Basic Electrical Safety

Lab Safety Training
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Why Electrical Safety?

To provide basic information on electrical safety in labs and work spaces.

• Electrocutions comprise about 5% of all workplace fatalities in the US – an annual average of 411 has been reported by the Bureau of Labor Statistics since 1998.

• 32,000 US workers suffered electrical shock and/or burns between 1999 and 2006.
How Electricity Can Hurt You

The effects vary and depend on:

- Voltage, amplitude, and resistance
- How long the shock lasts
- Pathway of current through the body
# Effects of Electrical Current

<table>
<thead>
<tr>
<th>Current</th>
<th>Effect</th>
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<tbody>
<tr>
<td>1 mA (milliampere) (one thousandth of a full ampere)</td>
<td>Faint tingle</td>
</tr>
<tr>
<td>10-25 mA</td>
<td>Painful shock, loss of muscle control</td>
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<tr>
<td>50-150 mA</td>
<td>Extreme pain, respiratory arrest, severe muscular contractions</td>
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<tr>
<td>1-4 amperes (A)</td>
<td>Heart stops; death likely</td>
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<tr>
<td>5-12 A</td>
<td>Current drawn by typical household appliances</td>
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<tr>
<td>10 A</td>
<td>Cardiac arrest and severe burns; death probable</td>
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<tr>
<td>15 A (most standard household circuits)</td>
<td>Lowest overcurrent at which a typical fuse or circuit breaker operates</td>
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Ohm’s Law

\[
\text{Voltage (volts, } V) \div \text{Resistance (ohms, } \Omega) = \text{Current (amps, } A) \]

This is not what hurts

This is!
Types of Injuries

There are four main types of electrical injuries:

• Electrocution
• Electrical shock
• Electrical Burns
• Falls, other secondary injuries
Electrocution

• If you see someone being electrocuted, shut off the power.
  – Pull the plug.
  – Trip the breaker.
• Do NOT touch them.

• Accidents occur from rewiring or installing electrical equipment without following national codes or using an electrician.

• Capacitors and other electrical equipment can hold charges, even after disconnected.

• Keep electrical equipment separate from water and liquids.
Electrical Shock

• Injuries vary depending on intensity and duration.
• Damages and can stop the heart, lungs, brain and other organs.
• Not just serious injuries require medical attention.
Electrical Burns

• Most common shock-related, nonfatal injury.
• Often occurs on the hands.
• Ranges from partial to full thickness.
• Extremely painful.
Falls and other Secondary Injuries

- Electric shock can cause secondary injuries. Falls are the most common.

- Workers in elevated locations who experience shock can fall, resulting in injury or death.
What Should I Look For?

• Damaged electrical equipment – including extension cords and power strips.

• Improperly grounded or insulated power tools and equipment.

• Overloaded circuits and inadequate wiring.

• Ground Fault Circuit Interrupters (GFCI) in wet areas.
Use of Flexible Cords

More vulnerable than fixed wiring, flexible cords can be damaged by:

- Aging
- Edges of other items, such as windows and doors
- Staples or fastenings
- People in the area

Improper use of flexible cords can cause shocks, burns, fire, and can be a trip hazard.
Courtesy UW Worksafe. Used with permission.
How Many Cords Can You Find?
Cabinets, Boxes & Fittings

• All boxes and fittings must have approved covers.
  – Duct tape is not an appropriate cover.
• There should be no unused openings in cabinets (breaker panels) or boxes (outlets).
Unprotected Electrical Components

All electrical components must be insulated or guarded to shield people from exposed circuitry.
Grounding & Double Insulation

• Power tools present a shock hazard due to hand contact
• To protect from shock, burns, and electrocution, tools must:
  • Be UL/CSA certified
  • Have a three-wire cord with ground and be plugged into a grounded receptacle; or
  • Be double insulated

Which one is double insulated?
Overload Effects

• High temps
• Melted insulation
• Arcing
• Fires
Electrical Safety Devices

• Insulation (barrier)
• GFCI
• Grounding
• Fuses and breakers

Courtesy ELCOSH. Used with permission.
Ground Fault Circuit Interrupter (GFCI)

Protects *people* from shock by detecting small current leaks, called a ground fault.

When a GF is detected, GFCI shuts off electricity within $1/40^{th}$ of a second.
Fuses and Circuit Breakers

*Overcurrent* devices for protection of equipment – not for protection of people.

When there is too much current:

- Fuses melt
- Circuit breakers trip
Clues That Electrical Hazards Exist

• Repeated tripped circuit breakers or blown fuses.
• GFCI trips unexpectedly.
• Overheated tools, wires, cords, connections, or junction boxes.
• Worn or frayed insulation around wire or connection.
What to Do?

• Inspect cords and equipment before use.
• Properly use plugs.
• Use 3-prong grounded extension cords.
• Protect cords and equipment.
What Not to Do?

• Don’t fasten cords using nails, staples, etc.
• Don’t bundle cords while plugged in.
• Don’t strain cords.
• Don’t splice cords.
What Else to Do?

• Label electrical hazards.
• Use barriers and guards appropriately.
• No jewelry or metal objects around electricity.
• Use GFCI in wet areas.
• Repair and maintain equipment.
• Be aware of Lock Out / Tag Out situations.
What If an Injury Happens?

- Never rescue a victim in contact with electricity before disconnecting the power.
- Shut down power at remote controls or breaker.
- Seek immediate medical help for all electrical injuries.
- Provide first aid and CPR (if trained) until help arrives.
- Notify a supervisor and fill out an accident report. UW uses the Online Accident Reporting Systems (OARS).
New Installation

• For changes to your lab space:
  – Installation of electrical outlets, upgrades to lab, contact Facilities Services for qualified electricians.
    • May need to upgrade electrical system.
    • Asbestos and lead paint maybe present in walls, floors ceilings.
  – Manufacturer or contract reps should assemble new equipment.
    • Ensure you review and understand the warranty.
    • Review contract for costs.
  – Plug and play – go for it.
Other Resources

Basic Electrical Safety:
• NIOSH Electrical Safety Student Manual

High Voltage Research Safety:
• Colorado State University High Voltage Safety Manual

Safe Use of Extension Cords & Surge Protectors:
• UC Berkeley EH&S Fact Sheet

Local, Equipment-Specific Guidance:
• Consult and Follow the Manufacturer’s Instructions.

If you have any other concerns or questions about electrical safety, please contact UW EH&S at (206) 543-7262 or ehsdept@uw.edu.