Controlling Electrical Hazards

An Online Continuing Education Course for Engineers

Course Number: E-1013

Credit: 1 Hour / 1 PDH / 1 CPD

Controlling Electrical Hazards

Introduction

This course provides an overview of basic electrical safety on the job.

Electricity is essential to modern life, both at home and on the job. Some employees—engineers, electricians, electronic technicians, and power line workers, among them—work with electricity directly. Others, such as office workers and sales people, work with it indirectly. Perhaps because it has become such a familiar part of our daily life, many of us do not give much thought to how much our work depends on a reliable source of electricity. More importantly, we tend to overlook the hazards electricity poses and fail to treat it with the respect it deserves.

Why should you be concerned about electrical hazards?
Electricity has long been recognized as a serious workplace hazard, exposing employees to electric shock, electrocution, burns, fires, and explosions. In fact, electrocution has historically accounted for about 5% of all on-the-job fatalities in the U.S., according to the Bureau of Labor Statistics. What makes these statistics more tragic is that most of these fatalities could have been easily avoided.

Electricity: The Basics

What affects the flow of electricity?
Electricity flows more easily through some materials than others. Some substances such as metals generally offer very little resistance to the flow of electric current and are called "conductors." A common but perhaps overlooked conductor is the surface or subsurface of the earth. Glass, plastic, porcelain, clay, pottery, dry wood, and similar substances generally slow or stop the flow of electricity. They are called "insulators." Even air, normally an insulator, can become a conductor, as occurs during an arc or lightning stroke.

How does water affect the flow of electricity?
Pure water is a poor conductor. However, small amounts of impurities in water like salt, acid, solvents, or other materials can turn water itself and substances that generally act as insulators into conductors or better conductors. Dry wood, for example, generally slows or stops the flow of electricity. However, when saturated with water, wood turns into a conductor. The same is true of human skin. Dry skin has a fairly high resistance to electric current, but when skin is moist or wet, it acts as a conductor. This means that anyone working with electricity in a damp or wet environment needs to exercise extra caution to prevent electrical hazards.

What causes shocks?
Electricity travels in closed circuits, normally through a conductor, but sometimes a person's body—an efficient conductor of electricity—mistakenly becomes part of the electric circuit. This can cause an electrical shock. Shocks occur when a person's body completes the current path with:

- both wires of an electric circuit;
- one wire of an energized circuit and the ground;
- a metal part that accidentally becomes energized due, for example, to a break in its insulation; or
- another "conductor" that is carrying a current.

When a person receives a shock, electricity flows between parts of the body or through the body to a ground or the earth.

What effect do shocks have on the body?
An electric shock can result in anything from a slight tingling sensation to immediate cardiac arrest. The severity depends on the following:

- the amount of current flowing through the body,
- the current's path through the body,
- the length of time the body remains in the circuit, and
- the current's frequency.

This table shows the general relationship between the amount of current received and the reaction when current flows from the hand to the foot for just 1 second.

Effects of Electric Current in the Human Body

Current	Reaction
Below 1 milliampere	Generally not perceptible
1 milliampere	Faint tingle
5 milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6–25 milliamperes (women)	Painful shock, loss of muscular control*
9–30 milliamperes (men)	The freezing current or "let-go" range.* Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated.
50–150 milliamperes	Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
1,000–4,300 milliamperes	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes	Cardiac arrest, severe burns; death probable

* If the extensor muscles are excited by the shock, the person may be thrown away from the power source.

Source: W.B. Kouwenhoven, "Human Safety and Electric Shock," *Electrical Safety Practices*, Monograph, 112, Instrument Society of America, p. 93. November 1968.

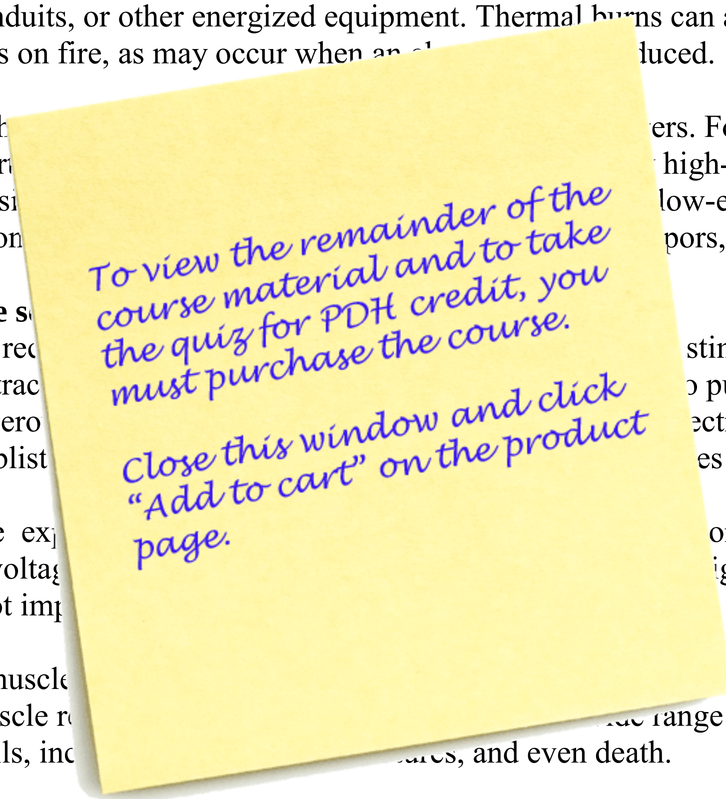
What kind of burns can a shock cause?
Burns are the most common shock-related injury. An electrical accident can result in an electrical burn, arc burn, thermal contact burn, or a combination of burns.

Electrical burns are among the most serious burns and require immediate medical attention. They occur when electric current flows through tissues or bone, generating heat that causes tissue damage.

Arc or flash burns result from high temperatures caused by an electric arc or explosion near the body. These burns should be treated promptly.

Thermal contact burns are caused when the skin touches hot surfaces of overheated electric conductors, conduits, or other energized equipment. Thermal burns can also be caused when clothing catches on fire, as may occur when an el... ...duced.

In addition to sh... ...ers. For example, arcs that result from shor... ...high-energy arcs can damage equipment, causi... ...low-energy arcs can cause violent explosion... ...pors, or combustible dusts.



Why do people s...
When a person rec... ...stimulation causes the muscles to contrac... ...pull free of the circuit. It is extremely dangero... ...ectricity and because the current causes blist... ...es the current.

The longer the ex... ...onger exposures at even relatively low volta... ...igher voltages. Low voltage does not im...

In addition to muscle... ...also can cause involuntary muscle r... ...range of other injuries from collisions or falls, inc... ...and even death.

What should you do if someone "freezes" to a live electrical contact?
If a person is "frozen" to a live electrical contact, shut off the current immediately. If this is not possible, use boards, poles, or sticks made of wood or any other nonconducting materials and safely push or pull the person away from the contact. It is important to act quickly, but remember to protect yourself as well from electrocution or shock.

How can you tell if a shock is serious?
A severe shock can cause considerably more damage than meets the eye. A victim may suffer internal hemorrhages and destruction of tissues, nerves, and muscles that are not readily visible. Renal damage also can occur. If you or a coworker receives a shock, seek emergency medical help immediately.