laboratory worker*, who is responsible for:

(a) Planning and conducting each operation in accordance with the institutional chemical hygiene procedures (7, 21, 22, 230); and

(b) Developing good personal chemical hygiene habits (22).

C. The Laboratory Facility

1. *Design*. The laboratory facility should have:

(a) An appropriate general ventilation system (see C4 below) with air intakes and exhausts located so as to avoid intake of contaminated air (194);

(b) Adequate, well-ventilated stockrooms/storerooms (218, 219);

(c) Laboratory hoods and sinks (12, 162);

(d) Other safety equipment including eyewash fountains and drench showers (162, 169); and

(e) Arrangements for waste disposal (12, 240).

2. *Maintenance.* Chemical-hygiene-related equipment (hoods, incinerator, etc.) should undergo continuing appraisal and be modified if inadequate (11, 12).

3. *Usage.* The work conducted (10) and its scale (12) must be appropriate to the physical facilities available and, especially, to the quality of ventilation (13).

4. *Ventilation.*-(a) *General laboratory ventilation.* This system should: Provide a source of air for breathing and for input to local ventilation devices (199); it should not be relied on for protection from toxic substances released into the laboratory (198); ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day (194); direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building (194).

(b) *Hoods.* A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals (199); each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 209). If this is not possible, work with substances of unknown toxicity should be avoided (13) or other types of local ventilation devices should be provided (199). See pp. 201-206 for a discussion of hood design, construction, and evaluation.

(c) *Other local ventilation devices.* Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed (199). Each canopy hood and snorkel should have a separate duct (207).

(d) *Special ventilation areas.* Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system (208). Cold rooms and warm rooms should have provisions for rapid escape in the event of electrical failure (209).

(e) M*odifications.* Any alteration of the ventilation system should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate (12, 193, 204).

(f) *Performance.* Rate: 4-12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control (194).

(g) Quality. General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas (194,195); airflow into and within the hood should not be excessively turbulent (200); hood face velocity should be adequate (typically 60-100 lfm) (200, 204).

(h) *Evaluation.* Quality and quantity of ventilation should be evaluated on installation (202), regularly monitored (at least every 3 months) (6, 12, 14, 195), and reevaluated whenever a change in local ventilation devices is made (12, 195, 207). See pp. 195-198 for methods of evaluation and for calculation of estimated airborne contaminant concentrations.

D. Components of the chemical Hygiene Plan

1. Basic Rules and Procedures
(Recommendations for these are given in section E, below)

2. Chemical Procurement, Distribution, and Storage

(a) *Procurement*. Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved (251, 216). No container should be accepted without an adequate identifying label (216).

(b) *Stockrooms/storerooms.* Toxic substances should be segregated in a well-identified area with local exhaust ventilation (221). Chemicals which are highly toxic (227) or other chemicals whose containers have been opened should be in unbreakable secondary containers (219). Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity (218-19).

Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person (219).

(c) *Distribution.* When chemicals are hand carried, the container should be placed in an outside container or bucket. Freight-only elevators should be used if possible (223).

(d) *Laboratory storage.* Amounts permitted should be as small as practical. Storage on bench tops and in hoods is inadvisable. Exposure to heat or direct sunlight should be avoided. Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom (225-6, 229).

3. Environmental Monitoring

Regular instrumental monitoring of airborne concentration is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devised (12) or when a highly toxic substance is stored or used regularly (e.g., 3 times/week) (13).

4. Housekeeping, Maintenance, and Inspections

(a) Cleaning. Floors should be cleaned regularly (24).

(b) Inspections. Formal housekeeping and chemical hygiene inspections should be held at least quarterly (6, 21) for units which have frequent personnel changes and semiannually for other; informal inspections should be continual (21).

(c) M*aintenance*. Eye wash fountains should be inspected at intervals of not less than 3 months (6). Respirators for routine use should be inspected periodically by the laboratory supervisor (169). Safety showers should be tested routinely (169). Other safety equipment should be inspected regularly. (e.g., every 3-6 months) (6, 24,171). Procedures to prevent restarting of out-of-service equipment should be established (25).

(d) *Passageways.* Stairways and hallways should not be used as storage areas (24). Access to exits, emergency equipment, and utility controls should never be blocked (24).

5. Medical Program

(a) *Compliance with regulations.* Regular medical surveillance should be established to the extent required by regulations (12).

(b) *Routine surveillance.* Anyone whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable (11, 50).

(c) *First aid.* Personnel trained in first aid should be available during working hours and an emergency room with medical personnel should be nearby (173). See pp. 176-178 for description of some emergency first aid procedures.

6. Protective Apparel and Equipment

These should include for each laboratory:

(a) Protective apparel compatible with the required degree of protection for substance being handled (158-161);

(b) An easily accessible drench-type safety shower (162, 169);

(c) An eyewash fountain (162);

(d) A fire extinguisher (162-164);

(e) Respiratory protection (164-9), fire alarm and telephone for emergency use (162) should be available nearby; and

(f) Other items designated by the laboratory supervisor (156, 160).

7. Records

(a) Accident records should be written and retained (174).

(b) Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations (7).

(c) Inventory and usage records for high-risk substances should be kept as specified in sections E3e below.

(d) Medical records should be retained by the institution in accordance with the requirements of state and federal regulations (12).

8. Signs and Labels

Prominent signs and labels of the following types should be posted:

(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers (28);

(b) Identity labels, showing contents of containers (including waste receptacles) and associated hazards (27, 48);

(c) Locations signs for safety showers, eyewash stations, other safety and first aid equipment, exits (27) and areas where food and beverage consumption and storage are permitted (24); and

(d) Warnings at areas or equipment where special or unusual hazards exist (27).

9. Spills and Accidents

(a) A written emergency plan should be established and communicated to all personnel; it should include procedures for ventilation failure (200), evacuation, medical care, reporting, and drills (172).

(b) There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms (172).

(c) A spill control policy should be developed and should include consideration of prevention, containment, cleanup, and reporting (175).

(d) All accidents or near accidents should be carefully analyzed with the results distributed to all who might benefit (8, 28).

10. Information and Training Program

(a) Aim: To assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs (5, 15).

(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment (154, 169).

Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures (6).

Such training as well as first aid instruction should be available to (154) and encouraged for (176) everyone who might need it.

(c) Receiving and stockroom/storeroom personnel should know about hazards, handling equipment, protective apparel, and relevant regulations (217).

(d) Frequency of Training: The training and education program should be a regular, continuing activity-not simply an annual presentation (15).

(e) Literature/Consultation: Literature and consulting advice concerning chemical hygiene should be readily available to laboratory personnel, who should be encouraged to use these information resources (14).

11. Waste Disposal Program

(a) Aim: To assure that minimal harm to people, other organisms, and the environment will result from the disposal of waste laboratory chemicals (5).

(b) Content (14,232, 233, 240): The waste disposal program should specify how waste is collected, segregated, stored, and transported and include consideration of what materials can be incinerated. Transport from the institution must be in accordance with DOT regulations (244).

(c) Discarding Chemical Stocks: Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened (24, 270.

Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage (226).

(d) Frequency of Disposal: Waste should be removed from laboratories to a central waste storage area at least once per week and from the central waste storage area at regular intervals (14).

(e) Method of Disposal: Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste (14, 238, 241).

Indiscriminate disposal by pouring waste chemicals down the drain (14, 231,242) or adding them to mixed refuse for landfill burial is unacceptable (14).

Hoods should not be used as a means of disposal for volatile chemical (40, 200).

Disposal by recycling (233, 243) or chemical decontamination should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

The Chemical Hygiene Plan should require that laboratory workers know and follow its rules and procedures. In addition to the procedures of the sub programs mentioned above, these should include the rules listed below.

1.General Rules

The following should be used for essentially all laboratory work with chemicals:

(a) *Accidents and spills*-eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention (33, 172).

Ingestion: Encourage the victim to drink large amounts of water (178).

Skin Contact: Promptly flush the affected area with water (33, 172, 178) and remove any contaminated clothing (172, 178). If symptoms persist after washing, seek medical attention (33).

Clean-up. Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal (24, 33). See pp. 233-237 for specific clean-up recommendations.

(b) *Avoidance of "routine" exposure;* Develop and encourage safe habits (230; avoid unnecessary exposure to chemicals by any route (23);

Do not smell or taste chemicals (32). Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices (199).

Inspect gloves (157) and test glove boxes (208) before use.

Do not allow release of toxic substances in cold rooms and worm rooms, since these have contained recirculated atmospheres (209).

(c) *Choice of chemicals:* Use only those chemicals for which the quality of the available ventilation system is appropriate (13).

(d) *Eating, smoking, etc.:* Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present (22, 24, 32, 40); wash hands before conducting these activities.

Avoid storage, handling, or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations (23, 24, 226).

(e)*Equipment and glassware:* handle and store laboratory glassware with care to avoid damage; do not use damaged glassware (250. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur (25). Use equipment only for its designed purpose (23, 26).

(f) *Exiting:* Wash areas of exposed skin well before leaving the laboratory (23).

(h) *Horseplay:* Avoid practical jokes or other behavior which might confuse, startle or distract another worker (23).

(i) *Personal apparel:* Confine long hair and loose clothing (23, 158). Wear shoes at all time in the laboratory but do not wear sandals, perforated shoes, or sneakers (158).

(j) *Personal housekeeping:* Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day (24).

(k) *Personal protection:* Assure that appropriate eye protection (154-156) is worn by all persons, including visitors, where chemicals are stored or handled (22, 23, 33, 154).

Wear appropriate gloves when the potential for contact with toxic materials exists (157); inspect the gloves before each use, wash them before removal, and replace them periodically (157). (A table of resistance to chemicals of common glove materials is given p. 159).

Use appropriate (164-168) respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls (164-5), inspecting the respirator before use (169).

Use any other protective and emergency apparel and equipment as appropriate (22, 157-162).

Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken (155).

Remove laboratory coats immediately on significant contamination (161).

(l) *Planning:* Seek information and advice about hazards (7), plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation (22, 23).

(m) *Unattended operations:* Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substance in the event of failure of a utility service (such as cooling water) to an unattended operation (27, 128).

(n) *Use of hood:* use the hood for operations which might result in release of toxic chemical vapors or dust (198-9).

As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less that 50 ppm (13).

Confirm adequate hood performance before use; keep hood closed at all times except when adjustments within the hood are being made (200); keep materials stored in hoods to a minimum and do not allow them to block vents or air flow (200).

Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off" (200).

(o) *Vigilance:* Be alert to unsafe conditions and see that they are corrected when detected (22).

(p) *Waste disposal:* Assure that the plan for each laboratory operation includes plans and training for waste disposal (230).

Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (22, 24).

Do not discharge to the sewer concentrated acids or bases (231); highly toxic, malodorous, or lachrymatory substances (231); or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow (242).

(q) *Working alone:* Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous (28).

2. Working with Allergens and Embryotoxins

(a) *Allergens* (examples: diazomethane, isocyanates, bichromates): Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity (35).

(b) *Embryotoxins* (34-5) (examples: organomercurials, lead compounds, formamide): If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact.

Review each use of these materials with the research supervisor and review continuing uses annually or whenever a procedural change is made.

Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container.

Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

3. Work with Chemicals of Moderate Chronic or High Acute Toxicity

Examples: diisopropylfluorophosphate (41), hydrofluoric acid (43), hydrogen cyanide (45).

Supplemental rules to be followed in addition to those mention above (Procedure B of "Prudent Practices"' pp. 39-41):

(a) *Aim:* To minimize exposure to these toxic substances by any route using all reasonable precautions (39).

(b) *Applicability:* These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities (39).

(c) *Location:* use and store these substances only in areas of restricted access with special warning signs (40, 229).

Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) (40) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance (39); trap released vapors to prevent their discharge with the hood exhaust (40).

(d) *Personal protection:* Always avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate) (39). Always wash hands and arms immediately after working with these materials (40).

(e) *Records:* Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved (40, 229).

(f) *Prevention of spills and accidents:* Be prepared for accidents and spills (41).

Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity (39).

Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such tray or cover work and storage surfaces with removable, absorbent, plastic backed paper (40).

If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment (41).

(g) *Waste*: Thoroughly decontaminate or incinerate contaminated clothing or shoes (41). If possible, chemically decontaminate by chemical conversion (40).

Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite) (40).

4. Work with chemicals of High Chronic Toxicity

(Examples: dimethylmercury and nickel carbonyl (48), benzo-a-pyrene (51), N-nitrosodiethylamine (54), other human carcinogens or substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance) (47). (Procedure A of "Prudent Practices" pp. 47-50).

(a) *Access*: Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances, for which all people with access are aware of the substance being used and necessary precautions (48).

(b) *Approvals:* Prepare a plan for use and disposal of these materials and obtain the approval of the laboratory supervisor (48).

(c) *Non-contamination/Decontamination*: protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood (49). Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area (49, 50).

Decontaminate the controlled area before normal work is resumed there (50).

(d) *Exiting:* On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck (49).

(e) *Housekeeping*: Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance was a dry powder (50).

(f) *Medical surveillance:* If using toxicologically significant quantities of such a substance on a regular basis (*e.g.*, 3 times per week), consult a qualified physician concerning desirability of regular medical surveillance (50).

(g) *Records:* Keep accurate records of the amounts of these substances stored (229) and used, the dates of use, and names of users (48).

(h) *Signs and labels:* Assure that the controlled area is conspicuously marked with warning and restricted access signs (49) and that all containers of these substances are appropriately labeled with identity and warning labels (48).

(i) *Spills:* Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available (233-4).

(j) *Storage:* Store containers of these chemicals only in a ventilated, limited access (48, 227, 229) area in appropriately labeled, unbreakable, chemically resistant, secondary containers (48, 229).

(k) G*love boxes*: For a negative pressure glove box, ventilation rate must be at least 2 volume changes/hour and pressure at least 0.5 inches of water (48). For a positive pressure glove box, thoroughly check for leaks before each use (49). In either case, trap exit gases of filter them through a HEPA filter and then release them into the hood (49).

(l) *Waste:* Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel (49, 50, 233).

5. Animal Work with Chemicals of High Chronic Toxicity

(a) *Access:* For large scale studies, special facilities with restricted access are preferable (56).

(b) *Administration of the toxic substance:* When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters (56).

(c) *Aerosol suppression:* Devise procedures which minimize formation and dispersal of contaminated aerosols, including those form food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood) (55, 56).

(d) *Personal protection:* When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator) (56).

(e) *Waste disposal:* Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to non-toxic products (238); otherwise package the waste appropriately for burial in an EPA-approved site (239).

F. Safety Recommendations

The above recommendations from "Prudent Practices" do not include those which are directed primarily toward prevention of physical injury rather than toxic exposure. However, failure of precautions against injury will often have the secondary effect of causing toxic exposures. Therefore, we list below page references for recommendations concerning some of the major categories of safety hazards which also have implications for chemical hygiene:

1. Corrosive agents: (35-6)
2. Electrically powered laboratory apparatus: (179-92)
3. Fires, explosions: (26, 57-74, 162-4, 174-5,219-20, 226-7)
4. Low temperature procedures: (26, 88)
5. Pressurized and vacuum operations (including use of compressed gas cylinders): (27, 75-101)

G. Material Safety Data Sheets

Material safety data sheets are presented in "Prudent Practices" for the chemicals listed below. (Asterisks denote that comprehensive material safety data sheets are provided).

*Acetyl peroxide (105)
*Acrolein (106)
*Acrylonilrile (107)
Ammonia (anhydrous) (91)
*Aniline (109)
*Benzene (110)
*Benzo[a]pyrene (112)
*Bis(chloromethyl) ether (113)
Boron trichloride (91)
Boron trifluoride (92)
Bromine (114)
*Tert-butyl hydroperoxide (148)
*Carbon disulfide (116)
Carbon monoxide (92)
*Carbon tetrachloride (118)
*Chlorine (119)
Chlorine trifluoride (94)
*Chloroform (121)
Chloromethane (93)
*Diethyl ether (122)
Diisopropyl fluorophosphate (41)
*Dimehylformamide (123)
*Dimethyl sulfate (125)
*Dioxane (126)
*Ethylene dibromide (128)
*Fluorine (95)
*Formaldehyde (130)
*Hydrazine and salts (132)
Hydrofluoric acid (43)
Hydrogen bromide (98)
Hydrogen chloride (98)
*Hydrogen sulfide (135)
Mercury and compounds (52)
*Methanol (137)
*Morpholine (138)
*Nickel carbonyl (99)
*Nitrobenzene (139)
Nitrogen dioxide (100)
N-nitrosodiethylamine (54)
*Peracetic acid (141)
*Phenol (142)
*Phosgene (143)
*Pyridine (144)
*Sodium azide (145)

*Sodium cyanide (147)
Sulfur dioxide (101)
*Trichloroethylene (149)
*Vinyl chloride (150)

Appendix B to 1910.1450-References (Non-Mandatory)

The following references are provided to assist the employer in the development of a Chemical Hygiene Plan. The materials listed below are offered as non-mandatory guidance. References listed here do no imply specific endorsement of a book, opinion, technique, policy or a specific solution for a safety or health problem. Other references not listed here may better meet the needs of a specific laboratory. (a) Materials for the development of the Chemical Hygiene Plan:

1. American Chemical Society, Safety in the Academic Chemistry Laboratories, 4th edition, 1985.
2. Fawcett, H.H. and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd edition, Wiley-Interscience, New York, 1982.
3. Flury, Patricia A., Environmental Health and Safety in the Hospital Laboratory, Charles C. Thomas Publisher, Springfield IL., 1978.
4. Green, Michael E. and Turk, Amos, Safety in Working with Chemicals, Macmillan Publishing co., NY, 1978.
5. Kaufman, James a., Laboratory Safety Guidelines, Dow Chemical Co., Box 1713, Midland MI 48640, 1977.
6. National Institutes of Health, NIH Guidelines for the Laboratory use of Chemical Carcinogens, NIH Pub. No. 81-2385, GPO Washington, DC 20402, 1981.
7. National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington DC, 1983.
8. National Research Council, Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, Washington DC, 1981.
9. Renfrew, Malcolm, Ed., Safety in the Chemical Laboratory, Vol. IV, *J. Chem. Ed.*, American Chemical Society, Easlon, PA, 1981.
10. Steere, Norman V., Ed., Safety in the Chemical Laboratory, J. Chem. Ed. American Chemical Society, Easlon, PA 18042, Vol, I, 1967, Vol. II, 1971, Vol. III 1974.
11. Steere, Norman, V., Handbook of Laboratory Safety, the Chemical Rubber Company Cleveland, OH, 1971.
12. Young, Jay A., Ed., Improving safety in the Chemical Laboratory, John Wiley & Sons, Inc. New York, 1987.

(b) Hazardous Substances Information:

1. American conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes, P.O. Box 1937 Cincinnati, OH 45201 (latest edition).
2. Annual Report on Carcinogens, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington DC (latest edition).
3. Best Company, Best Safety Directory, Vols. I and II, Oldwick, N.J., 1981.
4. Bretherick, L., Handbook of reactive Chemical Hazards, 2nd editon, Butterworths, London, 1979.
5. Bretherick, L., Hazards in the Chemical Laboratory, 3rd edition, royal Society of Chemistry, London, 1986.
6. Code of Federal Regulations, 29 CFR part 1910 subpart Z. U.S. Govt. Printing Office, Washingotn, DC 20402 (latest edition).
7. IARC Monographs on the Evaluation of the carcinogenic Risk of Chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).
8. NIOSH/OSHA pocket Guide to Chemical hazards, NIOSH Pub. No. 85-11, U.s. Government Printing Office, Washington, DC, 1985 (or latest edition).
9. Occupational Health Guidelines, NIOSH/OSHA NIOSH Pub. No. 81-123 U.S. Government Publishing Office, Washington, DC, 1981.
10. Patty, F.F., Industrial Hygiene and Toxicology, John Wiley & Sons, Inc., New York, NY (five Volumes).
11. Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of Documents U.S. Govt. Printing Office, Washington, DC 20402.
12. The Merck Index: An Encyclopedia of Chemicals and Drugs, Merck and Company Inc., Rahway, N.J., 1976 (or latest edition).
13. Sax, N.I. Dangerous Properties of Industrial Materials, 5th edition, Van Nostrand Reinhold, NY., 1979.
14. Sittig, Marshall, Handbook of Toxic and Hazardous Chemicals, Noyes Publications, Park Ridge, NJ, 1981.

(c) Information of Ventilation:

1. American Conference of Governmental Industrial Hygienists Industrial Ventilation, 16th edition Lansing, MI, 1980.
2. American National Standards Institute, Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2-1979 American National Standards Institute, N.Y., 1979.
3. Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids, Professional Safety pp 15-18, April 1980.
4. National Fire Protection Association, Fire Protection for Laboratories Using Chemicals NFPA-45, 1982.

Safety Standard for Laboratories in Health Related Institutions, NFPA, 56c, 1980.

Fire Protection Guide on Hazardous Materials, 7th edition, 1978.

National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

5. Scientific Apparatus Makers Association (SAMA), Standard for Laboratory Fume Hoods, SAMA LF-71980, 1101 16th Street, NW., Washington, C 20036.

(d) Information on Availability of Referenced Material:

1. American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.
2. American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.

(Approved by the Office of Management and Budget under control number 1218-0131)
[FR Doc, 90-1717 filed 1-30-90; 8:45 am]
BILLING CODE 4510-26-M

APPENDIX G

Example LSPP

UNC CHARLOTTE

Department of Engineering Technology & Construction Management

Laboratory Safety Project Plan	
Project Name: Grant No.: Project Duration:	
Principal Investigator:	Co-Investigator(s):
Building / Room:	
Office Phone:	Lab Phone (If Applicable):
Identification of Hazards: (e.g. chemical, biological, physical (be specific))	
Required Training: Include EHS training (e.g. Laboratory Safety Training, Fire Safety Training, Radiation Safety Training, etc.), departmental training, and individual lab training.	
Medical Monitoring:	
Registrations/Notifications/Permits:	
Special Emergency Procedures	
List of Laboratory Personnel:	
Signature:	Date: