Virginia Cooperative Extension
Knowledge for the CommonWealth

Electrical Safety in Agriculture

Christopher D. Wyckoff and Glen H. Hetzel,

Introduction

"Shocking Statistics"

- There are approximately 290 accidental electrocutions each year.
- An additional 800 people die in fires caused by faulty electrical systems every year.
- Thousands are shocked and burned as the result of accidental contact with electricity every year.
- An estimated $1.2 billion in property damage occurs each year due to faulty use of electricity.

Electricity, or electric current, is the flow of electrons from one atom to another in any material. Materials that allow electricity to flow easily are called conductors. Most metals, such as copper and aluminum, make good conductors of electricity. Insulators are materials that do not allow electricity to flow through them. Good examples of insulators are glass, plastic, and rubber. Unfortunately, our bodies can allow current to pass through them, causing anywhere from a mild tingling sensation to cardiac arrest and burning.

There are many ways in which electrical accidents happen. Hazards result from the degradation of electrical wire insulation due to rodents, weathering, or normal wear, improper wiring, improper wire size or type, and corrosion of electrical connections, for example. In addition to these normal hazards, agricultural workers are particularly subject to the hazards of electricity because tall equipment, such as grain augers, combines, and raised dump truck beds can become entangled in overhead power lines. Accidents have also occurred with overhead power lines when moving irrigation pipe. Agricultural buildings are subject to dusty, moist and corrosive environments, making them especially troublesome when using electricity. Electricity was the seventh largest cause of deaths on farms in 1988, and causes unknown amounts of property and livestock loss every year. Fortunately, there are several devices and methods that can be employed to protect yourself, your animals, and your property.

What Can You Do?

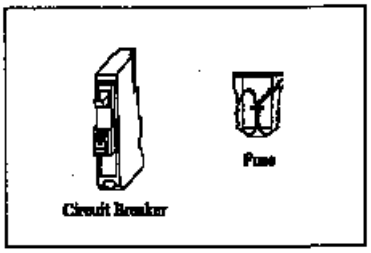
There are four kinds of electrical safety devices and features that you should be aware of. These are fuses and circuit breakers, GFCI's, grounding, and polarization.

Fuses and Circuit Breakers

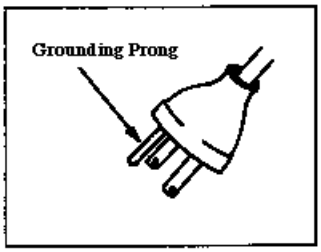
The most common form of electrical protection is the fuse or circuit breaker. These are devices that are designed to protect the electrical system from too much current. These devices, when used properly, work well to protect equipment and prevent electrical fires due to overloads on the electrical system. They do not, however, protect an individual from electrical shock. Fifteen amps, which is typically the smallest size breaker found in a normal household, is 250 times greater than is required to cause cardiac arrest in an individual.

Fuses and circuit breakers have a numbered rating system which indicates the maximum amount of current that they will allow through. The fuses and circuit breakers are matched to the size of the electrical wires used in the system. Thus, fuses should always be replaced with a new fuse of the same rating. A higher rated fuse will not offer any protection if the system was to draw too much electricity and could result in an electrical fire or damage to your equipment. A smaller rated fuse will cause the circuit to blow the fuse more frequently, leading to your aggravation and the temptation to bypass the system. If absolutely necessary, use a smaller rated fuse for temporary power, but never a larger one.

Grounding

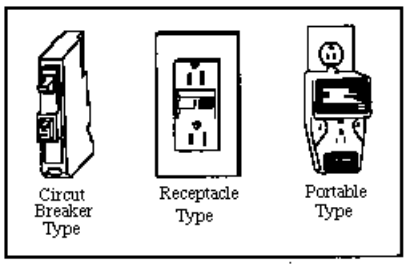


Another important safety feature is "grounding." Grounding occurs when a ground wire is connected from ground potential to the frame of an electrical device. Grounding is not necessary for a circuit to work, it is only there for the protection of individuals from stray current. In a normal circuit, electricity flows from the "hot" wire (which is usually black) to the electrical device and back to ground potential through the neutral wire (which is usually white or gray). A ground wire (which is usually bare or green) is provided so there can be an alternate path for the electricity to flow back to ground potential if an electrical short occurs. For example, if the wires inside an electrical device have become worn or the insulation broken down such that the hot wire makes contact with the case on the device, then the current could possibly flow through the individual using the device back to ground. If a ground wire is present, however, the current will take the path of least resistance and flow through the ground wire back to ground instead of flowing through the individual causing an electrical shock.



Never destroy or cut off the round grounding prong on a plug to fit it into a socket or extension cord that does not accommodate the prong. If the equipment you are working with does not have a ground wire, then consider rewiring the device to accommodate the grounding feature. Another option is to use double insulated tools. These tools have an air space around the device to help insulate you from an electrical shock.

GFCI's



Another protective device that can be used is called a Ground Fault Circuit Interrupter, commonly referred to as a GFI or GFCI. This device is meant to protect human beings from electrical shocks due to faulty electrical equipment. A GFCI works by monitoring the current flow to an electrical device and comparing it to the amount of current flowing back. If there is a difference between these two values, this means that some electricity is flowing back to ground through a path other than the wire. This is called a "ground fault" and when the GFCI detects this, it stops current flow altogether in the circuit. Consider the previous example in which the wires inside an electrical device have become worn or damaged so that the hot wire makes contact with the casing. If a person were to use the tool, then electricity could possibly flow through the individual back to ground. When a GFCI detects this situation, it stops current flow before harmful amounts of electricity flow through the individual. Electricity will flow through an individual easier if the person is working in wet or damp conditions, which is why it is recommended that GFCI's be installed in all bathrooms, kitchens laundry rooms, garages, and other buildings where moisture can be a problem. The protection from grounding and from a GFCI are similar. However, if your equipment does not have a ground wire,

then a GFCI is your only form of protection from faulty equipment. GFCI's also offer protection if the grounding mechanisms are faulty.

There are three different types of GFCI's available. The most common type is the GFCI breaker. These are used instead of conventional breakers to protect everything on the circuit. There are also GFCI outlets that can easily replace conventional outlets. These will offer protection for everything plugged into them. There are also portable types that can be plugged into any outlet. The device you want to use is then plugged into theGFCI. All GFCI's are equipped with test buttons which intentionally cause a ground fault to insure the device is working properly. It is recommended that all GFCI's be tested every month.

Polarization

Polarization refers to the plugs and outlets that have two different sized prongs or slots. The idea behind polarization is to ensure that the hot wire travels through the switch on the device before it encounters the load or resistance. This helps ensure there are no "live" wires that are exposed unless the switch is turned on and current is traveling through the entire circuit. Consider, for example, a lamp; without polarization, the hot wire could be traveling through the socket and then to the switch. If someone was to then touch the socket, they could be shocked. Polarization ensures that the hot wire travels through the switch first, protecting you from accidental contact with an energized socket.

Even with all of these protective devices in place, you can still get shocked if you accidentally touch both the hot and neutral wires of a live circuit. This is different from a ground fault because during a ground fault only some of the current in the circuit will flow through you to ground. If you touch both hot and neutral wires then all of the current in the system will flow through you and your body will act as a normal electrical device. Therefore, there are additional precautions you need to take to prevent accidental death and injury.

What Else Can You Do?

1. Install and use the electrical safety devices that are available.

2. Treat every electrical wire as a"hot" wire.

3. Check the condition of all power cords and devices and repair or replace as necessary.

4. Make sure power is disconnected before working on any electrical device.

5. If a "hot" circuit must be worked on, call a qualified electrician.

6. Use double insulated tools, which put an additional barrier between you and electricity.

7. Make sure that any wiring you do meets the suggestions from the National Electric Code, which are contained in most books on electricity.

Sizing Electrical Wires

The size of wire chosen, usually expressed in the American Wire Gauge number, for electrical circuits is determined by the electrical load. The larger the wire size number, the smaller the wire and therefore, the smaller the electrical load that can be operated through that circuit. The distance the electricity has to travel also makes a difference. You can not simply take a 12 gauge 100 ft. extension cord and expect to run a 1 hp motor efficiently. Improper wiring can result in decreased efficiency and heat build up in the wire, which in turn can result in a fire. Proper wiring is accomplished by looking at charts, which will yield you the proper gauge wire for a given load and a given distance for a 120 Volt AC circuit. Charts can be found in most books on electricity.

What About the Special Risks to Farmers?

Entanglement with overhead power lines is a special problem on farms. There are several things you can do to protect yourself from entanglement with overhead power lines. The best option is to bury all electrical wires underground. This will eliminate the possibility of entanglement, but

caution will be needed when digging. Always check with your electric company or call "Miss Utility" before digging to determine if there are any underground utility lines in the area. Another thing you can do is to ensure that all augers, dump truck beds, etc., are lowered before moving them. This simple procedure will prevent most accidental entanglements. Another thing you need to be careful of is bumping into the guide wires on electrical poles. This will cause sagging in the overhead lines and will make entanglement more likely. Always stay alert and never take unnecessary risks.

Another special problem with electricity on the farm is the dusty, moist and corrosive environments of most livestock houses. There are waterproof, dustproof, and even explosion proof electrical boxes, outlets, and motors available for use in the uniquely troublesome environments of livestock facilities. These materials ensure safe and reliable use of electricity throughout your farm.

What to do in Case of an Accident

So far we have focused on ways to prevent electrical accidents and misuse. If an accident still occurs, then certain steps should be taken.

- If a fire starts as the result of improper wire size, lack of overcurrent protection (fuses), or degradation of insulating materials, then only use fire extinguishers that are recommended for electrical fires. Fire extinguishers rated for use on electrical fires will be labeled as a C, BC, or ABC extinguisher.

- If someone is being shocked by electricity, then disconnect the power source by turning off the circuit breaker only. Never try to unplug the cord, move an energized line with any object, or grab the person yourself to free them. Once free, CPR should be administered to resuscitate the individual if necessary.

- If entanglement occurs with overhead power lines while in machinery, never try to leave the machinery. Wait until help arrives because the machine itself can be energized, acting as a path for the electricity to ground, and if you try to leave the machine then you can also become a path to ground. If it is absolutely necessary to leave the potentially energized machine, as in the case of a fire, then jump free of the machine with both feet at one time. Do not try to climb out of the machine as you would normally.