TEXAS A&M AGRILIFE EXTENSION

E-221
09/04

Preventing Electrical Shock

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August 7, 1992. A 33-year-old farmer was electrocuted when a hay elevator he was moving contacted a 7,200-volt power line almost 22 feet above the ground. The farmer had often moved the 45-foot hay elevator by himself, manually or by tractor, without mishap. On this occasion, a neighbor and a hired hand with 2 days' experience were helping him. The elevator may have slipped and dropped lower to the ground than planned, causing the discharge end to rise and contact the power line. Or, they may have failed to lift the loading end high enough to provide safe clearance between the power line and the discharge end. The farmer was pronounced dead at the scene by emergency personnel. The hired man and neighbor were treated and released at nearby hospitals.

Source: Wisconsin FACE 92WI09501

Electrical shock occurs when a person touches any electrically charged object while at the same time touching another surface that can conduct the electricity to the ground. Common sources of electrical shock are bare and damaged wires, machinery and tools, and extension cords. Proper grounding and electrical safety devices can help prevent electrical shock.

The following table describes the effect of varying electrical currents on the average adult. This table shows that current levels greater than 8 milliamperes are unsafe. This is only a fraction of the current needed to power a 60-watt light bulb, which draws about 500 milliamperes.

Interestingly, animals are more sensitive to low intensity electrical currents than are humans, because they are naturally grounded. Humans wear shoes or boots that provide some resistance to electric shock. Animals are more likely to feel stray current (released from an underground wire short) and may become reluctant to drink from waterers.

Effect of electric current on humans.

	Milliampere	Effects
SAFE	Less than 1	No sensation, not felt.
	1 to 8	Shock sensation; not painful; can let go at will.
UNSAFE	8 to 15	Painful shock; can let go at will.
	15 to 20	Painful shock; loss of adjacent muscle control; can not let go.
	20 to 50	Painful, severe muscular contractions; difficulty breathing.
	50 to 100	Possible ventricular fibrillation.
	100 to 200	Certain ventricular fibrillation.
	More than 200	Severe burns; severe muscular contractions; chest muscles clamp heart and stop it for the duration of shock.

One milliampere (mA) is 1/1000th of an ampere (current). Ventricular fibrillation is a breakdown of the pumping coordination of heart muscles that will not correct itself. This information applies to adults. Weaker currents could be fatal to children. Information taken from the National Safety Council.

Farm Electrocution Hazards

Electricity is a versatile and efficient source of power on farms. However, it can cause great harm if safety precautions are ignored. Electrical hazards on the farm can injure and kill humans and livestock and cause fires that destroy equipment and buildings. Almost 500 electrical fatalities occur each year, according to the National Safety Council, and about 62 of them occur on farms.

Most electrocution deaths on farms involve grain augers, irrigation pipes, front-end loaders, and other tall equipment that contacts high-voltage electric transmission lines. Damp weather increases the risk, especially in livestock containment areas. Electrical systems within barns and farm buildings can be damaged by rodents, ants, animals, dust and moisture, and unless these systems are properly grounded they also can be very hazardous.

The National Institute for Occupational Safety and Health conducted a multi-state study of farm- related fatalities from 1985 to 2002. The study was called the Fatality Assessment and Control Evaluation (FACE). It investigated 250 farm-related deaths to determine the causes and circumstances surrounding the incidents.

FACE investigated 15 electrocution fatalities on farms. Eleven of them involved grain augers, hay elevators and irrigation pipes contacting high voltage transmission lines. Three fatalities were caused by farm equipment and one was caused by lightning. Almost all of these accidents could have been prevented by observing potential dangers and avoiding unnecessary risks.

According to the study, major causes of electrocution deaths are:

- Contact with high voltage power lines while moving grain augers.
- Failure to recognize and estimate the distance to overhead power lines.
- Failure to keep portable grain augers in good working condition so that they can be easily lowered before being moved.
- Absence of ground fault circuit interrupters on barn electrical systems.
- Insufficient grounding on barn electrical systems.

Prevention

Many people do not recognize electrocution hazards until it is too late. Farm workers, children and family members should learn about common electrical dangers, know what safety precautions to take, and know how to react in case of electrical emergencies. Here are some important things you can do:

Transmission lines and electrical systems:

- Survey the farm and identify hazards posed by overhead transmission lines. Inform workers about overhead lines. Specify how grain augers and other tall machinery should be transported.
- Check and document the height of power lines before beginning any work near them.
- Locate all buried power lines and keep the information available for future reference before digging.
- Inspect the farm for problem areas such as barns and livestock facilities with dusty, moist and corrosive environments. Determine where there are risks for potential electrical shock and restrict access to those areas. Post signs warning of electrocution risk.
- Make sure all equipment (grain augers, irrigation pipe, front-end loaders, and hay elevators) is lowered to a safe position before it is moved from one location to another. Know the height of all equipment and have someone who knows the minimum distance requirements watch for lines when moving equipment. The equipment should not come within 10 feet of overhead power lines.
- Follow the National Electric Safety Code (NESC) standards for the placement of overhead power lines for grain handling systems. NESC standards for portable grain auger systems require that the overhead power line must be at least 18 feet above the highest part of the grain bin. For example, the overhead line for a 15-foot-tall bin must be at least 33 feet above the ground. Contact your electricity provider about burying electrical lines around grain bins and in other areas where equipment is used.
- When new service is requested or existing service is relocated, have the lines buried underground.
- Do not allow children to climb any tree near a power line. Ask your power company for help trimming tree branches that could touch power lines.

You do not actually have to contact electrical lines to be electrocuted. Electric currents can “jump” across open space in order to return to the ground.

OSHA standard 29CFT 1910.333 (c) (3) (i) says that when an unqualified person is working on the ground in the vicinity of overhead lines, the person may not bring any conductive object closer to unguarded energized overhead lines than the following distances: 1) For voltages to ground 50 kV or less–10 feet; 2) For voltages to ground more than 50 kV –10 feet plus 4 inches for every 10 kV over 50 kV.

- Never attempt to raise or move a power line. Treat all overhead power lines as though they are bare and uninsulated.
- When moving tall equipment, always use preplanned routes that avoid power lines and train workers to follow these routes.
- Apply decals to all equipment that may pose electrical shock hazards. Explain the decals to people who work with the equipment.

Machinery and power tools:

- Shut off all power before performing maintenance on electrical parts.
- Never use any electric hand tool that does not carry the Underwriters Laboratory (UL) mark. The UL mark means that the tool has been tested extensively and is safe when used properly.
- Make sure electric tools have three-pronged plugs. These plugs have an emergency wire to protect the user from an internal short or ground.
- Never disconnect or carry electric power tools by the cord. This could damage the cord’s internal insulation. Inspect cords regularly for fraying and other signs of deterioration.

- Make sure all electric motors and machinery are properly grounded.
- Do not operate machinery or power tools while standing in water or working in extremely damp environments.
- Never touch an electric power tool while your hands are wet.
- Check all equipment periodically for worn or cracked insulation, loose wire terminals, corroded wires, and defective parts.
- Use double-insulated power tools to reduce the risk of electric shock. Double-insulated tools do not conduct electric current.
- Use electric safety devices such as Ground Fault Circuit Interrupters (GFCI), fuses and circuit breakers, grounding, and polarization.

Ground fault circuit interrupters (GFCI) protect against electrocution by monitoring the current flow to an electrical device and comparing it to the amount of current flowing back, thus detecting if some current is flowing back through the ground through a path other than the wire. A GFCI recognizes these "ground faults" and stops current from flowing in the circuit. There are three types of GFCIs:

- GFCI breakers are used instead of conventional circuit breakers to protect everything on the circuit. These are typically used in damp places such as in bathrooms, kitchens, laundry rooms, garages and barns.
- GFCI outlets offer protection for everything plugged into them and can easily replace conventional power outlets.
- Portable GFCIs can be plugged into individual machinery or power tool cords and into extension cords to protect specific circuits.
- All GFCI devices are equipped with a test button that intentionally causes a ground fault to ensure that the device is working properly. They should be tested regularly.

Fuses and circuit breakers protect electrical systems against high current levels. Fuses and circuit breakers are rated by the maximum current they will allow and are matched to the size of the electrical wires used in the system.

Grounding protects electric circuits by providing an alternative path through which electricity can flow in case of an electrical short. Grounding occurs when a ground wire (typically green in color) is connected from the ground potential to the frame of electrical equipment. Grounding is not necessary for the circuit to work (i.e., the two-prong plug equipment); however, it does add protection against stray current. Never cut off the round grounding plug on a plug to force it to fit a two-hole extension cord or outlet. Instead, replace the cord or outlet so that it will accept a three-pronged plug.

Extension cords:

- Never use an extension cord unless absolutely necessary.
- Do not use extension cords in wet areas.
- Make sure all extension cords are plugged into three-hole, grounded outlets with face plates.
- Make sure the extension cords you use are right for the job. Extension cords for agricultural use must have a strong outer coating. Extension cords labeled "Type S" (Hard Service Cord) have the strongest outer coating available and are the ones to use on farms.
- Do not try to splice two wires together or repair extension cords. Throw old cords away.
- Use the right size extension cord with the correct size wire (gauge) for the intended use. Never use household-type cords to operate heavy machinery.
- All outdoor extension cords should be equipped with GFCI outlets.
- Do not place heavy objects on extension cords while in use.
- Do not abuse extension cords or use them to tie or secure objects. Check extension cords for nicks and cuts before each use.
- Keep extension cords out of high traffic areas. Route the cord to protect it from machinery and animals.
- Place safety covers on unused outlets.
- Never leave an extension cord plugged in to the power outlet while the opposite end is open.
- After using extension cords, roll them up and hang them where they will not be in the way.

Emergency Procedures

These suggestions address only a few of the situations that may occur on a farm. Other emergency procedures may be necessary for specific incidents or circumstances.

If a tractor or machine comes in contact with overhead power lines while you are on it, do not leave the machine. Try to call for help and wait until help arrives. If you climb off the machine you will become a path for the electricity to reach the ground. If the machine is on fire and you must leave the machine, jump as far away as possible with your feet together. Then shuffle away from the machine using short strides. Long strides could put each foot in separate voltage zones and electrocute you. Once away from the equipment, do not approach it again. Contact the electric service provider or emergency personnel to manage the accident.

If someone is being shocked by electricity, disconnect the power source immediately by turning off the circuit breaker only. Never attempt to unplug the cord, move an energized line with any object, or grab the person to free him. Once the person is free, administer CPR immediately, if necessary, to try to resuscitate the individual.

In case of an electrical fire, turn off the electrical power source at the circuit breaker, and use only fire extinguishers labeled for use on electrical fires. These are Class C fire extinguishers. Water-based extinguishers (Class A) will only increase the potential for electrocution.

Be prepared for emergencies. Have an emergency plan that all co-workers and family members know. Have a complete set of directions handy for directing emergency crews to the farm site. Keep the telephone number of the fire department and other emergency services posted near the telephone to avoid any delay in reporting an accident.

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