

Department of Engineering Safety Manual

WAKE FOREST UNIVERSITY

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1. Introduction

Working in an engineering laboratory can expose workers to a variety of mechanical, physical and chemical hazards. This manual outlines general safety principles, regulations to be followed, and specific protocols used by the Department of Engineering.

2. Regulatory Oversight

The University is regulated by a number of Federal agencies such as OSHA (Occupational Health and Safety Administration), EPA (Environmental Protection Agency) as well as state and local agencies. The regulations provide information to employers so they may advance a healthy and safe work environment. Failing to abide by the regulations can result in fines, suspension of licenses, loss of grant money, or other stiff penalties.

3. Engineering Department Responsibilities

a. Faculty Members

- Ensure that all personnel under supervision read this Safety Manual and follow all applicable safety procedures.
- Maintain written records indicating that they have provided lab-specific safety training for their personnel.
- Prepare a STANDARD OPERATING PROCEDURE (SOP) that documents lab-specific hazards. The SOPs must be available in the lab as supplements to this manual.
- Support the Engineering Department's efforts to comply with local fire department, state, and federal laws regarding hazardous substance management.
- Maintain an accurate online inventory of all chemicals in their lab areas.

b. Laboratory Manager

- Helps individual faculty identify and reduce hazards in their research labs.
- Oversees the department's training and certification programs, including (but not limited to) the initial job-specific training program, and annual safety review.
- Assists faculty members with fire and life safety compliance in conjunction with the EHS Department.

c. Environmental Health and Safety Department

- Informs departments of new regulations or significant changes to existing regulations.
- Assists departmental laboratory managers in identifying and correcting safety issues.
- Schedules and submits work orders for monthly and annual inspections of fire protection equipment, including extinguishers, safety showers, and eye wash stations.
- Manages chemical disposal.
- Provides a portion of the safety training for all employees, and components of specialized training as applicable.

4. Preparing for Work in the Engineering Laboratory

Prior to beginning work in the lab, Faculty, Staff and Students are required to complete online safety courses provided through the EHS Department. To sign up for the appropriate courses complete the [Training Request Form](#).

The specific lab in which you are working may require additional training provided by the faculty member or designee. This is especially true if you will be using any machinery in the lab.

If you are working with chemicals within the lab you must also review the [WFU Chemical Hygiene Plan](#). The Plan reviews policies, procedures and responsibilities that protect faculty, staff and students from the health hazards associated with the hazardous chemicals within their particular lab. All lab workers must review those portions of the plan pertinent to their work and to any areas in the lab that may present hazards. The Plan is available on the WFU EHS website.

a. Machine Safety

The Engineering Department operates a number of machines within laboratory spaces. Moving machinery can cause injuries or death in a number of ways.

- Individuals can be struck and injured by moving parts of machinery or ejected material.
- Loose clothing and body parts can be drawn in or trapped between rollers, belts and pulley drives. Crushing or shearing can occur when moving parts together or towards a fixed part of the machine or wall.
- Sharp edges can cause cuts and severing injuries, sharp-pointed parts can cause stabbing or puncture the skin, and rough surface parts can cause friction or abrasion.
- Machine parts can heat during use and may potentially cause skin burns.
- Many machines run on electrical power, allowing for potential electrical shock and burns.
- Injuries can also occur due to machinery becoming unreliable and developing faults or when machines are used improperly through inexperience or lack of training.

Prior to using any machinery you must first be trained by an experienced user who has been approved by the Department Faculty to provide the training. You should read the instruction manual for the machine prior to beginning training. The trainer will make the determination as to your readiness to use the machine.

It is important to be aware of warning and hazard signs located on and around machinery. The most common signs are the following:



Rotating Parts



Hot Surface



Crushing



Flying Debris



Haz Voltage

As of Fall Semester 2020, the Engineering Department machinery included:

- i. M-Prep 5 Grinder/Polisher – used for manual grinding/polishing of prepared samples. It is possible to entangle hands or fingers in the moving parts. Stop operating and use caution before reaching into the machine or changing plates. Protective eyewear should be worn while operating this machine.
- ii. Omega-RT Manual Rockwell Hardness Tester – the hardness tester should not pose any significant hazards, but eyewear is recommended in the event the sample breaks.
- iii. BYK Heavy-Duty Impact-Tester – the impact test requires dropping heavy weights from significant height. The weight hits the sample with tremendous force. No portion of the operator's body or clothing should be in the impact area during a test. Test samples may explode when impacted. Eye protection must be worn while operating this device.
- iv. Tinius Olsen ST-Series Materials Testing Machine – this machine applies high forces intended to break specimens. Specimens can shatter, emitting projectiles. A shield should be in place to block projectiles, and protective eyewear must be worn when using this machine. Grips and other tooling are heavy. Be careful not to strain muscles and request assistance if necessary.
- v. Armfield Fluid Mechanics Bench – the bench involves the use of water, which under certain conditions can create a health hazard due to infection by harmful micro-organisms. Any water contained within the product must not be allowed to stagnate. Any rust, sludge, scale or algae on which micro-organisms can feed must be removed regularly, i.e. the equipment must be cleaned regularly. The unit operates from a main voltage electrical supply. The equipment is designed and manufactured in accordance with appropriate regulations relating to the use of electricity. If the unit fails to operate properly or you notice potential electrical problems (i.e. frayed wiring, burning smell) DO NOT USE the unit. Take out of service until qualified repairs can be made.
- vi. CNC Milling Machine - machining process which employs computerized controls and rotating multi-point cutting tools to progressively remove material from the workpiece and produce a part or product. Mills can pose a potential eye injury threat as rotating blades cut away material which can be thrown or ejected at high speed. Rotating machinery has the potential to grab loose clothing, jewelry, or hair. Keep hands, tools, and clothing at least a foot from the moving mill. Do not wear gloves near the mill. Be sure to wear safety glasses.
- vii. 3D Printers – extrudes molten plastic through a computer controlled nozzle, printing successive layers to build a three-dimensional object. Primary hazards are heat and high voltage. Chemical vapors may be hazardous depending on media used.
- viii. Compound miter saw – compound saws allow for blade tilt up to 45°. Main hazard is to operators hands which may result in severe cuts or amputations if they contact the moving blade. Be sure all guards are in place and functioning prior to use. A guide stick is recommended to direct material to the blade.

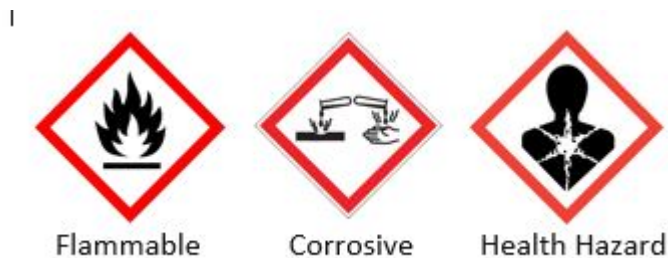
This list is not exhaustive and additional equipment and machinery are located in research labs.

b. Chemical Safety

Most Engineering labs will have a limited number of chemicals for use in teaching and research. These chemicals can still pose physical and health hazards and must be treated with caution. If you are using

chemicals in the lab be sure to review the [WFU Chemical Hygiene Plan](#) located on the EHS website under “Laboratory Safety” section.

The primary hazards associated with chemicals used in Engineering are Flammability, Corrosivity and Toxicity. The following pictograms will be on the respective container so you can readily identify the hazard.



A current list of chemicals, the quantities, and their locations must be maintained by each lab. The WFU chemical inventory system, [Vertere](#), is available on-line. Call the EHS Department if you need access.

The Safety Data Sheet (SDS) must be available for each chemical. WFU uses an [on-line SDS system](#) that encompasses nearly all global Safety Data Sheets. Access is available through the EHS website. See Appendix A for instructions.

All primary and secondary containers of chemicals must be labeled appropriately. Do not remove the label from a primary chemical container. Secondary containers must be labeled as described in the WFU Chemical Hygiene Plan, Section V.B.2.

Fume hoods are to be used whenever working with a chemical that has the potential to produce airborne dust, vapors or fumes.

i. Chemical Waste

Chemical waste is to be collected in designated containers for proper disposal. Be sure waste collection containers are:

- properly marked with the contents
- do not contain materials that are incompatible with the container or each other, and
- the container is closed when not adding waste.

Do not remove waste from laboratories. The EHS department will collect chemical waste on a weekly basis. If you need the waste removed prior to normal pick up call the EHS office at x3427.

5. Personal Protective Equipment

Personal Protective Equipment (PPE) provides a physical barrier between a chemical or physical hazard and the wearer. In the Engineering laboratory, the main types of protective equipment are eyewear and gloves.

It is the responsibility of the Faculty or designee to conduct a complete assessment to determine PPE requirements within the lab. A full review must be made of hazards that may require protection from both

chemical and physical hazards. This review should be task specific, so that the requirements are known prior to beginning work. Proper PPE is to be provided to laboratory personnel at no cost to those personnel. The Faculty member or designee is also responsible for training those under their direction on the proper use and function of PPE. This includes identification of proper PPE for the hazard, donning and doffing PPE, decontamination (if applicable), and disposal. The Faculty must ensure that lab personnel follow all PPE rules, and Faculty must also conduct an annual assessment to confirm the requirements are still applicable to hazards.

a. Eye Protection in the Lab

Eye protection is required at all times in the laboratory and where hazards to the eye may exist. This includes splashes, sprays, aerosols, dust, powder, fumes and vapor. Safety glasses with side shields are appropriate for situations where there is no risk of fumes or vapors. In cases where fumes or vapors may be present, safety goggles must be worn, as these provide much better protection against these hazards.

i. Standard Safety Glasses

Safety glasses with side shields afford the minimum protection for use in the lab. Safety glasses are available that will fit over prescription glasses. Standard prescription glasses are not a substitute for safety glasses. Prescription glasses with safety lenses must also have side shields.

ii. Eye Protection from UV radiation

Ultraviolet (UV) radiation can damage skin and eyes. In the lab, common sources of UV radiation are UV light boxes or UV Transilluminator, UV Crosslinkers, and Germicidal Lamps. Eye exposure to UV radiation can damage the cornea and cause lesions. Standard prescription eyewear, standard safety glasses, and goggles do not protect against UV radiation. Protective eyewear must be ANSI-Z87 rated to provide proper UV protection. This marking will be stamped onto the eyewear. Contact the safety glass manufacturer before you use the protective eyewear if you are unsure.

iii. Eye Protection from Lasers

The focused energy of lasers has the ability to cause corneal, lens and retinal damage to the eye. It is important to note that no single safety lens material is effective against all wavelengths or for all radiation. Protective eyewear should provide maximum attenuation of the laser and transmit the maximum amount of ambient light. When choosing protective eyewear consider the parameters of the operation, the wavelength and the Maximum Permissible Exposure (MPE). The MPE has been set by ANSI Z136.1

b. Skin and Hand Protection

i. Proper clothing

Always wear clothing that adequately covers the torso and legs. Shorts are not permitted in the lab. Loose clothing should not be worn as it could easily become caught on equipment, come in contact with chemicals or catch fire. Natural fiber clothing is recommended over synthetic fiber, as synthetic fiber will melt to the body in the event it catches fire. Open toe and open top shoes are prohibited in the lab. Always wear shoes that cover the entire foot, and preferably have a rubber non-slip sole.

ii. Gloves

Since skin exposure, cuts and abrasions are most likely to occur at the hand, it is imperative that the correct glove be used whenever encountering a chemical or physical hazard. Gloves should never be worn outside of the laboratory unless required for safety reasons (i.e. transporting autoclaved material). Never touch items

with gloves that will be touched with ungloved hands. This includes light switches, elevator buttons, computers, and phones.

iii. Gloves for Mechanical Hazards

Gloves used to protect hands from mechanical hazards are based on the potential for cuts or abrasions. If cuts and slices are the main hazard (i.e. using a razor) the gloves should be made of cut-resistant material. If abrasions or impact are the main hazard a heavy-duty work glove should be used. Since these gloves are typically used repeatedly they should be assigned to individuals if possible.

iv. Gloves for Chemical Hazards

Nitrile gloves generally provide the best overall protection for the widest range of chemicals. Be sure to blow into the glove before use to check for pinhole leaks. When removing disposable Nitrile gloves, be sure not to touch exposed skin with the gloved fingertips. Turn gloves inside out when removing. Disposable nitrile gloves are never to be re-used, and should be replaced on a regular basis even if there is no obvious deterioration.

6. Laboratory Signs

Each laboratory door is marked with a Space Hazard Sign. The Space Hazard Sign indicates the chemical and physical hazards present within the space and includes emergency contact information. These signs were developed by EHS with the assistance of the Faculty. It is the Faculty responsibility to ensure the information on the Space Hazard Sign is correct. Any changes to chemical or physical hazards in the lab will be provided to EHS so an updated sign can be created.

Exit signs are posted throughout each building. Exit signs are backlit to provide visibility in the event of a power outage. Always know the location of at least two exits from a building. This allows for a safe evacuation from a building in the event the primary exit is blocked. Emergency equipment signs are posted to identify the location of safety showers, eyewash stations, and fire extinguishers.

7. Training

All personnel must have initial job-specific safety training, as well as annual refresher training. The minimum initial training must include an introduction to physical and chemical hazards associated with the working environment. Faculty, Staff and Students are required to complete online safety courses provided through the EHS Department. To sign up for the appropriate courses complete the [Training Request Form](#).

Additional training for specific lab hazards is to be completed by the Faculty member and recorded on the [Research Laboratory Training Checklist](#). The completed checklist for each lab worker should be maintained in the Lab Compliance Kit.

Each laboratory should have Lab Compliance Kit. This binder is the central repository for hard copy documentation required in the lab (aside from SDS), as well as a point of reference on laboratory safety. The kit should always have an updated copy of the Engineering Safety Plan along with all SOP's appropriate to the lab. In addition, the kit should hold copies of all signed training checklists for personnel currently working in the laboratory.

8. Emergencies

a. Medical Assistance

i. First Aid

First aid kits are available in each Engineering Lab as well as in the break area kitchen on each floor of Building 60. Be sure you alert the Lab Manager if the first aid kit needs to be restocked. The first aid kit is for minor, non-life threatening injuries. However, it is still required that a First Report of Injury form be completed by the injured person and Faculty member. The form is located on the [Human Resources](#) website.

ii. Injuries Requiring Medical Attention

For any life-threatening injury, immediately call 911, or x5911 on a campus phone. Describe the victim's injury, your location (building, floor, room), and a phone number the 911 operator can call if the line becomes disconnected. Never leave the victim alone. Direct another individual to call 911 if you are not near a phone, and have an individual meet arriving medical personnel and bring them to the victim. Be sure to protect yourself before administering any assistance. Don gloves, eye protection, and lab coat, if necessary, to avoid potential chemical contact and to avoid blood contact. For non-life threatening injuries that require medical attention, undergraduate and graduate students should proceed to the Student Health Center. Be sure to inform the Faculty that an injury has occurred, and at the earliest opportunity complete the [First Report of Injury](#) form. Employees injured in the lab should alert their supervisor and proceed to the Wake Forest University medical provider:

Novant Health Urgent Care and Occupational Medicine

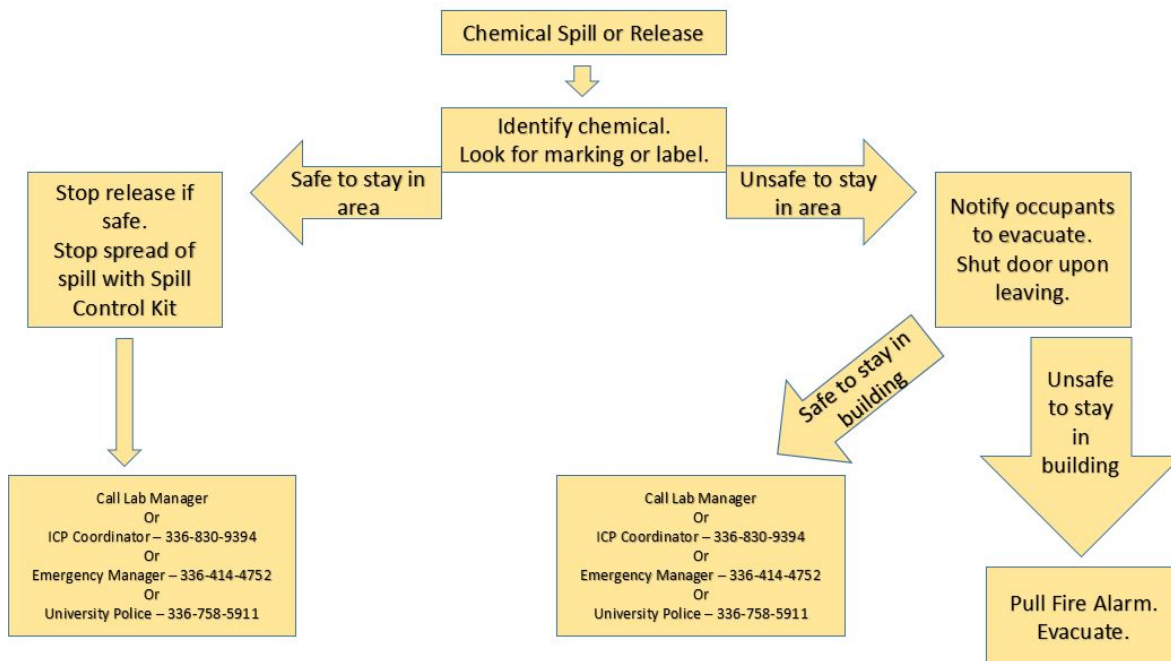
7811 North Point Blvd. Winston-Salem, NC 27106

336-281-5965

b. Chemical Spill or Release

Spills or releases of hazardous materials, fires, and weather related events also constitute emergencies that will require proper action to minimize potential consequences.

Follow the flow chart to determine the course of action if there is a chemical spill or release.



i. Flammable Liquid Spill

Flammable liquids with flash points less than 140F pose a fire hazard when spilled. Open flames in the area should immediately be extinguished and any operations that may cause sparking must be stopped during clean up.

ii. Corrosive Liquid Spill

Corrosive spills can cause damage to living tissue on exposure to skin, and may burn lungs and trachea upon inhalation of vapors. Set fume hoods to Emergency Exhaust to assist in removing vapors.

iii. Toxic Chemical Spill

Toxic chemicals can cause both acute and chronic health issues and in some cases may lead to permanent injury or death. Any spilled substance that is a poison by inhalation hazard requires immediate evacuation of the lab. Only trained personnel from EHS, WSFD, or approved contractor may clean up spills of poison by inhalation. Other toxins may only be cleaned by individuals trained to do so, and who are wearing appropriate PPE to prevent exposure.

iv. Gas Cylinder

Leak from compressed gas cylinders can be life threatening by asphyxiation, poisoning, and / or explosion. Immediately evacuate the area and notify Lab Manager or Security.

v. Cleaning a Minor Spill

Minor spills in the laboratory can be cleaned using chemical spill kits available in each department. Ask the Lab Manager for the location of the nearest spill kit to the lab. A minor spill is one that would require no more than one person and no more effort than general housecleaning to clean. Refer to the SDS for proper spill clean-up procedure. Report minor spills to the Lab Manager so spill kit materials used during clean-up can be replenished if necessary. Collected spill material must be containerized and labeled as waste, and include the proper chemical name. Contact EHS to have the spill container removed from the lab.

c. Fire

Uncontrolled fire in the laboratory is life threatening due to the storage of potential sources of fuel and oxygen located in many labs that may add to a conflagration. Use a fire extinguisher only if you know the type of fire that has occurred (chemical, electrical, paper, etc.), you have the correct extinguisher for the fire, and the fire is not an immediate threat to life or health.

i. Fire Extinguisher Use

To operate a fire extinguisher, remember the word PASS:

1. **Pull** the pin. Remove the fire extinguisher pin by pulling firmly.
2. **Aim** low. Point the extinguisher nozzle at the base of the fire.
3. **Squeeze**. Slowly and evenly squeeze the handle.
4. **Sweep**. Sweep the nozzle back and forth at the base of the fire.

Before using a fire extinguisher, notify all lab occupants to evacuate. Pull the fire alarm. The building must be evacuated in the event it becomes too large to be extinguished with the fire extinguisher. Always keep your back to a clear exit when using the fire extinguisher. This will ensure an unimpeded escape route should the fire continue to grow. If you feel that your life is in danger, do not use the fire extinguisher. Instead, pull the fire alarm and evacuate the building.

ii. Fire Prevention

Fire prevention is accomplished by reducing its potential through education, the observation of safe work practices, housekeeping and inspections. The fire prevention guidelines include:

- Observe proper housekeeping by keeping work areas uncluttered and clean
- Be cognizant of the location and use of all emergency equipment (such as fire extinguishers, eye washes, and safety showers) in the laboratory
- Always plan laboratory work before executing it. You should understand the hazards associated with the chemicals involved before you start the experiment. The majority of lab fires have resulted from mental or procedural errors or carelessness.
- Minimize materials and avoid accumulating excessive paper products and corrugated materials. This minimizes fire risk and reduces costs and waste. Do not store combustible items such as paper and cardboard against electrical panels, in telephone closets, stairwells, and corridors
- Do not store large quantities of flammable, combustible liquids and gases outside a flammable storage cabinet
- Avoid using extension cords and maintain electrical equipment in good working order. Periodically check for potential electrical hazards such as frayed cords, broken plugs and overloaded electrical outlets.
- Do not block exit doors or emergency equipment.
- Observe restrictions on equipment (keep solvents only in an explosion-proof refrigerator)
- Keep barriers in place (shields, hood doors, lab doors)

d. Weather Related Emergencies

Due to the unpredictability of weather, weather related emergencies can develop slowly or very rapidly. It is important to always be prepared in the event of a sudden emergency to lessen potential hazards.

i. Tornadoes and Severe Thunderstorms

Both tornadoes and severe thunderstorms exhibit high velocity winds that are capable of throwing objects hundreds of yards, with the potential for broken windows, flying glass, and downed trees and power lines. Wind speeds for tornadoes are generally higher than that of the straight line winds associated with severe thunderstorms. Be alert to changing weather conditions, especially in spring and summer months, when tornadoes and severe thunderstorms are most prevalent. If a tornado alert is issued for the campus, the University [Wake Alert System](#) will notify all faculty, staff and students via e-mail and text message. Immediately shut off any open flames and turn off all nonessential electrical items. Evacuate the lab into the hallway and close the lab door as you leave. If time permits, go to the lowest floor and innermost part of the building and wait for instructions.

ii. Winter Weather

Winter weather ice or snow storms generally provide advanced warning prior to arrival. Winter storms have the ability to cause power outages and make roads impassable for periods of time. Prepare the laboratory prior to arrival of a winter storm. The lab should be secured as if it were to be unoccupied for at least three to four days. This means that only absolutely essential items may be powered on, and must be able to operate safely without attention for at least three to four days. No experiments or operations should be left that will require attention by lab personnel as travel may be impossible.