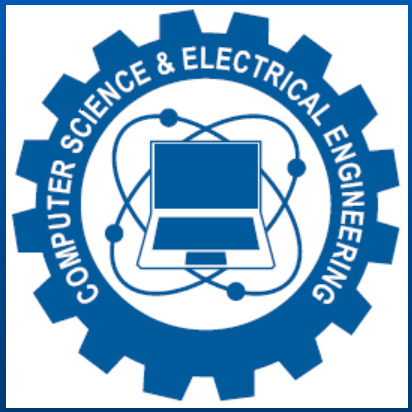
Electrical Safety



Electricity is Dangerous

Electrical shock causes injury or death!

- Whenever you work with power tools, electronic equipment, or on electrical circuits there is a risk of electrical hazards, especially electrical shock. Anyone can be exposed to these hazards at home, school, or at work.
- Coming in contact with an electrical voltage can cause current to flow through the body, resulting in electrical shock and burns. Serious injury or even death.
- Electrocution is the third leading cause of work related deaths among 16- and 17-year-olds, after motor vehicle deaths and workplace homicide. Electrocution is the cause of 12% of all workplace deaths among young workers.

How Is an Electrical Shock Received?

- An electrical shock is received when electrical current passes through the body. Current will pass through the body in a variety of situations. Whenever two wires are at different voltages, current will pass between them if they are connected. Your body can connect the wires if you touch both of them at the same time. Current will pass through your body.
- You will receive a shock if you touch two wires at different voltages at the same time.

Wires carry current!

HOW?

- In most household wiring, the black wires and the red wires are at 120 volts. The white wires are at 0 volts because they are connected to ground.
- The connection to ground is often through a conducting ground rod driven into the earth. The connection can also be made through a buried metal water pipe. If you come in contact with an energized black wire—and you are also in contact with the neutral white wire—current will pass through your body. You will receive an electrical shock.

Important Terms

- ***Current*** — the movement of electrical charge
- ***Voltage*** — a measure of electrical force
- ***Circuit*** — a complete path for the flow of current
- ***Ground*** — a physical electrical connection to the earth

Important Terms (continued)

- ***Energized* (live, "hot")** — similar terms meaning that a voltage is present that can cause a current, so there is a possibility of getting shocked
- ***Conductor*** — material in which an electrical current moves easily
- ***Neutral*** — at ground potential (0 volts) because of a connection to ground

Metal electrical boxes should be grounded to prevent shocks!

- Plumbing is often grounded. Metal electrical boxes and conduit are grounded.
- You will receive a shock if you touch a live wire and are grounded at the same time.

Most electronic equipment requiring 120 volts is grounded to prevent shock!

Any electronic equipment which is energized by 120 volts is a potential shock hazard.

Black and red wires are usually energized, and white wires are usually neutral.

If you are in contact with a live

wire or any live component of an

energized electrical circuit—and

also in contact with any

grounded object—you will

Dangers of Electrical Shock

- The severity of injury from electrical shock depends on the *amount* of electrical current, the *length of time* the electrical current passes through the body, and the *path* of the electrical current.
- The greater the current, the greater the shock!
- The longer the shock, the greater the injury.
- You will be hurt more if you can't let go of a tool giving a shock.

Dangers of Electrical Shock (continued)

- The amount of internal current a person can withstand and still be able to control the muscles of the arm and hand can be less than 10 milliamperes (milliamps or mA).
- Currents above 10 milliamperes can paralyze or “freeze” muscles. When this “freezing” happens, a person is no longer able to release a tool, wire, or other object. In fact, the electrified object may be held even more tightly, resulting in longer exposure to the

Dangers of Electrical Shock (continued)

shocking current. If you can't let go of the electrified object, current continues through your body for a longer time, which can lead to respiratory paralysis (the muscles that control breathing cannot move). You stop breathing for a period of time. People have stopped breathing when shocked with currents from voltages as low as 49 volts. Usually, it takes about 30 milliamperes of current to cause respiratory paralysis.

Dangers of Electrical Shock (continued)

- Currents greater than 75 milliamperes cause ventricular fibrillation (very rapid, ineffective heartbeat). This condition will cause death within a few minutes unless a special device called a defibrillator is used to save the victim.
- Currents at 4 amperes, cause heart paralysis which means the heart does not pump at all.
- Currents greater than 5 amperes will cause tissue to burn.

Effects of Electrical Current on the Body

- 1 milliampere — Just a faint tingle.
- 5 milliamperes — Slight shock felt. Disturbing, but not painful. Most people can “let go.” However, strong involuntary movements can cause injuries.
- 6–30 milliamperes — Painful shock. Muscular control is lost. This is the range where “freezing currents” start. It may not be possible to “let go.”

Effects of Electrical Current on the Body (continued)

- 50–150 milliamperes — Extremely painful shock, respiratory arrest (breathing stops), severe muscle contractions. Flexor muscles may cause holding on; extensor muscles may cause intense pushing away. Death is possible.
- 1–4.3 Amperes — Ventricular fibrillation (heart pumping action not rhythmic) occurs. Muscles contract; nerve damage occurs. Death is likely.
- 10 Amperes — Cardiac arrest and severe burns occur. Death is probable.

High voltages cause additional injuries!

High voltages can cause violent muscular contractions. Or you may lose your balance and fall, which can cause injury or even death. Muscle contractions may cause bone fractures from either the contractions themselves or from falls.

Higher voltages can cause larger currents and more severe shocks!

At 600 volts, the current through the body may be as great as 4 amperes, causing damage to internal organs such as the heart, internal blood vessels may clot, nerves in the area of the contact point may be damaged, and can also cause severe burns.

Some injuries from electrical shock cannot be seen!

Severe shock can cause much more damage to the body than is visible. Sometimes the hidden injuries caused by electrical shock result in a delayed death. Shock is often only the beginning of a chain of events. A person may suffer internal bleeding and destruction of tissues, nerves, and muscles. Even if the electrical current is too small to cause injury, your reaction to the shock may cause you to fall, resulting in bruises, broken bones, or even death.

Currents across the chest are very dangerous!

The path of the electrical current through the body affects the severity of the shock, currents through the heart or nervous system are most dangerous.

Skin resistance affects shock severity!

- ***Resistance*** — a material's ability to decrease or stop electrical current.
- ***Ohm*** — unit of measurement for electrical resistance

Skin resistance hinders current. The lower the resistance, the greater the current will be. Dry skin may have a resistance of 100,000 ohms or more. Wet skin may have a resistance of only 1,000 ohms. Wet working conditions or broken skin will drastically reduce resistance.

Skin resistance affects shock severity! (continued)

The low resistance of wet skin allows current to pass into the body more easily and give a greater shock.

When more force is applied to the contact point or when the contact area is larger, the resistance is lower, causing stronger shocks.

Current causes the body to ‘sweat’ as it heats the skin.

The wet skin reduces the body resistance causing more current to flow and therefore continue to ‘cook’ the skin.

Skin resistance affects shock severity! (continued)

Never work on a live electric circuit or near any electronic equipment when you are near water.

Your risk of receiving a shock is greater if you stand in a puddle of water.

Wet clothing, high humidity, and perspiration also increase your chances of being electrocuted.

What Should I Do If Another Is Shocked or Burned by Electricity?

Shut off : the electrical current if the victim is still in contact with the energized circuit. While you do this, have someone else call for help. If you cannot get to the breaker quickly, pry the victim from the circuit with something that does not conduct electricity such as dry wood.

Do not touch the victim yourself if they are still in contact with an electrical circuit!!!You do not want to be a victim, too!!!

What Should I Do If Another Is Shocked or Burned by Electricity? (continued)

***Do not leave* :** the victim unless there is absolutely no other option. You should stay with the victim while Emergency Medical Services (EMS) is contacted. The caller should come back to you afterwards to verify that the call was made. If the victim is not breathing, does not have a heartbeat, or is badly injured, quick response by a team of emergency medical technicians (EMT's) or paramedics gives the best chance for survival.

What Should I Do If Another Is Shocked or Burned by Electricity? (continued)

CPR (Cardial Pulmonary Resusitation) **:** in some cases CPR might have to be administered if the victim is not breathing and/or does not have a heartbeat. CPR should only be applied if you are trained. This might be the victim's only chance for survival until emergency medical technicians (EMT's) or paramedics arrive.

What must I do to be safe?

1. Identify any potential electrical hazards.
2. Don’t listen to reckless, dangerous people.
3. Evaluate your risk.
4. Take steps to control hazards.
5. Create a safe workplace.
6. Work safely.
7. Use the safety model to recognize, evaluate, and control hazards.

Safety Model

To be safe, you must think about what you are doing and plan for hazards. To avoid injury or death, you must understand and ***recognize*** hazards. You need to ***evaluate*** the situation you are in and assess your risks. You need to ***control*** hazards by creating a safe work environment, by using safe work practices, and by reporting hazards to a supervisor or teacher.

Safety Model (continued)

Recognize **:** Inadequate or bad wiring, exposed electrical parts, overhead powerlines, ungrounded electrical systems and tools, overloaded circuits, damaged power tools and equipment, wrong tools or equipment, metal ladders, wet working surface, untidy work area.

Safety Model (continued)

Evaluate **:** Tripped circuit breakers (*GFCI*), warm electrical tool, appliance, wire, or component. A cable, fuse box, or junction box that feels warm may indicate burning odor may indicate overheated insulation. Worn, frayed, damaged insulation around any wire. Exposed wire could cause a shock.

Safety Model (continued)

Control **:** Treat all conductors and equipment as if they are energized.

Safety Quiz