FACT SHEET

Electrical Hazards: Take Precautions to Reduce Injury and Fatality Risk

This WorkCare Fact Sheet describes electrical hazards in the workplace, the nature of electricity-related injuries, recommendations for first response, related regulatory standards, and injury and fatality prevention.

While it has been harnessed to serve the needs of mankind, electrical energy is a natural—and potentially dangerous—phenomenon.

Employees whose jobs involve direct contact with electricity are trained to protect themselves and others from electrical hazards. But even with safety training, regulatory standards and personal protective equipment, electricity-related injuries and fatalities (electrocutions) occur.

Increased awareness helps save lives, especially in workplaces where electrical hazards are not top of mind.

Exposure Risk

Work-related fatalities and injuries can result from exposure to generated electricity, arc flash or lightning strike.

When an electrical current passes through the body, it generates heat. The current can cause cardiac arrest, damage internal organs and tissues, and burn the skin. The path the current takes, type and strength of voltage, duration of exposure and the recipient's health status are all determining factors for injury severity. According to the U.S. Bureau of Labor Statistics:

- 6,000 electricity-related work fatalities were reported between 1992 and 2013.
- From 2003-2010, contact with electric current ranked seventh among the top-10 causes of work-related fatalities.
- 24,100 non-fatal, electrical work-related injuries occurred between 2003 and 2012.
- 78 electricians died in work-related incidents in 2014, 14 more than in 2013 (Census of Fatal Occupational Injuries).

Generated Electricity: Consequences can be severe whether a worker comes in contact with an object as seemingly innocuous as a broken light bulb or a high-voltage power line.

An electric shock can occur when a person touches a grounded surface and electrical equipment at the same time—the flow of electric current (amperage) flows through the body to the ground. Even exposure to the current drawn by a small, low-watt lamp can be

fatal. Exposure to household alternating current (AC) has been found to be more dangerous than exposure to direct current (DC) because it is more likely to cause involuntary muscle contractions, prolonging duration of exposure.

Arc Flash: An arc flash occurs when an electrical current leaves its intended path and travels through the air from one conductor to another, or to ground. An arc flash can ignite a fire and be powerful enough to propel objects such as shards of molten metal. Intense heat, blast pressure and percussive sound present serious health risks for workers and bystanders.

Lightning: While lightning strikes are one of the leading causes of weather-related fatalities, the Centers for Disease Control and Prevention (CDC) reports the odds of being struck are only about 1 in 500,000. In 2014, there were 26 lighting-related deaths in the U.S. The 30-year average, from 1985 to 2014, was 49 fatalities per year. The date and location of each incident is reported online by the National Weather Service. The number of non-fatal injuries is much higher, however, there isn't a comprehensive system in place to accurately track lightning injury and severity distributions across the U.S.

The number-one way to prevent electrical injuries and fatalities is to de-energize equipment before working on it.

Injury and Fatality Causes

A review of selected Occupational Safety and Health Administration (OSHA) investigations of electrical injury incidents and related research indicate many injuries are associated with "work inappropriately performed on energized equipment" or "failure to recognize all electrical sources." The main cause of death among electricians in construction, who as an occupational group have a higher than average degree of exposure risk, was found to be contact with live equipment, wiring and light fixtures, most often involving electrical control devices.

The U.S. Department of Labor reports:

- 37 percent of non-fatal electrical injuries were caused by "contact with electrical current of machine, tool, appliance or light fixture" between 2003 and 2010.
- "Contact with wiring, transformers or other electrical components" accounted for 35 percent of non-fatal injuries.
- Contact with overhead powerlines caused 40 percent of fatal injuries between 2003 and 2010 but only 2 percent of non-fatal injuries.

In some cases, workers may be injured or killed when they take shortcuts because of time constraints or pressure from peers or supervisors, or when they fail to consistently use appropriate personal protective equipment,

according to a Fire Protection Research Foundation report.

Arc flash is often attributed to failure to de-energize equipment or circuits. Other contributing factors may include the presence of dust, dropping tools, accidental contact, condensation, material failure, corrosion or faulty installation. Not establishing or complying with approach boundaries also increases injury risk, according to the Workplace Safety Awareness Council, an organization that received an OSHA grant to develop electrical hazard safety training materials.

In cases involving lightning strikes, location plays a significant role because lightning is predisposed to hit an object based on its height, isolated position and shape. Less than 5 percent of lightning deaths are caused by a direct strike. Most injuries and deaths are caused when lightning side-flashes after hitting an object such as a tree or tower, or the electrical charge passes through roots, the ground, metal pipes, wires or other objects before coming into contact with a person, either outside or indoors.

Signs and Symptoms

Electrical injuries are often debilitating and can have a dramatic effect on quality of life and productivity. If not fatal, severe electric shock causes unconsciousness, respiratory paralysis, muscle contractions, bone fractures and joint dislocations, serious burn injuries and damage to vital organs. If the victim falls from a height as a result of electric shock, additional injuries may result.

Physical limitations and neurological deficit, memory loss, irritability and other changes in behavior may develop as a result of exposure to electrical currents. Other related complaints include:

- Irregular heart beat
- Chest, arm, neck, jaw or back pain
- Headache
- Problems with swallowing, vision or hearing
- Numbness or tingling
- Difficulty breathing
- Seizures

Electrical arcs may cause severe burns, hearing loss, eye injuries and lung damage.

The physics of lightning differs from man-made electricity, with corresponding differences in pathophysiology and injury patterns, experts say. Serious lightning injuries primarily involve cardiac arrest, neurologic injury and hypoxia (inadequate oxygen supply). Burns, hearing loss and the development of cataracts are also associated with lightning strikes. In mild to moderate cases, musculoskeletal discomfort and burning or prickling sensations, irritability and other non-specific complaints may be present.

Emergency Response

Emergency medical response and specialty follow-up care is recommended for electrical injuries. For serious electric shock, treatment may involve measures such as CPR, defibrillation and intravenous administration of electrolytes to help stabilize vital functions.

During an emergency response, the following steps are recommended:

1. Call 911 or follow your company's emergency response procedure.
2. Do not touch the person with your hands if they are still in contact with the source of electricity. Do not attempt to approach a person near active high-voltage lines.
3. Turn off the electrical current at the source if it is safe to do so, for example, unplug the cord or turn off circuit breakers. Turning off equipment or an appliance may not stop the flow of electricity.
4. If the current cannot be turned off, use a non-conducting object such as a wooden broom handle or rubber doormat to push the person away from the source of the current. Do not use a wet or metal object. If possible, stand on something dry that that doesn't conduct electricity, such as a newspaper or wooden board. A person who is struck by lightning does not carry an electrical charge and can be immediately helped.
5. Once the person can be safely reached, check his or her airway, breathing and pulse. Begin CPR, as indicated. Refer to the International Liaison Committee on Resuscitation for 2015 American Heart Association and other current CPR guidelines.
6. Do not move the person while waiting for help to arrive unless there is a risk of fire or explosion.
7. For burns, apply cool water and cover with a sterile, non-adhesive bandage or clean cloth. Do not use ice, ointments, medication, cotton dressings or adhesive bandages. Follow-up treatment of skin burns includes evaluation for possible muscle involvement.
8. If the person you are assisting is faint, pale or shows other signs of shock, lay him or her down with the head slightly lower than the trunk and legs elevated; cover with a blanket or coat.

Standards

OSHA's electrical standards apply to general industry (29 CFR 1910), shipyard employment (29 CFR 1915) and marine terminals (29 CFR 1917). A web page on OSHA's Electric Power Generation, Transmission and Distribution Standard explains revised rules that became effective July 10, 2014, and changes specifically affecting the construction industry. Standards that apply to the control of hazardous energy (lockout/tagout) are contained in 29 CFR 1910.147.

Updated rules include requirements for fall protection, minimum approach distances and arc-flash protection. The rules also call for host employers and contract employers to exchange safety-related information.

Related documents include:

- Questions and Answers on the final rule
- Memorandum to OSHA field offices regarding enforcement of fall protection requirements
- General memorandum on enforcement dates and a related memorandum on enforcement dates for requirements on flame-resistant clothing, arc-rated

clothing and other protective equipment.
- Memorandum on the applicability of Section 1910.269 to line-clearance tree trimming

Additional sources for standards and best practices include:

- American National Standards Institute Workplace Standards – ANSI is a private, non-profit organization that coordinates and administers U.S. voluntary standards
- International Organization of Standardization – The ISO is a non-profit organization that develops and publishes global standards
- National Fire Protection Association – 70E Standard for Electrical Safety in the Workplace, 2015 edition
- Underwriters Laboratories Electrical Code Topics – UL is a global, independent safety science company dedicated to promoting safe living and working environments

Prevention

When working with or around electricity, it's essential to comply with all applicable occupational standards, personal safety precautions and manufacturer guidelines. At construction sites, thorough, pre-job planning with qualified personnel is essential to identify all electrical sources, including unanticipated hazards that are not included in drawings.

Here are some simple but important safety tips that apply no matter what type of work you do:

Overhead Lines

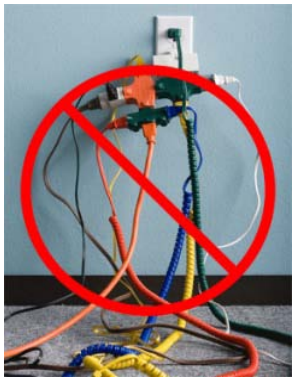
- Assume that all overhead lines are energized at lethal voltages. Never assume a wire is safe to touch, even if it is down or appears to be insulated. Call the utility company in your service area to report fallen electrical lines.
- Stay at least 10 feet away from overhead wires during cleanup and other activities.
- If working at heights, on scaffolding or handling objects such as a tall metal ladder or electric trimmer, survey the area for overhead lines before starting work.
- If an overhead wire falls across your vehicle while driving, stay inside and continue to drive away from the line. If the engine stalls, do not leave the vehicle. Call or signal for help but do not let others approach the vehicle. Immediately report the situation to the local electric utility company and emergency services.

Outdoor Operations

- Call your local utility company before digging so underground lines can be marked.
- Never operate electrical equipment while standing in water.
- Test before touch. Always de-energize equipment before working on it.
- Never repair electrical cords or equipment unless you are qualified and authorized to do so.
- Do not repair cracked or broken extension cords with black electrical

tape; it does not provide adequate insulation.
- Have a qualified electrician inspect electrical equipment that has gotten wet before energizing it.
- If working in damp locations, inspect electric cords and equipment to ensure that they are in good condition and free of defects; use a ground-fault circuit interrupter (GFCI).

Indoor Safety



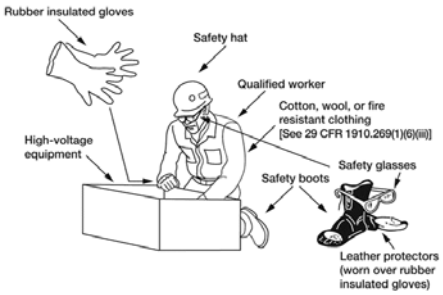
- Use surge suppressors, power strips and extension cords as directed; do not overload the power supply.
- Replace old, frayed or damaged wiring and plugs.
- Use appliances and equipment according to manufacturer's instructions; repair or replace damaged equipment.
- Use GFCI interrupter protection when working where water is near electricity to protect against shock. (These are the types of electrical outlets typically installed in bathrooms.)
- Use an arc fault circuit interrupter to detect and stop electrical arcs that can cause fires.
- Check products/equipment for approval by an independent testing lab such as the Canadian Standards Organization, ETL or UL.
- If children are present, baby-proof your home or office using approved devices to block outlets.
- When working around electricity, do not wear metal jewelry that might make contact with current.

Lockout/Tagout

- Check all machinery and equipment to ensure it is de-energized or disengaged and blocked or locked out during cleaning, servicing, adjusting or setting up operations.
- If the power disconnect for equipment does not also disconnect the electrical control circuit, ensure that the control circuit can also be disconnected and locked out.
- Questions to ask include:
  - Is it required that only the employee exposed to the hazard can place or remove the safety lock?
  - Is there a means provided to identify employees who are working on locked-out equipment by their locks or accompanying tags?
  - Are a sufficient number of incident prevention signs or tags and safety padlocks provided for any reasonably foreseeable repair emergency?
  - If equipment or lines cannot be shut down, locked out and tagged, is a safe job procedure established and rigidly followed?

OSHA's lockout/tagout standard prevents an estimated 120 fatalities and 50,000 injuries year, but non-compliance continues to be one of the most-cited violations.

Personal Protective Equipment (PPE)



- Always wear PPE designed and recommended for the job. This may include hard hat; gloves; goggles, safety glasses or a face shield; safety shoes or boots; and protective clothing.
- Consistently use fall protection equipment as instructed.
- Wear PPE as the outermost layer, using zippers, buttons, straps and other devices as recommended.
- Maintain PPE and replace it when it becomes worn or ill-fitting.

Electrical Storms

- Before working outdoors, check the weather forecast. Pay attention to early signs of potential lightning strikes such as high winds, dark clouds or distant thunder or lightning. When these occur, do not start any activity that you cannot quickly stop.
- Follow your company's lightning safety warning program, including access to a safe location.
- In a storm, avoid rooftops, scaffolding, utility poles, ladders, trees and large equipment such as bulldozers, cranes and tractors. Do not touch materials or surfaces that conduct electricity, including metal scaffolding, metal equipment, utility lines, water or pipes.During an electrical storm, leave immediately if you are in an area with explosives.

Summary

Electricity is a natural and versatile form of energy, but it can be extremely dangerous if not correctly managed. Sound safety practices help reduce the risk of accidents, injuries and fatalities. The more you understand about electrical energy, the safer you will be at work and home.

Recommended Resources:

1. Electrical Safety Foundation International Workplace Safety, www.esfi.org/workplace-safety
2. Lightning Injuries, Medscape, Sept. 26, 2014, http://emedicine.medscape.com/article/770642-overview
3. NIOSH website on electrical hazards, www.cdc.gov/niosh/topics/electrical/
4. Occupational Injuries From Electrical Shock and Arc Flash Events; R Campbell, D Dini; Fire Protection Research Foundation, March 2015 www.nfpa.org/research/fire-protection-research-foundation/
5. OSHA Electrical Safety Quick Card, www.osha.gov/Publications/electrical_safety.html
6. Understanding Arc Flash, www.osha.gov/dte/grant_materials/fy07/sh-16615-07/arc_flash_handout.pdf
7. Worker Deaths by Electrocution: A summary of NIOSH surveillance and investigative findings, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 1998, www.cdc.gov/niosh/docs/98-131/pdfs/98-131.pdf