Electrical Safety
Electrical and Computer Engineering
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This handout is intended as a guide to help you work safer in Electrical and Computer Engineering Laboratories. It provides general guidelines, but does not cover every possible situation. Specific questions regarding lab safety should be addressed to you lab instructor or course instructor.

Introduction

The web site http://www.labsafety.org/ states that: “Unfortunately, the accident rate in schools and colleges is 100 to 1000 times greater than at Dow or Dupont.” Our intent is to disprove this statement in the Electrical and Computer Engineering Department at MSU. Hence, as you learn about engineering and scientific principles it is also important that you learn about safety. To work safely in the lab means that---

YOU KNOW the hazards
YOU KNOW the worst things that could happen
YOU KNOW what to do and how to do it if they should happen
YOU KNOW and use the prudent practices, protective facilities, and protective equipment needed to minimize the risks.

Electrical Hazards

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.

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.

Current	**Reaction**
1 Milliampere	Perception level
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 contraction
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 laboratory.

<u>Electrical Emergency Response</u>

The following instructions provide guidelines for handling three types of electrical emergencies:

1. Electric Shock:
   When someone suffers serious electrical shock, he or she may be knocked unconscious. If the victim is still in contact with the electrical current, immediately turn off the electrical power source. If you cannot disconnect the power source, try to separate the victim from the power source with a nonconductive object, such as a wood-handled broom.

   IMPORTANT:
   Do not touch a victim that is still in contact with a power source; you could electrocute yourself.

   Have someone call for emergency medical assistance immediately (911). Administer first-aid, as appropriate.

2. Electrical Fire:
   If an electrical fire occurs, try to disconnect the electrical power source, but only if you can do it without endangering yourself. If the fire is small, you are not in immediate danger, and you have been trained in fighting fires, use any type of fire extinguisher except water to extinguish the fire.

   IMPORTANT:
   Do not use water on an electrical fire.

3. Power Lines:
   Stay away from live power lines and downed power lines. Be particularly careful if a live power line is touching a body of water. The water could conduct electricity.

   If a power line falls on your car while you are inside, remain in the vehicle until help arrives.

Electrical and Electronic Safety

Please follow these general guidelines pertaining to electrical safety.

1. Turn off power and unplug from the wall before working on electric or electronic circuits, except when absolutely necessary.
2. Complete all your wiring and check it carefully before turning on the power supply.
3. When a setup or circuit is to be reconfigured or rewired, turn the power supply off. It is also a good practice to disconnect it from the power supply.
4. When you are done with an experiment, turn off the power supply first before disassembling the circuit.
5. Do not work on electrical equipment in a wet area or when touching an object that may provide a hazardous earth ground path.
6. Turn off power and unplug equipment before checking or replacing fuses. Locate and correct the cause of a blown fuse or tripped circuit breaker before replacing the fuse or resetting the circuit breaker.
7. Immediately report and do not use defective cords and plugs. Inspect cabling for defects such as frayed wiring, loose connections, or cracked insulation.
8. Remove metal jewelry, watches, rings, etc., before working on electrical circuits.
9. Always check the electrical ratings of equipment you use and be sure you use that equipment within its ratings.
10. Never overload circuits.
11. Never leave unprotected systems unattended.
12. Never place containers of liquid on electrical systems.
13. Never defeat the purpose of a fuse or circuit breaker. Never install a fuse of higher amperage rating than that specifically listed for your circuit.
14. Make sure equipment chassis or cabinets are grounded. Never cut off or defeat the ground connection on a plug.
15. Safely discharge capacitors in equipment before working on the circuits. Why? Because, 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.
16. When shifting probes in a live/active circuit, be sure to shift using only one hand: It is best to keep the other hand off other surfaces and behind your back.
17. If you are working on a design project and you plan to work with voltages equal to or above 50 volts, notify your instructor and obtain their approval before proceeding.

Preventing Electrical Hazards

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

1) Inspect wiring of equipment before each use. Report and do not use damaged or frayed electrical cords immediately.
2) Use safe work practices every time electrical equipment is used.
3) 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.
4) Limit the use of extension cords. Use only for temporary operations. In all other cases, request installation of a new electrical outlet.
5) Use only multi-plug adapters equipped with circuit breakers or fuses.
6) Place exposed electrical conductors (especially those with greater than 50 volts) in protective chassis boxes or behind Plexiglas shields.
7) Minimize the potential for water or chemical spills on or near electrical equipment.
8) Only equipment with three-prong plugs should be used in the laboratory. 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.
9) When designing circuits and systems include circuit protection devices as needed.

   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.

   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.

References

1) http://www.labsafety.org/
2) Princeton University Environmental Health and Safety Laboratory Safety Training Guide, Located at: http://www.princeton.edu/~ehs/labguide/sec-4.htm
3) http://ehsd.tamu.edu/manual/05-elect.htm