

Penn State University

Laboratory Environmental Health and Safety Handbook



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LABORATORY SAFETY

Laboratory hazards vary depending on the materials and equipment being handled. The following summarizes key practices to follow when working in a laboratory. This guide is by no means all encompassing and employees/students should speak to the laboratory supervisor for additional information regarding hazards in university laboratories.



1. INTRODUCTION

The Pennsylvania State University is committed to protecting the health and safety of its employees, students, visitors and the environment. All University employees and students have specific responsibilities to comply with established health and safety policies, standards, rules, procedures and regulations. Compliance with these requirements is essential to create and maintain a healthy and safe environment at all University locations. University Safety Policy SY01 describes Penn State's environmental, health and safety commitments and everyone's responsibilities in implementing that policy:

<http://guru.psu.edu/policies/SY01.html>

2. GENERAL SAFETY

Penn State wants everyone to practice four essential principles of safety. These principles are:

- Practice safety
- Be concerned about the safety of others
- Prevent accidents
- Respond to emergencies

The following information supports these four safety principles:

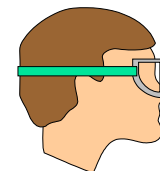
2.1 General Safety Guidelines- Make sure that all lab personnel are aware of potential hazards and good laboratory safety practices. Laboratory personnel are not to work alone where the risk of personal injury is high, unless other personnel are aware of their presence and can come quickly to aid. Special hazard signs should be in place (i.e. lasers, cryogenic liquids, radioactive materials, biohazards).

2.2 Good Housekeeping- Laboratory work areas should be kept uncluttered and cleaned up at the end of each class and workday. This is particularly important for areas with hazardous materials and equipment. Floors should be maintained free from tripping, slipping, and falling hazards (e.g. cords, cables, wires, equipment, and tools). Spills should be cleaned immediately and thoroughly. Emergency equipment and controls should not be blocked, and hallways and stairways should not be used as storage areas. Workbenches and shelves should not be overloaded with unused equipment, chemicals, or other materials.

2.3 Entrances, Exits, Hallways and Stairways- All entrances, exits, hallways and stairways in and around laboratories must be clear and unobstructed to allow everyone to exit the lab safely in the event of an emergency.

2.4 Personal Protective Equipment- Personal Protective Equipment appropriate to the laboratory activities should be worn:

- Eye Protection- Safety glasses (ANSI Z87) with side shields or goggles must be worn at all times when working with chemicals and when working in engineering labs with machining/mechanical equipment. Chemical goggles should be worn when working with corrosive chemicals, strong oxidizing agents, and other chemicals with severe hazards. Face shields should be used in addition to safety glasses and/or goggles when splashing of hazardous chemicals is possible.
- Foot Protection- Substantial shoes covering the entire foot should be worn. No sandals, shoes with open toes or high heeled shoes are allowed.
- Protective Clothing- Should be worn while working at the lab bench. Impervious lab coats, coveralls, aprons, or other protective clothing should be worn when working with corrosive liquids or strong oxidizing chemicals. Clothing that leaves large areas of skin exposed (e.g. shorts and short skirts) is inappropriate in laboratories where hazardous chemicals are in use.
- Gloves- Should be selected according to hazard involved. Chemical resistant gloves should be selected on the basis of the chemical being used. Insulated gloves should be used when handling hot/cold materials in and out of ovens, furnaces, cryogenic baths and other hot or cold devices. Heavy cloth barrier or leather gloves should be worn when working with sharp objects and broken glass. See the EHS website or other glove vendor information for information on glove selection for chemical resistance:



<http://www.ehs.psu.edu/occhealth/gloves.cfm>

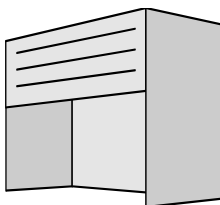
- Miscellaneous- Long hair should be pulled back, dangling jewelry removed, and loose fitting clothing should be restrained.

2.5 Good Hygiene- Eating food, drinking, or applying cosmetics is not permitted in areas where hazardous materials (e.g. radioactive, biohazardous, or chemical) are used. Always wash hands after working in the laboratory and before eating, drinking or smoking.

2.6 Lab Equipment- Lab equipment must not block aisles and exits. Benches and shelves should not be overloaded with unused equipment and/or chemicals, and no combustibles should be stored within three feet of the ceiling. No damaged glassware (broken, chipped) should be in use. Lab apparatus should be properly assembled and used in a safe manner according to manufacturer's instructions. Bicycles are not allowed in laboratories.

2.7 Fume Hood Operation- The fume hood is designed to capture chemical vapors that escape from their containers or apparatus and to remove them from the laboratory environment before they can be inhaled. Characteristics to be considered in requiring fume hood use are **physical state, volatility, toxicity, flammability, eye and skin irritation, odor, and the potential for producing aerosols**. A fume hood should be used if a proposed chemical procedure exhibits any one of these characteristics to a degree that:

- airborne concentrations might approach the permissible exposure limit,
- **flammable** vapors might approach one tenth of the lower explosion limit,
- materials of unknown **toxicity** are used or generated, or
- the **odor** produced is annoying to laboratory occupants or adjacent units.



Fume hoods should be inspected regularly to make sure that:

- Hood sashes open and close and that the glass is intact
- Hood is free of excess chemical storage/equipment
- Hood sashes are down (panels closed) when not being accessed

When in use, the hood sash should be located no higher than the label on the hood indicates to be safe. The face velocity of each fume hood should be tested at least once every 3 years and marked with the required level for the hood sash and type of chemicals that can be used safely within the hood. Visual indicators may be put in place on hoods to verify air flow between hood tests.



2.8 General Electrical Safety- Make sure that all electrical equipment is used safely within the laboratory as follows:

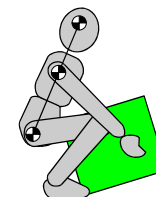
- Electrical apparatus should be equipped with ground plugs or be properly grounded.
- Extension cords should be in good condition (no splices) and for temporary use only, not overloaded and no longer than 6 feet.
- Torn or frayed cords should be repaired or replaced.
- Do not daisy chain electrical power strips together in a series.
- Two prong appliances should not be within a 5 foot radius or located directly above flammables or sinks.
- Appliances should be properly grounded.
- Electrical outlets within 6 feet of a sink or shower must be protected by a Ground Fault Circuit Interrupter (GFCI).
- Only trained and qualified employees should make electrical repairs or perform permanent equipment installation (e.g. lab hood).

2.9 Vacuum Equipment- When using vacuum equipment, make sure that:

- Vacuum pump belt guards are in place
- Glass Dewars are wrapped or shielded
- Protective shatter proof shields are in place when in use
- Glass desiccators under vacuum are stored in metal guards or shielded

2.10 Back Care and Lifting Safety-The following is a list of common sense items to prevent back and lifting-related injuries. These guidelines should be used when lifting or moving ANY objects, both at work and home.

- Get close to the load and get a firm footing. Keep your feet apart for a stable base and point the toes slightly outward.
- Bend your knees. Don't bend at the waist. Keep "leverage" in mind at all times. Don't do more work than you have to. Lifting while bent at the waist means you are not only lifting the weight of the load but also about 1/2 your own body weight.
- Tighten stomach muscles. Abdominal muscles support your spine when you lift, offsetting the force of the load. Train muscle groups to work together. Any type of abdominal exercise to tone muscles will also help.
- Lift with your legs. Let your powerful leg muscles do the work, not your weaker back muscles.
- Keep the load close. Don't hold the load away from your body. The closer it is to your spine, the less force it exerts on your back.
- Keep your back upright. Whether lifting or laying down the load, don't add the weight of your body to the load. Again, bend your knees.
- Pivot, don't twist. Turn with your feet, not your back.
- NEVER use "jerking" or twisting motions while lifting or carrying anything, no matter how heavy it is.
- Get help with oversized or heavy loads.



3. CHEMICAL AND HAZARDOUS MATERIALS SAFETY

3.1 Chemical Hazards- Chemicals have many valuable uses and play an important role in our lives. But many chemicals also present potential health and safety hazards whether used at Penn State or at home. You have the right to know about the hazards of the chemicals at Penn State, and you also have a right to know how to protect yourself from those hazards. Right-to-Know training is available and should be taken by anyone working with chemicals in the laboratory.

There are two primary means of conveying information on chemical hazards:

- **Material Safety Data Sheets (MSDS), and**
- **Container labels**

Material Safety Data Sheet: An MSDS is a source of information which is supplied by the chemical manufacturer or supplier. The MSDS provides the following information:

- Product identification
- Name, address and contact information for manufacturer
- Chemical composition and information on hazardous ingredients
- Physical and chemical properties
- Fire and explosion hazards (e.g. flash point, vapor pressure)
- Health hazard information (acute, chronic and carcinogenicity)
- Stability and reactivity information
- Handling and storage procedures
- Exposure controls and personal protective equipment
- Emergency response procedures- first aid, fire, spills
- Other regulatory and miscellaneous information

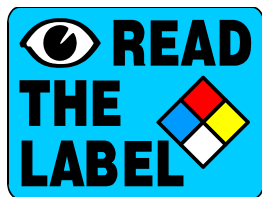


MSDSs are available for every chemical and hazardous material at Penn State. MSDSs are made available through paper copies in the lab or through chemical supplier Web Sites. See the following Penn State Web Site for links to sources of MSDSs:

<http://www.ehs.psu.edu/hazmat/msds.cfm>

Container Labels: Every container of chemicals in the laboratory **must** be labeled with the contents of the container.

Container labels must use words (not chemical formulas) to describe the contents. Chemical containers in laboratories and stockrooms should also be labeled with the date the chemical was received as well as the date the container was first opened. Do not remove chemical container labels.



A **chemical inventory** must be maintained in each laboratory or stockroom where chemicals are stored. This inventory should be updated annually to make sure that the most current information is available.

Make sure that you are aware of the hazards of the chemicals you are working with before you begin using them.

3.2 Safe Chemical Storage- Be aware of the hazards of the chemicals you are working with by reviewing MSDSs and container labels. Chemicals must be safely stored in the laboratory by making sure that:

- Chemical containers/safety cans/wash bottles must be labeled with a proper chemical name, capped and in good condition. Containers should be labeled with a date of receipt and a date of opening the container.

- No chemicals are stored on, above or next to a desk.
- No liquid chemicals are stored above "eye level".
- Shelves should be strong enough to hold chemicals being stored. Do not overload shelves.
- Chemicals should be segregated according to hazard class (e.g. flammables, corrosives, oxidizers, etc.)
- **Acids**- Store concentrated acids on lower shelves in chemical resistant trays or in a corrosives cabinet. Store acids separate from bases and flammables.
- **Bases**- Store concentrated bases on lower shelves in chemical resistant trays or in a corrosives cabinet. Store bases separate from acids and flammables.
- **Flammables**- Store flammable liquids in an approved flammable liquid cabinet. Vent bungs in cabinets should be in place unless cabinet is actively vented. See Penn State Policy SY08 "Storage, Dispensing and Use of Flammable Liquids on University Property":



<http://guru.psu.edu/policies/SY08.html>

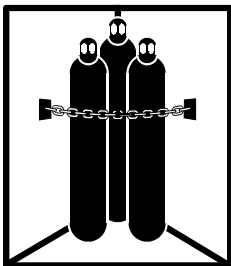
Store excess solvents in approved safety cans equipped with self-closing lids that are closed, have flame arrestors and are placed in flammable liquid cabinets. Note that glacial acetic acid should be stored in flammable liquid cabinets because of its flammability.



- **Oxidizers**- Store away from flammables and combustibles.
- **Peroxide Forming Chemicals** (e.g. ether, dioxane, THF) - Store in airtight containers in a dark, cool and dry place. Always label peroxide forming chemicals with the date received, date opened, and disposal/ expiration date. Dispose of peroxide forming chemicals before the date of expected peroxide formation. As a general rule, do not purchase greater than 6 months supply of these materials.
- **Water Reactives**- Store in a cool, dry place. Do not store under sinks or near water baths.
- **Toxics**- Store according to other hazard classes. Many lab chemical containers are color coded to allow ease in chemical segregation.
- Store only cleaning materials under sinks
- Storage of chemicals and all materials must be at least 18 inches below sprinkler heads to make sure that they can function properly.
- A chemical inventory should be maintained and updated at least annually.
- **Spill response kits** should be located in labs to allow prompt containment and cleanup of chemical spills. Immediately contact your professor or lab technician in the event of any chemical spill for proper cleanup. For spills that are too large or hazardous for you to clean up, call 911 or PSU EHS (814-865-6391).

3.3 Compressed Gas Cylinders - All gas cylinders must be properly secured in an upright position, with cylinder clamp/chain fastened to prevent falling.

- Regulators, connections, and tubing should be in good condition
- Flammable gas tubing secured and labeled
- Flame arrestors in place on flammable gas supply
- If toxic gases in use; proper leak sensors/alarms in place and regularly checked and calibrated
- If toxic gases or gases with poor warning qualities are used (e.g. odorless), redundant systems and shutoffs in place in case of leaks/emergencies
- Stored cylinders tightly capped and kept to a minimum
- Flammable gases/materials stored a minimum of 20 feet from cylinders containing oxidizers
- Use cylinder carts with a chain in place to move gas cylinders from one location to another
- Mark empty cylinders



See Policy SY25 for additional information on Compressed Gas Cylinder safety:

<http://guru.psu.edu/policies/SY25.html>

3.4 Laboratory Refrigerators and Freezers- Refrigerators and freezers are frequently used in laboratories. The following guidelines should be observed:

- Only "explosion proof" or "explosion safe" refrigerators/freezers may be used in labs to store flammables.
- Refrigerators/freezers that are not "explosion proof" or "explosion safe" must be labeled "**NO FLAMMABLES ALLOWED**".
- Refrigerators/freezers should be labeled for "**CHEMICAL USE ONLY**" or "**FOOD USE ONLY**" and used accordingly.
- Interior should be sound and free of chemical spills or contamination; containers stoppered or tightly closed

See Penn State Policy SY11 for more information on explosion proof refrigerators

<http://guru.psu.edu/policies/SY11.html>

3.5 Mercury/Mercury Thermometers- Penn State has a pollution prevention initiative to reduce the amount of mercury in laboratories. Through the Mercury Thermometer Exchange Program (MTEP), mercury thermometers (and other mercury containing devices) are collected and replaced with high-tech accurate alternatives that are safe and non-toxic, environmentally friendly thermometers. All Penn State locations should switch to non-mercury thermometers (except where absolutely needed). Immediately contact your professor or lab technician in the event of a mercury spill or mercury thermometer breakage. See the EHS mercury thermometer web site for additional information:

<http://www.ehs.psu.edu/envprot/mtep.cfm>

4. WASTE DISPOSAL

4.1 Chemical Waste- Chemical waste must be handled in accordance with chemical waste handling procedures:

- Chemical waste containers must be labeled with red tags and chemical compositions specified. Containers should be closed except when adding waste to the container.
- Evaporation of chemicals in chemical fume hoods or by other means, if not part of an experimental procedure, is not acceptable.
- Waste chemicals should not be poured down the drain to the sanitary sewer unless specifically approved by Environmental Health and Safety.
- Remember that mixing of certain wastes can be hazardous. Do not mix incompatible materials and segregate incompatible materials appropriately.
- Store waste in compatible chemical containers.
- Waste containers should be stored in secondary containment that will contain spills in the event a container breaks.
- Weekly satellite accumulation inspections must be conducted as required
- Complete an on-line "Chemical Waste Disposal Request Form" for disposal of any chemical waste, chemicals no longer being used, and chemicals past their expiration date or very old.
- Commonwealth campus personnel should contact campus safety officer to arrange a chemical waste pickup.
- An annual self audit of the chemical waste program must be completed.

See the following Penn State Web Site for links to information on chemical waste disposal and Penn State's Hazardous Waste Disposal Policy SY20:

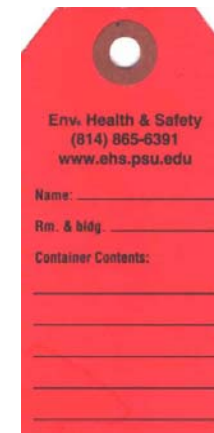
<http://www.ehs.psu.edu/hazmat/index.cfm>

4.2. Infectious Waste- Infectious waste includes specimens and materials from biology labs as well as blood containing materials from first aid and medical care areas.

- Biohazard/infectious wastes should be placed into the appropriate containers (e.g. red/orange biohazard plastic bag, sharps container)
- Biological specimens (e.g. cats for dissection) should be disposed through the infectious waste disposal vendor.
- Infectious waste should be disposed of in accordance with the Penn State infectious waste disposal policy SY29:

<http://guru.psu.edu/policies/sy29.html>

Contact Penn State EHS or the infectious waste disposal vendor to arrange pick up of infectious waste.



5. EMERGENCY EQUIPMENT/PROCEDURES

5.1 First Aid- To ensure everyone's safety, first aid kits are available in designated areas. Each kit should contain an inventory list and should be properly stocked according to Policy SY21:

<http://guru.psu.edu/policies/SY21.html>

5.2 Emergency Information- A lab information sign should be posted on the outside of each laboratory door providing primary and alternate contact information for each lab. This information is useful in the event of an emergency after normal hours. Emergency and lab safety phone numbers should be posted next to all lab and office phones.

Additional Emergency Contact information is provided on the back of this pamphlet.

5.3 Safety Showers/Eye Washes- Any area which deals with corrosive, flammable or other hazardous material is required to have immediate access to eyewash and drench shower facilities. All showers and eye wash equipment must be in full operational order and unobstructed. Regular inspections should be conducted in addition to annual inspections by EHS.



5.4 Fire Extinguisher/Inspection and Location- Extinguishers must be properly mounted, unobstructed and properly labeled for the intended use. Employees who may use fire extinguishers should receive proper training. Fire extinguishers should match the hazard for the laboratory where they are located. All fire extinguishers are inspected annually.

6. RADIATION AND LASER SAFETY

6.1 Radiation Safety- Radiation safety involves both radiation producing equipment as well as use of radioactive materials:

a. Radiation producing equipment must be registered with PaDEP and must be labeled with a sign bearing the words "Caution Radiation—This Equipment Produces Radiation When Energized" or words containing a similar warning. Radiation producing equipment includes the following:

- analytical x-ray instruments;
- industrial, medical and veterinary radiographic instruments;
- electron microscopes;
- electron beam welders;
- x-ray vacuum spectroscopy systems;



- x-ray gauging devices; and
- any electrical equipment that produces radiation incidental to its operation for other purposes.

Anyone operating or conducting maintenance on radiation producing equipment must have access to a copy of the operating procedures and instruction in, and demonstrated an understanding of, the operating procedures necessary to ensure radiation safety.

See the EHS Department and University Safety Policy SY15 for more information regarding radiation producing equipment:

<http://guru.psu.edu/policies/SY15.html>

b. Radioactive Material Use

All receipt, possession, and disposal of radioactive material is strictly regulated by the Nuclear Regulatory Commission or the Pennsylvania Department of Environmental Protection. Any use of radioactive material must have pre-approval by the Penn State University Isotopes Committee. Contact Penn State EHS as soon as you think you will need to use radioactive material for assistance in obtaining this approval.



See Penn State Safety Policy SY14 for more information:

<http://guru.psu.edu/policies/SY14.html>

6.2 Radioactive Waste Disposal- The University provides for the disposal of radioactive waste in a variety of ways. All the waste disposal methods are costly and time consuming, and disposal expenses often exceed the original cost of the radioactive material. Therefore, it is imperative that experimenters procure only as much radioactive material as is required for their experiments and minimize the amount of radioactive waste produced. See the following for additional information on radioactive waste disposal:

<http://www.ehs.psu.edu/radprot/index.cfm>

6.3 Laser Safety- LASER is an acronym which stands for Light Amplification by Stimulated Emission of Radiation. Lasers produce an intense, highly directional beam of light. If directed, reflected, or focused upon an object, laser light will be partially absorbed, raising the temperature of the surface and/or the interior of the object, potentially causing an alteration or deformation of the material. The human body is vulnerable to the output of certain lasers, and under certain circumstances, exposure can result in damage to the eye and skin.

Classes: Based on their hazard, lasers are categorized into 4 classes: from Class 1 to 4. Class 1 lasers have the lowest hazard while Class 4 lasers create the greatest hazard. Penn State Policy SY17 applies to Class 3b lasers, Class 4 lasers, and Class 1 laser systems with embedded Class 3b or Class 4 lasers:



<http://guru.psu.edu/policies/SY17.html>

Standard Operating Procedures (SOPs): Areas where Class 3b and 4 lasers are used must develop SOPs that include the following information:

- Introduction (location, description of laser, etc.)
- Hazards
- Controls
- Operating procedures
- Training
- Responsibilities
- Other information

Training- Anyone working with one of these lasers must complete a laser safety training class offered by Penn State EHS prior to beginning work with the laser. The training consists of laser fundamentals, laser hazards, non-beam hazards, laser accidents, control measures and an overview of Penn State's laser safety program. Supervisors must then provide training to users in operating and safety procedures for each individual laser system.

Warning Signs- Warning signs must be posted on doors entering rooms and on laser equipment to warn people of the hazards in those work areas.

Personal Protective Equipment- Appropriate laser eye protection and other PPE must be established and worn by individuals working around lasers. The type of protective equipment will be based on the hazards of the laser involved.

See the Penn State EHS laser program web site for more information on laser safety:

<http://www.ehs.psu.edu/radprot/laser.cfm>

7. EQUIPMENT SAFETY

7.1 Engineering Lab/Machine Safety- Machines make work easier and more efficient. However, machines can pose a significant risk of injury to the operator.

Moving parts present the greatest hazards around machinery. Common machine hazards occur around moving parts including:

- **Pinch points** where two parts move together (e.g. belt, chain and gear drives, and feed rolls)
- **Wrap points** (e.g. rotating shafts).
- **Shear points** (e.g. saws, blades, cutters and shears)
- **Crush points** (e.g. mechanical and hydraulic presses)
- **Pull-in points** (e.g. feed rolls and grinders)
- **Thrown objects** (e.g. metal and plastic from grinding, sawing, drilling, etc)

Guards are provided on machinery for your protection and the protection of those around you to prevent access to danger areas. The following guidelines are provided regarding machine guards:

- Do not remove guards and never use machinery without a guard.
- Never reach around or under a guard.
- Don't reach blindly into areas that may contain energized parts.
- Anchor guards securely.
- Do not defeat safety interlocks that guard machinery.
- Perform routine safety checks on machinery and safety guards. Replace or fix guards that are damaged before using machinery/tools.
- Follow **Lockout/Tagout** procedures during maintenance and repair.
- Know where emergency stop buttons are for equipment.



For your protection, the following guidelines should be followed when working around powered machines and tools:

- Only trained personnel may operate equipment. Obtain training and read equipment manuals before using machinery.
- Always wear proper Personal Protective Equipment in the engineering lab/machine shop. At a minimum, always wear safety glasses with side shields. Goggles and/or face shields should be worn if there is a significant hazard from flying objects or splashing of chemicals.
- Keep your hands away from moving parts. Never reach into equipment while parts are in motion.
- Don't wear jewelry. Remove rings, bracelets, watches, necklaces and dangling jewelry before working around moving equipment. These items can become caught in moving machine parts and can also cause shock from coming in contact with electrical equipment.

