

## SAFETY OF OPERATIONSnII

### 2.2 electrical hazards:

Electrically powered equipment, such as hot plates, stirrers, vacuum pumps, electrophoresis apparatus, lasers, heating mantles, ultrasonicators, power supplies, and microwave ovens are essential elements of many work areas. These devices can pose a significant hazard to workers, particularly when mishandled or not maintained. Many electrical devices have high voltage or high power requirements, carrying even more risk. Large capacitors found in many laser flash lamps and other systems are capable of storing lethal amounts of electrical energy and pose a serious danger even if the power source has been disconnected.

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### Electrical Hazards

The major hazards associated with electricity are electrical shock and fire. Electrical shock occurs when the body becomes part of the electric circuit, either when an individual comes in contact with both wires of an electrical circuit, one wire of an energized circuit and the ground, or a metallic part that has become energized by contact with an electrical conductor.

The severity and effects of an electrical shock depend on a number of factors, such as the pathway through the body, the amount of current, the length of time of the exposure, and whether the skin is wet or dry. Water is a great conductor of electricity, allowing current to flow more easily in wet conditions and through wet skin. The effect of the shock may range from a slight tingle to severe burns to cardiac arrest. The chart below shows the general relationship between the degree of injury and amount of current for a 60-cycle hand-to-foot path of one second's duration of shock. While reading this chart, keep in mind that most electrical circuits can provide, under normal conditions, up to 20,000 milliamperes of current flow

Current	Reaction
1 Milliampere	Perception <u>level</u>
5 Milliamperes	Slight shock felt; not painful but

	disturbing
6-30 Milliamperes	Painful shock; "let-go" range
50-150 Milliamperes	Extreme pain, respiratory arrest, severe muscular <u>contraction</u>
1000-4,300 Milliamperes	Ventricular fibrillation
10,000+ Milliamperes	Cardiac arrest, severe burns and probable death

In addition to the electrical shock hazards, sparks from electrical equipment can serve as an ignition source for flammable or explosive vapors.

Even loss of electrical power can result in extremely hazardous situations. Flammable or toxic vapors may be released as a chemical warms when a refrigerator or freezer fails. Fume hoods may cease to operate, allowing vapors to be released into the work area. If magnetic or mechanical stirrers fail to operate, safe mixing of reagents may be compromised.

## Preventing Electrical Hazards

There are various ways of protecting people from the hazards caused by electricity, including insulation, guarding, grounding, and electrical protective devices. Workers can significantly reduce electrical hazards by following some basic precautions:

- ☞ Inspect wiring of equipment before each use. Replace damaged or frayed electrical cords immediately.
- ☞ Use safe work practices every time electrical equipment is used.
- ☞ Know the location and how to operate shut-off switches and/or circuit breaker panels. Use these devices to shut off equipment in the event of a fire or electrocution.
- ☞ Limit the use of extension cords. Use only for temporary operations. In all other

cases, request installation of a new electrical outlet.

- ☞ Use only multi-plug adapters equipped with circuit breakers or fuses.
  - ☞ Place exposed electrical conductors (such as those sometimes used with electrophoresis devices) behind Plexiglas shields.
  - ☞ Minimize the potential for water or chemical spills on or near electrical equipment.
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## **Insulation**

All electrical cords should have sufficient insulation to prevent direct contact with wires. It is particularly important to check all cords before each use, since corrosive chemicals or solvent vapors may erode the insulation.

Damaged cords should be repaired or taken out of service immediately, especially in wet environments such as cold rooms and near water baths.

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## **Guarding**

Live parts of electric equipment operating at 50 volts or more (i.e., electrophoresis devices) must be guarded against accidental contact. Plexiglas shields may be used to protect against exposed live parts.

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## **Grounding**

Only equipment with three-prong plugs should be used. The third prong provides a path to ground that helps prevent the buildup of voltages that may result in an electrical shock or spark. This does not guarantee that no one will receive a shock, be injured, or be killed. It will, however, substantially reduce the possibility of such accidents, especially when used in combination with other safety measures.

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## **Circuit Protection Devices**

Circuit protection devices are designed to automatically limit or shut off the flow of electricity in the event of a ground-fault, overload, or short circuit in the wiring

system. Fuses, circuit breakers, and ground-fault circuit interrupters are three well-known examples of such devices.

Fuses and circuit breakers prevent over-heating of wires and components that might otherwise create hazards for operators. They disconnect the circuit when it becomes overloaded. This overload protection is very useful for equipment that is left on for extended periods of time, such as stirrers, vacuum pumps, drying ovens, Variacs and other electrical equipment.

The ground-fault circuit interrupter, or GFCI, is designed to shutoff electric power if a ground fault is detected. The GFCI is particularly useful near sinks and wet locations. Since GFCIs can cause equipment to shutdown unexpectedly, they may not be appropriate for certain apparatus. Portable GFCI adapters (available in most safety supply catalogs) may be used with a non-GFCI outlet.

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## Motors

In areas where volatile flammable materials are used, motor-driven electrical equipment should be equipped with non-sparking induction motors or air motors. Avoid series-wound motors, such as those generally found in vacuum pumps[🔗](#), rotary evaporators and stirrers. Series-wound motors are also usually found in household appliances such as blenders, mixers, vacuum cleaners and power drills. These appliances should not be used unless flammable vapors are adequately controlled.

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## Safe Work Practices

The following practices may reduce risk of injury or fire when working with electrical equipment:

- ☞ Avoid contact with energized electrical circuits.
- ☞ Disconnect the power source before servicing or repairing electrical[🔗](#) equipment.
- ☞ When it is necessary to handle equipment that is plugged in, be sure hands are dry and, when possible, wear nonconductive gloves and shoes[🔗](#) with insulated soles.

- ☞ If it is not unsafe to do so, work with only one hand, keeping the other hand at your side or in your pocket, away from all conductive material. This precaution reduces the likelihood of accidents that result in current passing through the chest cavity.
  - ☞ Minimize the use of electrical equipment in cold rooms or other areas where condensation is likely. If equipment must be used in such areas, mount the equipment on a wall or vertical panel.
  - ☞ If water or a chemical is spilled onto equipment, shut off power at the main switch or circuit breaker and unplug the equipment.
  - ☞ If an individual comes in contact with a live electrical conductor, do not touch the equipment, cord or person. Disconnect the power source from the circuit breaker or pull out the plug using a leather belt.
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## High Voltage or Current

Repairs of high voltage or high current equipment should be performed by trained electricians. Individuals who are experienced in such tasks and would like to perform such work on their own equipment must first receive specialized electrical safety related work practices training by EHS staff.

The following additional precautions should be taken:

- ☞ Always assume a high voltage potential exists within a device while servicing it, even if it is de-energized and disconnected from its power source.
- ☞ Avoid becoming grounded by staying at least 6 inches away from walls, water, and all metal materials, including pipes.
- ☞ Use voltmeters and test equipment with ratings and leads sufficient to measure the highest potential voltage expected to be found inside the equipment being serviced.
- ☞ After servicing, check equipment with a multimeter or appropriate device to ensure it is grounded before reconnecting to the power source.

### 2.3 chemical hazards: What are chemical hazards and toxic substances?

Chemical hazards and toxic substances pose a wide range of health hazards (such as irritation, sensitization, and carcinogenicity) and physical hazards (such as flammability, corrosion, and reactivity).

This page provides basic information about chemical hazards and toxic substances in the workplace. While not all hazards associated with every chemical and toxic substance are addressed here, we do provide relevant links to other pages with additional information about hazards and methods to control exposure in the workplace.

**In order to ensure chemical safety in the workplace, information about the identities and hazards of the chemicals must be available and understandable to workers. OSHA's Hazard Communication Standard (HCS) requires the development and dissemination of such information:**

- Chemical manufacturers and importers are required to evaluate the hazards of the chemicals they produce or import, and prepare labels and safety data sheets to convey the hazard information to their downstream customers;
- All employers with hazardous chemicals in their workplaces must have labels and safety data sheets for their exposed workers, and train them to handle the chemicals appropriately. The training for employees must also include information on the hazards of the chemicals in their work area and the measures to be used to protect themselves

### **Allowable airborne concentrations**

Employers are required to identify and evaluate the respiratory hazard(s) in their workplaces. Various types of Occupational Exposure Limits (OELs) have been established by a number of organizations, and are listed on many of OSHA's Safety and Health webpages on chemical hazards and toxic substances. Here is an explanation of some of the different levels.