

GLP ACTIVITIES STANDARD OPERATING PROCEDURES

BIOMECHANICS AND BIOMATERIALS LABORATORIES

*Multidisciplinary Research Building
Department of Aerospace and Mechanical Engineering
University of Notre Dame*

TITLE: Guidelines for Safe Laboratory Practices

A. DESCRIPTION

This SOP describes guidelines for safe laboratory practices, including emergency procedures, the use of personal protective equipment, general guidelines and specific guidelines for high temperature, chemical and biological safety. The goal of safe laboratory practices is that you conduct yourself and your experiments in a responsible manner so as not to endanger you or your co-workers.

B. EMERGENCY PROCEDURES

- 1) CALL 911 to contact emergency services. If you are in doubt as to the severity of the emergency, CALL 911!
- 2) FIRE. In the event of a fire or fire hazard, such as uncontrolled combustion of a chemical or material, a hazardous gas leak or chemical spill, smoke or the odor of burning, immediately follow these procedures:
 - ACTIVATE the building fire alarm. If not possible or not functional, verbally notify persons in the building.
 - CALL 911. Provide the operator with your name, location, the nature of the emergency, the identity and amount of any chemicals involved.
 - ISOLATE the area and EVACUATE the building. If possible, shut down equipment in the area. Close doors to the area. Use a portable fire extinguisher to evacuate yourself and/or others, or to control a small fire (e.g., size of waste paper basket). DO NOT attempt to put out a larger fire with the portable fire extinguisher.
 - NOTIFY the fire and/or police department respondents with details of the problem upon their arrival including the nature of the fire hazard and chemicals involved.
 - STOP, DROP AND ROLL. If you or someone else is on fire, drop to the ground and roll. A jacket or blanket may also be useful to smother the flames while on the ground.

3) INJURY.

- If an ambulance is needed, CALL 911. If you are not sure, CALL 911.
- Do not move a seriously injured person unless he or she is in further danger if not moved.
- If someone is not breathing, do not administer artificial respiration unless you are trained. ALWAYS call 911 first. The operator at 911 will assist you in taking appropriate actions.
- Provide emergency and medical personnel with your name, location, the nature of the emergency, the identity and amount of any chemicals involved, the area(s) of the body affected and symptoms (e.g., not breathing, redness and swelling of skin, etc.).
- Do not touch someone who has been electrocuted unless the power source has definitely been shut off.

4) Familiarize yourself with the location and operation of exits, telephones, fire alarms, fire extinguishers, first aid kits, safety showers and eye washes in case of an emergency.

C. PERSONAL PROTECTIVE EQUIPMENT (PPE) AND DRESS

1) Protective eyewear must be worn at ALL times in ALL laboratories.









For example, when I was a graduate student, I was using a Dremel tool to clean the edges of a small piece of metal – a seemingly harmless task. Something hit my eye which I initially ignored. The pain became excruciating a day later and physician had to cut a piece of metal from my eye in the emergency room. I could have permanently damaged my eyesight. I was fortunate, but too many are not, losing all or partial eyesight. The risk is not worth taking.

- 2) ALL laboratory personnel are responsible for becoming familiar with the PPE that may be necessary beyond eyewear, such as gloves, masks, respirators, goggles, face shields, gowns, lab coats, etc. If you do not feel the PPE available to you is adequate to prevent the risk of exposure, the Director of your lab to obligated to provide additional equipment.
- 3) PPE, in particular laboratory gloves, should NEVER be worn outside the laboratory in hallways, offices, bathrooms, etc. NEVER touch door handles or instrument controls with gloves. ALWAYS wash your hands before exiting the laboratory.
- 4) Long hair, dangling clothing and jewelry must be tied back or otherwise secured.
- 5) Open-toe shoes (e.g., sandals or flip-flops) may not be worn in any laboratory. If you like to wear open-toe shoes, leave a pair of closed-toe shoes in your office for working in the lab.

D. GENERAL PRACTICES

- 1) The most important practice anyone can follow is to do nothing until you are certain that what you are doing is safe. NEVER ASSUME that what you are doing is safe. When in doubt ask technical staff, more experienced graduate students, postdocs or faculty. A list of qualified Laboratory Managers and Directors is provided in Table 1.

Table 1. Laboratory Managers and Directors for the Biomechanics and Biomaterials Laboratories in the Multidisciplinary Research Building. Note that this table is posted and will be periodically updated on the Resources page of the AME BIO group website (<http://www.nd.edu/~amebio/resources/index.html>).

Room	Laboratory	Manager(s)	Director(s)
110	Micromechanics	Connie Slaboch Michael Giordano	Timothy C. Ovaert Steven R. Schmid
114	Manufacturing	Tim Rodts	Steven R. Schmid Timothy C. Ovaert
115	Tribology	Michelle Michalenko Kyle Jones	Timothy C. Ovaert Steven R. Schmid
118	 Mechanical Testing	Jackie Garrison (Instron) Travis Turnbull (Bose) Bob Kane (MTS)	Glen L. Niebur Ryan K. Roeder
203	Cell & Tissue Culture	Carly Kemmis Bob Kane	Diane R. Wagner Ryan K. Roeder
206	 Biomaterials Processing	Ryan Ross Tim Conrad	Ryan K. Roeder
207	 Histology & Specimen Preparation	Christina Merrill Jackie Garrison	Ryan K. Roeder Glen L. Niebur
207A/B	 Biological Tissue	Jackie Garrison Justin Deuerling	Glen L. Niebur Ryan K. Roeder
210	 Biomedical Imaging	Justin Deuerling (microscopy) Zach Kaltz (micro-CT) Xiutao Shi (computers)	Ryan K. Roeder Glen L. Niebur
211	 Tissue Engineering & Mechanics	Carly Kemmis Nathaniel Hollingsworth	Diane R. Wagner
216A	 Cardiovascular Biology	Daniel Hoehn	Philippe Sucusky
216B	 Flow Diagnostics	Daniel Hoehn	Philippe Sucusky

- 2) Unfortunately, accidents will happen. NEVER try to cover up an accident. Report accidents to the Laboratory Manager and/or Director (Table 1) as soon as safely possible. If there is an immediate danger, refer to section B. EMERGENCY PROCEDURES. Alert all other personnel near the accident if they may be in danger.

- 3) Avoid working alone on hazardous experiments in laboratories after regular hours and on weekends. Normal building hours are from 8 a.m. to 5 p.m. Monday through Friday except for University holidays. As a first course of action when working alone in the lab after hours, notify other students or faculty who happen to be present in the building and who can check on you in case of an accident. If no one else is present in the building, let someone off-site know (e.g., spouse, roommate, fellow student or faculty member) who can check on you if you do not return at an expected time.
- 4) NEVER dispose of broken glass, scalpel blades or other sharps in a trash can or leave them on countertops or floors. Dispose of them in a designated sharps or broken glass container.
- 5) Label all unattended experiments with the full name of all chemical contents (even water), your name or initials, a phone number where you can be reached, the time/date that the experiment began and is expected to end, and any potential hazards, such as high temperature or pressure, explosion, radiation, etc.
- 6) ALL tools, glassware and apparatus from a completed experiment must be cleaned and returned to their proper place of origin or storage the same day as used.
- 7) If you place glassware in a dishwasher, sink or drying rack, you are responsible for removing it. Signs will be posted on dishwashers indicating whether contents are “clean” or “dirty.”
- 8) If you deplete the supply of chemicals, gas cylinders or disposable lab supplies, you are responsible for ordering replacements or notifying someone who can (Table 1).
- 9) ALWAYS treat the experiments and belongings of others as you would want them to treat yours.
- 10) ALL table tops and cabinets must be kept orderly and clean.
- 11) NEVER use equipment for which you have not received training. Ask the Laboratory Manager or Director (Table 1) for training if you wish to use equipment in that lab.
- 12) Sign all equipment log books and treat equipment as you would your own child!
- 13) NEVER alter controls or settings on equipment without understanding what you are doing.
- 14) When grinding or polishing small specimens, use specimen holders or mounting to prevent grinding down your finger tips. Since the skin removal is gradual, you may not feel anything until you hit a nerve!
- 15) ALWAYS use water or oil-based fluids when cutting, grinding or polishing in order to keep the specimen cool and contain potentially hazardous dust.
- 16) NEVER look directly at ultraviolet radiation in biological safety cabinets or the microscope.

- 15) BE AWARE of what others around you are doing. If they are doing anything unsafe, or in direct violation of the guidelines in this document, confront them immediately and report the incident to the Laboratory Director. Lab safety is too important to avoid such confrontation.

E. HIGH TEMPERATURE SAFETY

- 1) ALWAYS use caution handling materials or equipment in and around ovens or furnaces. Materials heated up to 800°C will not look hot but will burn very badly. Place your hand near the object before touching to ascertain whether or not it is hot.
- 2) High temperature gloves and/or tongs should be used to handle hot objects or materials.
- 3) ALWAYS place a warning sign near any materials, objects or equipment that are hot.
- 4) Red hot graphite will ignite if placed in open air.
- 5) Ceramics materials should be heated and cooled gradually to avoid thermal shock.
- 6) ALWAYS wear a face shield, high temperature gloves and fireproof coat when working with molten metals. NEVER allow molten metal to contact water or add cold scrap to molten metal.

F. CHEMICAL SAFETY

- 1) When mixing or handling chemicals, including acids, bases or solvents, personal protective equipment should ALWAYS include protective eyewear with side-shields, gloves and a laboratory coat, AT MINIMUM. Disposable latex gloves are suitable for organic solvents, powders or weak acids/bases. Rubber or nitrile gloves are required for strong acids/bases. ALL laboratory personnel are responsible for becoming familiar with additional personal protective equipment that may be necessary (e.g., breathing apparatus) as indicated in the material safety data sheet (MSDS).
- 2) If chemicals contact your eyes, call for help and then flush in the eyewash station for at least 15 minutes.
- 3) ALL stored chemicals must be properly labeled and inventoried. A MSDS must be kept on file in the lab where chemicals are used and stored. An Excel spreadsheet for chemical inventories is posted and will be periodically updated on the Resources page of the AME BIO group website (<http://www.nd.edu/~amebio/resources/index.html>).
- 4) ALL vessels containing chemicals, especially chemical waste, must be labeled with the full name of ALL chemical contents (even water), your name or initials, and the date.

- 5) ALWAYS refer to the MSDS and/or Merck Index for information regarding personal protective equipment, handling procedures, spill containment and potential hazards, BEFORE using any chemicals. If you are still uncertain of the hazards or precautionary measures to be taken, contact the Laboratory Manager or Director (Table 1).

For example, suppose methanol (CH_3OH) and nitric acid are to be mixed as an etchant for a metal specimen. You look in the solvent cabinet and find that the methanol has been depleted (see Section D, guideline 8), but there is propanol which has a similar chemical structure ($\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$). This could be a tempting but tragic mistake. Propanol plus nitric acid has been used as a rocket propellant. In 1993, such a mistake gave a student at Michigan State 500 stitches and student working nearby temporarily lost use of his right arm. Too many similar mishaps have been documented.

- 6) ALL bottles, chemicals and waste containers must be capped or sealed when not in use. Acceptable containers for storage include glass or polyethylene vessels (see MSDS) with screw caps. Flasks and beakers should only be used for short term experiments and temporary storage (no more than several days).
- 7) ALL chemicals must be transported in capped or sealed containers. NEVER remove chemicals from a laboratory without permission of the Laboratory Manager and/or Director (Table 1).
- 8) Large volumes of acids or bases must be transported in approved safety containers which confined spills or broken bottles in the event of an accident. DO NOT simply carry glass jugs in the hallway.
- 9) Acids, bases and solvents must be stored in separate spaces. ALL flammable liquids and solvents must be stored in a solvent cabinet. NEVER mix or store oxidizers (e.g., nitric, perchloric, chromic acids or peroxides) with any organic liquid. This is an extremely dangerous explosion hazard.
- 10) ALWAYS add acid/base slowly to water, and NOT vice versa. NEVER add solids to hot liquids, which can result in violent boiling if the liquid is superheated. Add solids before heating the liquid.
- 11) ALWAYS keep flammable liquids and solvents away from a potential ignition source.

In the summer of 2005, ethanol was accidentally spilled onto a hotplate which resulted in auto-ignition. Fortunately, no one was injured because the student had already taken the precaution of conducting the experiment in a chemical hood which contained the spill/fire and responded according to the emergency procedures outlined above for a laboratory fire.

- 12) NEVER put chemicals back into the storage bottle. This will contaminate the contents.
- 13) NEVER leave a mess. Clean up any and all spilled chemicals. Clean the area where you were working after you are done even if you don't think you spilled anything. For example,

mass balances should always be left spotless when you are done! Always leave the lab cleaner than you found it.

- 14) Major chemical spills must be reported immediately to the Laboratory Manager and/or Director (Table 1) and cleaned following instructions in the MSDS. If the spilled chemical presents a fire or health hazard, call 911 and refer to section B. EMERGENCY PROCEDURES. Concentrated acids should be diluted with water or neutralized with sodium bicarbonate before cleaning. Paper towels used to clean up organic solvents should be placed in the chemical hood to evaporate the solvent before placing them in the trash.
- 15) ALWAYS open and use volatile chemicals, such as acetic acid and ammonia, under a chemical hood. The chemical hood is also a good place to mix chemicals that could pose a spill hazard.
- 16) ALWAYS close the sash of chemical hoods when you step away, even for a moment. NEVER stick your head into the hood for any reason.
- 17) ALWAYS use the minimum volume of hazardous chemicals necessary to perform your experiment.
- 18) NEVER heat a closed system.
- 19) All hazardous chemical waste must be disposed of in a properly labeled (see guideline 2, above) container in a designated chemical waste area. Use a funnel to add waste to a narrow mouth bottle. Arrange a chemical waste pickup by calling the Risk Management and Safety Office at 1-5037.
- 20) Most water soluble chemical waste can be disposed in the sink. Concentrated acids and bases should be diluted by a factor of at least ten, before disposing in the sink with running water. (Remember, add acid to water.) The following should not be put down the sink: powder slurries or dispersions; water soluble lead, silver, barium, cadmium, chromium, mercury, selenium or arsenic compounds; organic solvents; organometallic compounds; and compounds containing cyanide.
- 21) Rinse empty chemical bottles at least three times before disposing or using for chemical waste storage.
- 22) Perchloric and hydrofluoric acid pose special hazards and may not be used without approval of the Laboratory Director.
- 23) Do not use mercury thermometers. Replace them with modern thermometers. Report mercury spills immediately to the Risk Management and Safety Office at 1-5037.
- 24) Compressed gas cylinders should be placed ONLY in designated racks or clamps with secure chains or straps both in the laboratory and loading dock. ALWAYS use a regulator when dispensing gas from a compressed gas cylinder. Open valves slowly. Compressed gas

cylinder should be transported ONLY with the valve cap securely in cap in place using a designated cart with secure chains or straps in the freight elevator.

Compressed gas cylinders weigh up to 100 lbs. If the valve is opened without a regulator or the regulator is broken off in a fall, the cylinder will become a violent projectile, indiscriminately striking equipment and people. Gas cylinders have been known to carry enough velocity to travel through cement block walls!

- 25) Know whether the gas you are using is heavier or lighter than air. Avoid using gases in small spaces as any gas can cause asphyxiation.

G. BIOLOGICAL SAFETY

- 1) ALL biological tissue or fluids, such as bone, tendon, cartilage, etc., should be treated as potentially infectious. ALL space and equipment within designated biohazard labs (Table 1) should be considered as potential biohazard areas. If you have not been trained to work with biohazardous substances, or do not wish to be exposed to biohazardous substances, you must not work in these areas.
- 2) TRANSPORTATION: Appropriate engineering controls should be used when transporting or handling biological samples. The samples should be treated as biohazard, regardless of your knowledge of the sample source.
 - Biological samples that are being transported between laboratories must be in closed containers that you can carry without wearing gloves.
 - Biological samples that have not been dried or otherwise embedded must be in closed containers when in a laboratory other than those designated for biohazards (Table 1).
 - Human samples for the micro-CT should be in closed covered containers before they are taken into the Biomedical Imaging Laboratory (room 210). Place the biohazard sign next to the scanner if you are scanning fresh human tissue.
 - When transporting biological samples to the Mechanical Testing Laboratory (room 118), be certain that the area around the testing system you are using is clearly marked as a biohazard area.
- 3) PPE: Barrier protection should ALWAYS be used to reduce the risk of exposure to biohazardous materials, including, AT MINIMUM, latex or nitrile gloves, gowns, shoe covers and safety glasses.
 - Face shields or goggles must be worn when using the band saw.
 - Use two pairs of latex gloves whenever working with large samples, or sharp objects.
 - If you do not feel the PPE available to you is adequate to prevent the risk of exposure, ask the Laboratory Director (Table 1) to provide additional equipment.
 - NEVER wear PPE outside of designated biohazard areas.

- 6) When working in the wet labs, use blue absorbent pads to protect counter surfaces. Mark the pad with your initials and the date, so it is clear who is responsible for the mess.
- 7) If you will be leaving the immediate area of your work, but returning in a short time, clearly mark the area with Work In Progress (“WIP”), the time you left, and when you intend to return.
- 8) When working with human tissue, all waste and disposable PPE should be placed in a RED BIOHAZARD BAG. Store biohazardous waste in the freezer until there is sufficient waste for a pickup to be scheduled. If there is not sufficient storage space contact the Laboratory Manager (Table 1) to have it picked up by waste management.
- 9) ALWAYS use 10% bleach solution to clean all tools and surfaces that may have been exposed to biological fluids. No other cleaning compounds (including anti-bacterial soaps, etc.) are acceptable substitutes. Note that bleach is very corrosive, and you should rinse with copious water afterward.
- 10) ALWAYS wash your hands with soap and water before leaving the lab. The “Bac-Down” (bactericidal) gel may be used additionally.
- 11) Dispose of sharps in the sharps container. Do not close the sharps container until it is full. When it is full notify the Laboratory Manager (Table 1) to have it disposed of and to obtain a new sharps container.
- 12) Sharps are the most likely instrument to cause an exposure event! NEVER place a scalpel handle into a drawer or other storage area with a blade in place. NEVER save or reuse blades, even in containers. Scalpel blades are disposable and should be disposed of in the sharps container after use. NEVER leave scalpels on tables or other work surfaces for use “in the future.”
- 13) ALL personnel who work with biological samples or in a biohazard laboratory (Table 1) MUST be vaccinated for hepatitis-B. Attachment B must be completed and signed by all personnel who work with biological samples or in a biohazard laboratory (Table 1). If you are not sure or need to be vaccinated contact your advisor and fill out Attachment C for testing or vaccination at Health Services (1-7497)
- 14) EXPOSURE: If you are exposed to human blood or body fluids by way of a cut or puncture wound, ingestion, or contact with the eyes or mucous membranes:
 - FLUSH with copious water.
 - NOTIFY the Laboratory Director and/or your advisor.
 - CONTACT health services (1-7497).
 - If after hours, CONTACT the St. Joseph Hospital Emergency Room (237-7111) or Memorial Hospital Emergency Room (647-1000).

