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High-Voltage Electric Safety

by Pam Tompkins

Establishing safety precautions for horticulture employees working near high-voltage power lines is of utmost importance.

Many horticulture employees are exposed daily to electricity, both low and high voltages, in their work environments. Workplace surroundings can be very safe as long as employees understand the basic principles of electricity and the safety precautions that must be taken when working around energized lines and equipment. According to the US Labor Department's Bureau of Labor Statistics' Census of Fatal Occupational Injuries, electrocutions are the sixth leading cause of workplace deaths. Contact with overhead and underground power lines accounted for 43 percent of all on-the-job electrical deaths.

The number of people who believe that normal household current is not lethal or that overhead power lines are insulated and do not pose a hazard is alarming. There are basic principles of high voltage, including rules for tree trimmers and landscapers who may work near energized, high-voltage lines.

Fundamental electricity facts. Electricity is always looking to travel to the ground and is constantly seeking the shortest route there — the path of least resistance. Electric shock occurs when the path of least resistance is through the human body. The human body is composed of approximately 80 percent water, which is a great conductor of electricity.

Electricity travels at the speed of light (186,000 miles per second) and can reach extreme temperatures that easily melt steel. When a short circuit occurs or a current flow is interrupted, an arc is often created. If the current involved is great enough, these arcs can cause injury or start a fire. Fires can also be caused by overheating equipment or by conductors carrying too much current. Extremely high-energy arcs can damage equipment, causing fragmented metal to fly in all directions. In explosive or combustible atmospheres, even low-energy arcs can cause violent explosions.

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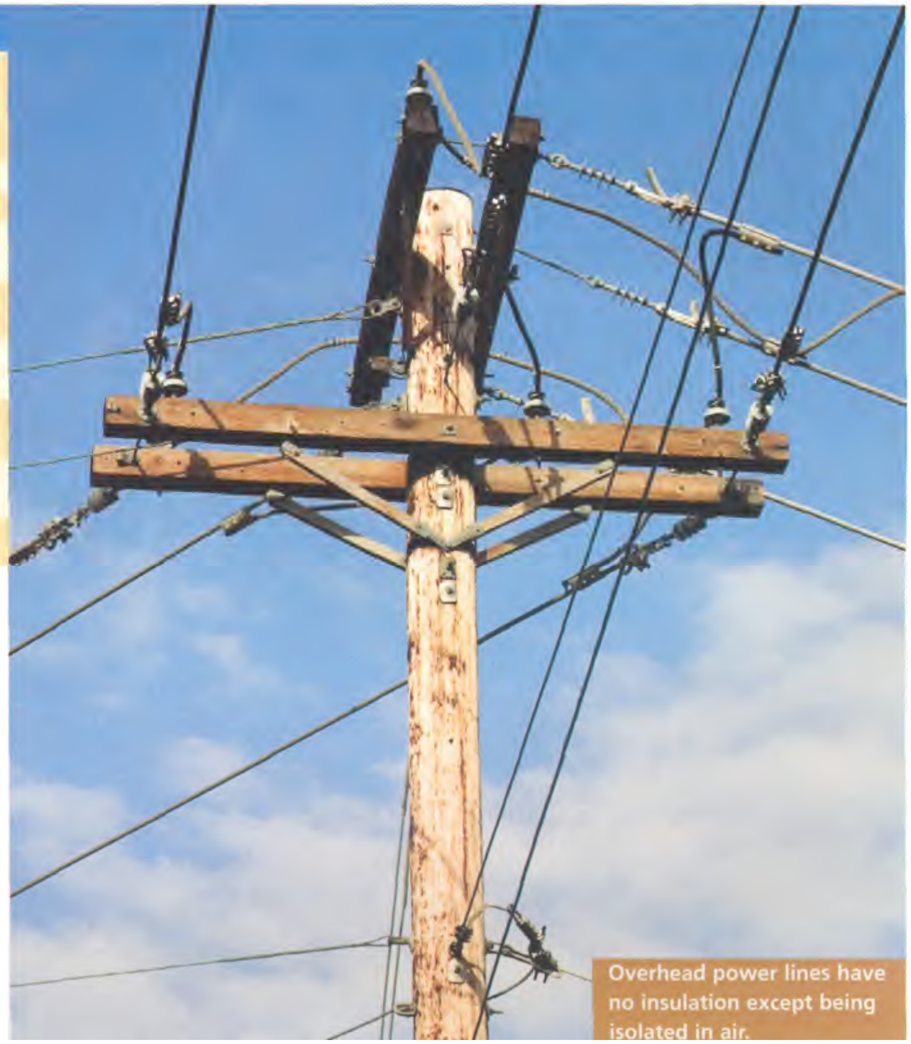
Electrical injury reactions

Physiological effects of current at different intensities:

1 milliamp	No sensation felt
2 milliamps	Numbness of hand
5 milliamps	Tremor of hand and spasm of forearm
10 milliamps	Voluntary "let-go/release" current
20 milliamps	Painful muscular contractions
50 to 100 milliamps	Possible ventricular fibrillation
100 to 200 milliamps	Certain ventricular fibrillation
4 amps	Heart stops



Overhead power lines have no insulation except being isolated in air.

Overhead power lines have no insulation except being isolated in air. The air serves as an insulator because air has fewer free electrons than the wire conductor. For this reason, an overhead bare-metal conductor is installed on insulators made of porcelain, glass or synthetic polymer materials.

Dangerous voltages. Voltages greater than 600 volts are considered high voltage. High-voltage electric shock is very powerful and normally pushes (or blows) the person away from the source, due to the high-voltage pressure. It can rupture human skin, greatly reducing the resistance of the human body, allowing more current to flow, which causes greater damage to internal organs.

Step and touch potentials are very hazardous; extreme caution should always be taken to prevent their occurrence. Step potential is the voltage between the feet of a person standing near an energized grounded object. A person could be at risk of injury during a fault simply by standing near the grounding point. Electricity reacts basically the same way as a pebble skipping across the water. The concentric circles in the water get larger and larger, which is how electricity reacts across the Earth's surface. Electricity will dissipate across the Earth's surface, creating different voltage potentials. As a person moves his/her feet apart, the amount of voltage drop across their bodies could be fatal.

Touch potential is the voltage between the energized object and the feet of a person in contact with the object. An example would be an employee standing on the ground placing a pruning tool into an overhead power line. Electricity will flow down the pruning tool through the employee into the ground, causing extreme personal injury.

Step and touch potentials can occur when a tree trimmer or landscaper is working in an elevated position or on the ground near overhead lines. The location should be established such that the person and the longest conductive object he or she may contact cannot come within 10 feet for lines 50 kilovolts or less and more for higher voltages.

Electrical injuries. Electrical injuries consist of four main types: electrocution (fatal), electric shock, electrical burns and falls caused from contact with electrical energy. Electrical injuries may occur in various ways, such as:

- direct contact with electrical energy, like when a person directly touches an energized conductor or equipment;
- when electricity arcs to a victim, such as an arc blast (flash) creating a serious hazard when an electrical arc occurs; and
- flash burns generated by an electrical arc during an arc blast (flash), and all skin not covered with clothing can receive serious burns.

Flame burns, on the other hand, are produced by the ignition of clothing or other combustible materials. An electric arc can be extremely hot, causing clothing consisting of man-made fibers, such as polyester, rayon and nylon, to stick to human skin. Also, the intensity of the arc could ignite natural-fiber clothing, such as cotton, causing it to burn intensely. The effect that electricity has on an individual depends on four factors: the voltage of the circuit; internal body resistance; the amount of current that flows through the body; and the path electricity takes through the body.

Body resistance. The average body resistance with dry skin is about 100,000 ohms. As the body starts to sweat, the resistance of the body decreases as skin becomes moist through sweat or contact with water. Mild sweating can reduce the skin resistance to 10,000 ohms; excessive sweating can reduce the skin resistance to 1,000 ohms. This resistance of the body becomes very important in hot or wet work environments.

Ohm's Law states, "The current equals the voltage divided by the resistance." When body resistance decreases, current flow through the body increases. An appli-

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cation of Ohm's Law with 15,000 volts and a normal body resistance would result in 150 milliamps of current flow through the body. An application of 15,000 volts and excessive sweating would result in 15,000 milliamps of current flow through the body. An application of 120 volts and excessive sweating would result in 120 milliamps of current flow through the body. Many people are killed with low voltage because of the amount of current flow through the body with the body resistance conditions. These amounts are measured in milliamps of current flow, one-thousandth of an amp. The chart (page 25) shows 4 amps of current flow will cause the human heart to immediately stop functioning. Many of the circuit breakers and fuses in homes and businesses are 20 to 30 amps. This fact proves circuit breakers and fuses are not for personal safety, but rather to prevent overloading and fires.

Controlling electrical hazards. Understanding the nature of electricity will help in preventing electric contacts. Conduct a "job safety analysis" of all tasks that might expose tree trimmers and landscapers to the hazards associated with electrical lines and equipment, including both overhead and underground lines. Identify potential electrical hazards and appropriate safety procedures that must be followed during the planning phase of tree trimming, landscaping and other horticulture projects.

When operating equipment near electric power lines, an equipment safe zone (boundary) must be marked to ensure employees that the potential of contacting overhead power lines will not cross into the unsafe zone. The OSHA standards require a 10-foot clearance from power lines of 50 kilovolts or less — and even more for higher voltages. *This is a minimum standard and should never be violated.* Companies should train all employees concerning the hazards of step and touch potentials. When marking the safety zone (boundary), a good rule of thumb is to measure on the ground, mark a line with chalk or tape and require employees not to cross the line.

Always call the local utility or cable locator service to mark underground lines. Electric lines in the ground can be very hazardous and could have the capability of causing dangerous step and touch potentials if equipment hits the lines. Always treat overhead and underground lines as energized. Marking lines prior to digging is an important safety rule that must be followed when planting trees and shrubs or performing any digging operations, such as sprinkler installation. Many states have laws requiring underground cable locates to be completed prior to digging.

Ensure compliance with existing OSHA regulations. OSHA addresses electrical safety in 29 CFR 1910, Subpart S for general industry and 29 CFR 1926, Subpart K for construction. Additionally, the National Electrical Code and the National Electric Safety Code comprehensively address electrical safety regulations. Provide additional specialized electrical safety training to those employees working around energized lines or equipment, and conduct scheduled and unscheduled safety inspections at worksites.

Electrical hazards are present in practically every workplace. Many workers are unaware of the potential electrical hazards, which make them more vulnerable to the dangers of electrocution and electrical burns. A strong commitment to safety by both management and workers is essential in the prevention of severe occupational injuries and death due to contact with electrical energy.

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