**Laboratory Equipment Hazards**

Numerous physical hazards may be present in the laboratory. Physical hazards are responsible for the majority of workplace injuries. Instruments and equipment that operate at high voltage, high pressures, high speeds or high temperatures, are potentially dangerous. Such equipment should be inspected and maintained regularly and serviced to reduce the hazards from failure.

Many of the pieces of equipment you use daily can pose a hazard. When using any equipment remember:

* use the correct equipment
* know how to operate the equipment
* inspect the equipment
* use the equipment properly

Use the equipment for its intended purpose only. Do not modify or adapt equipment without guidance from the equipment manufacturer. Do not defeat, remove, or override equipment safety devices.

Another potential hazard from operating equipment is aerosol production. Aerosols containing infectious agents and hazardous materials can pose a serious risk because:

* Small aerosol particles can readily penetrate and remain deep in the respiratory tract, if inhaled.
* Aerosols may remain suspended in the air for long periods of time.
* Aerosol particles can easily contaminate equipment and ventilation systems

The following equipment may produce aerosols:

* Centrifuge
* Shaker
* Magnetic stirrer
* Sonicator
* Pipette
* Syringe and needle
* Vacuum-sealed ampoule
* Grinder, mortar, and pestle
* Separatory funnel

Follow these guidelines to eliminate or reduce the hazards associated with aerosols:

* Conduct procedures that may produce aerosols in a chemical fume hood.
* Keep tubes stoppered when vortexing or centrifuging.
* Allow aerosols to settle for one to five minutes before opening a centrifuge, blender, or tube.
* When combining liquids, discharge the secondary material down the side of the container or as close to the surface of the primary liquid as possible.
* Use a mechanical pipetting device.

**Centrifuges**

Centrifuging presents the possibility of two serious hazards: mechanical failure and aerosols. The most common hazard associated with centrifuging is a broken tube. To ensure safety when operating a centrifuge, take precautions to ensure the following:

* Proper loading (accurate balancing)
* Safe operating speeds (do not exceed manufacturer recommendations)
* Safe stopping
* Complete removal of materials
* When loading the rotor, examine the tubes for signs of stress, and discard any tubes that are damaged.
* Inspect the inside of each tube cavity or bucket. Remove any glass or other debris from the rubber cushion.
* Ensure that the centrifuge has adequate shielding to guard against accidental flyaways.
* Use a centrifuge only if it has a disconnect switch that deactivates the rotor when the lid is open.
* Do not overfill a centrifuge tube to the point where the rim, cap, or cotton plug becomes wet.
* Always keep the lid closed during operation and shut down. Do not open the lid until the rotor is completely stopped.
* Do not brake the head rotation by hand.
* When balancing the rotors, consider the tubes, buckets, adapters, inserts, and any added solution.
* Stop the rotor and discontinue operation if you notice anything abnormal such as a noise or vibration.
* Frequently inspect, clean, and dry rotors to prevent corrosion or other damage.
* Review the rotor SOP to insure it includes the manufacturer's safety instructions.

**Heating systems**Devices that supply heat for reactions or separations include the following:

* Open flame burners
* Hot plates
* Heating mantles
* Oil and air baths
* Hot air guns
* Ovens
* Furnaces

Common hazards associated with laboratory heating devices include electrical hazards, fire hazards, and hot surfaces. Follow these guidelines when using heating devices:

* Ensure that heating devices and all connecting components are in good working condition.
* Heated chemicals can cause more damage and more quickly than would the same chemicals at a lower temperature.
* Heating baths should be equipped with timers to ensure that they turn on and off at appropriate times.
* Use a chemical fume hood when heating flammable or combustible solvents. Arrange the equipment so that escaping vapors do not contact heated or sparking surfaces.
* Use non-asbestos thermal-heat resistant gloves to handle heated materials and equipment.
* Minimize the use of open flames. Never leave an open flame unattended.

**Pressurized Systems**Do not conduct a reaction in, or apply heat to, a closed system apparatus unless the equipment is designed and tested to withstand pressure. Pressurized systems should have an appropriate relief valve. Pressurized systems must be fully shielded and should not be conducted in an occupied space until safe operation has been assured. Do not leave a pressurized system unattended. Use protective shield or enclosures.

**Refrigerators/Freezers**Using a household refrigerator to store laboratory chemicals is not allowed in the lab. The storage compartment of a household refrigerator contains numerous ignition sources including thermostats, light switches, and heater strips that may cause a fire.

Explosion-proof refrigerators are required in areas that may contain high levels of flammable vapors (e.g., chemical storage rooms with large quantities of flammables).

Follow these rules for using refrigerators in the laboratory:

* Never store flammable chemicals in a household refrigerator.
* Do not store food or drink in a laboratory refrigerator/freezer.
* Ensure that all refrigerators are clearly labeled to indicate suitable usage.
	1. Laboratory-safe and explosion-proof refrigerators should be identified by a manufacturer label.
	2. “Not Safe for Flammable Storage" labels are should be available in each lab.

**Vacuum Systems**Vacuum systems pose severe implosion hazards. Follow these guidelines and requirements to ensure system safety:

* Ensure that pumps have belt guards in place during operation.
* Ensure that service cords and switches are free from defects.
* Always use a trap on vacuum lines to prevent liquids from being drawn into the pump, house vacuum line, or water drain.
* Replace and properly dispose of vacuum pump oil that is contaminated with condensate. Used pump oil must be disposed as hazardous waste.
* Place a pan under pumps to catch oil drips.
* Do not operate pumps near containers of flammable chemicals.
* Do not place pumps in an enclosed, unventilated cabinet.
* Conduct all vacuum operations behind a table shield or in a fume hood.

The glassware used with vacuum operations must meet the following requirements:

* Only heavy-walled round-bottomed glassware should be used for vacuum operations. The only exception to this rule is glassware specifically designed for vacuum operations, such as an Erlenmeyer filtration flask.
* Wrap exposed glass with tape to prevent flying glass if an implosion occurs.
* Carefully inspect vacuum glassware before and after each use. Discard any glass that is chipped, scratched, broken, or otherwise stressed. Glass desiccators often have a slight vacuum due to contents cooling. When using desiccators, follow these guidelines:
* When possible, use molded plastic desiccators with high tensile strength.
* For glass desiccators, use a perforated metal desiccator guard.

**Distillation of Organic Solvents**

Potential hazards from distillations arise from pressure buildup, flammable materials, and the use of heat to vaporize the chemicals involved. Care must be taken during construction of the system to insure effective separation and to avoid leaks which could lead to fires or contamination. Take precautions with distillations and reactions, especially when they run overnight. Use these guidelines for safe

distillations:

* Prevent overheating by ensuring that all hoses and connections are securely tightened.
* Always leave a phone number where you can be reached. Post it on the door of your lab so that emergency responders can contact you for information in case of a fire or emergency.
* Use boiling chips or stir bars to prevent bumping during distillations, refluxing, and similar procedures.
* Be aware when distilling chemicals that certain types may autoxidize and accumulate peroxides. Peroxides can explode when heated and concentrated during a distillation.
* Use only round-bottom flasks for vacuum distillations. Erlenmeyer flasks are more likely to implode. Vacuum distillations or evaporations should always be shielded in case of implosion.

**Flammable liquids and Hot Plates**

1. Do not smoke while using flammable liquids and do not allow those around you to smoke. Display NO SMOKING sign, available from EHS Office.
2. Safety hot plates or steam bathes must be used for heating low-boiling flammable liquids.
3. Never heat flammable liquids with a gas burner. When removing liquids by steam bath or hot plate, use a distillation flask as a receiver. Such distillations must be carried out in a fume hood. Explosion-proof motors, lights, switches and wiring are necessary when these devices are used around low-boiling flammable solvents.
4. Bottles of volatile liquids should not be stored near heat sources or in direct sun light. Particularly dangerous is the lens effect of the bottles that can focus the sun’s rays, overheat the liquid, and this may cause fire.

**Natural Gas**

1. Gas cocks should be kept closed when are not in use.
2. The rubber tubing that carries gas should be kept in good condition and should be placed so as not to be exposed to heat or flame or other equipment.
3. Gas flames should be shut off when not in use.
4. Open flames must not be left operating unattended in the laboratory.
5. Electric hot plates and heating mantles should be substituted for gas burners whenever possible.

**Condenser Cooling**

1. The water flowing through condensers and other equipment should be shut off overnight.
2. When the apparatus is to be left running unattended overnight, the water supply must be carefully checked before leave. Enough water should flow through the equipment to do the job expected, but not enough to break the connections in the system to force the drainage tube out of the sink.
3. Adjust your equipment after the regular evening shutdown.
4. Wiring or clamping rubber-tubing connections will prevent many accidents.

**Nuclear Magnetic Resonance (NMR)**

The NMR facility is adjacent to the Materials Science and Optics Building Connector. NMR uses a powerful electromagnet in the identification process of chemical compounds. Due to the strong magnetic field certain precautions must be taken. Persons with pacemakers must not enter the NMR facility. The following are guidelines for safely working in and with the NMR.

1. Permission to enter the facility is required. To obtain permission, contact the Director of the NMR facility. The Director will brief persons obtaining permission to enter the NMR facility on the appropriate safety precautions.
2. The 10-gauss perimeter must be demarcated in the facility. Persons with implanted or attached medical devices such as prosthetic parts and stints must remain outside of the 10-gauss perimeter from the centerline of the magnet.
3. All metal objects e.g., ordinary tools, electronic equipment, compressed gas cylinders, steel chairs, and steel carts, must be outside the 10-gauss perimeter from the centerline of the magnet. These objects can suddenly fly towards the magnet, possibly causing injury or damage to the equipment and facility.
4. Cards with magnetic strips (credit, check, Charger cards) will be erased of information under the presence of the magnetic field. These types of cards must not be taken within the 10-gauss perimeter from the centerline of the magnet.
5. Computer monitors and TV screens may be distorted by fringe magnetic field. Appropriate shielding is necessary.
6. Only qualified maintenance personnel shall remove equipment covers or make internal adjustments. Dangerous high voltages that can kill or injure exist inside the instrument. Before working inside the cabinet, turn off the main power switch located on the back of the console, then disconnect the AC power cord.
7. Do not substitute parts or modify the instrument. Any unauthorized modification could injure personnel or damage equipment.
8. Do not operate in the presence of flammable gases or fumes. Operation with flammable gases or fumes present creates the risk of injury or death from toxic fumes, explosion, or fire.
9. Leave the area immediately in the event of a magnet quench (sudden appearance of gases from the top of the dewar). This could result in an oxygen deficient atmosphere.
10. Avoid liquid helium or nitrogen contact with any part of the body. The cause damage similar to a burn.
11. Do not look down the upper barrel. Unless the probe is removed from the magnet, never look down the upper barrel as it is pneumatically driven and may cause injury as the sample is ejected.

**Microwave Radiation**

Exposure to uncontrolled microwave radiation can be a health hazard. Since microwave can penetrate body tissues, severe internal burns can result from over exposure to this radiation. The operation of cardiac pacemakers can be affected and persons wearing these should avoid areas where microwaves are used.