Electrical Safety

"SHOCKING STATISTICS"

- There are approximately 411 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.

Introduction

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 or 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. The National Institute of Occupational Safety and Health (NIOSH) states that an average of one worker is electrocuted on the job every day of 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, GFCIs, 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 that indicates the maximum amount of current that they will allow through. The fuses and circuit breakers are matched to the size of electrical wires used in the system. Thus, fuses should always be replaced with a new fuse of the same rating. A higher rate 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 air space around the device to help insulate you from an electrical shock.

GFCIs

A ground-fault circuit interrupter (GFCI) is a circuit breaker designed to prevent serious shock to people or animals under certain conditions. It can reduce the risk of shock when using electrical tools or appliances in damp or wet areas. 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 the GFCIs be installed in all bathrooms, kitchens, laundry rooms, garages, and other building where moisture can be a problem. The protection from grounding and from a GFCI is similar. However, if your equipment does not have a ground wire, then a GFCI is your only form of protection from faulty equipment. GFCIs also offer protection if the grounding mechanisms are faulty

GFCIs, cont'd

Ground-fault circuit interrupters come in several styles. They are commonly used as a receptacle outlet, part of an extension cord, or can be installed in the main electrical panel to replace an existing circuit breaker. When installed as a circuit breaker, the GFCI offers shock protection to an entire electrical branch. All GFCIs are equipped with test buttons, which intentionally cause a ground fault to insure the device is working properly. It is recommended that all GFCIs be tested every month.

Ground-fault circuit interrupters are available for 120-V circuits with one hot wire and a neutral. A GFCI will work on older two-wire electrical systems that have no ground wire. A 120-V, single-pole GFCI fits into the same size space as a standard single-pole breaker. There are also GFCIs for 240-V circuits using two hot wires. All equipment plugged into a GFCI protected receptacle, including any two-prong (two wire) electrical plug, will have ground-fault protection.

A portable GFCI is recommended for persons using power tools. The portable GFCI is plugged into an outlet and the power tool is plugged into the GFCI. Certain conditions can result in "nuisance tripping" of a GFCI protected circuit or receptacle. Avoiding the following conditions can reduce nuisance tripping:

- Circuits longer than 100 feet.
- Older non-double insulated power tools that contain faulty electrical insulation.
- Fluorescent cords with cuts or splices where moisture has entered the cut or splice creating a "leak" (ground fault) or path for the current to flow outside of the wire to the ground.
- Permanently installed electric motors.

Polarization

Polarization refers to the plugs and outlets that have two different sized prongs or slots. The idea behind polarization is to insure that the hot wire travels through the switch on the device before it encounters the load or resistance. This helps insure 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 insures that the hot wire travels through the switch first, protecting you from accidental contact with an energized socket.

Even with all 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 neu tral 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 pow er 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 all wiring meets the National Electric Code.

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 cannot 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.

Extension Cords

Damaged or improperly used cords can result in electrical shocks and start fires. Avoid using extension cords, whenever a permanent circuit is needed. Follow these precautions if you must use an extension cord:

- Do not use in wet areas.
- Do not try to repair a damaged extension cord or splice two wires together. Replace the cord.
- Keep cords away from sharp objects, heat, oil, and solvents that can damage insulation.
- Check an extension cord before each use for nicks and cuts. Replace the cord if the insulation is damaged or worn.
- Use an extension cord with correct size wiring (gauge) for intended use. Do not overload an extension cord or use a "household" type extension cord to operate heavy-duty machinery. Overloading may cause excessive heating that may result in a fire.
- Use a grounded wire (three-prong with a "safety grounding" wire) for tools and machines having a grounded plug and use a portable GFCI (ground-fault circuit interrupter).
- Be sure the package for the cord indicates the maximum current and/or wattage rating of the cord.
- Route the cord to protect it from machinery and animals. Also, people should not be able to trip over or accidentally damage the cord.

- Two extension cords plugged together for additional length will reduce the amperage rating and increase the risk of an electrical hazard.
- Extension cords deteriorate; do not use them in place of permanent electrical installations.
- When purchasing extension cords, make sure the cord has a listing mark or certification of a recognized independent testing labor atory. For agricultural use, extension cords with a strong outer coating should be purchased. Extension cords labeled "Type S" (Hard Service Cord) have the strongest outer covering available and should be purchased for work on the farm. Do not be confused with other "S" ratings such as "Type SJ" (the J stands for Junior Hard Service Cord), which should not be used out-of-doors.

Extension cords are sold in various cable sizes, with the smaller number being the larger wire size (a number 10 wire is larger than a number 14).

General guidelines for cord length of extension cords.

Hard Service Extension Cords

Cord Length	Conductor AWG No.
Up to 35'	#14
36' to 75'	#12
76' to 100'	#10

#16 cord should be primarily for service cords on appliances and equipment where the maximum load does not exceed 10 amperes or 1150 watts.
#18 cord (PO-1 or SF-1) will safely carry a maximum load of 7 amperes or 800 watts.

What about the Special Risks in Agriculture?

Entanglement with overhead power lines can be a special problem in agriculture. Large equipment can become entangled in overhead wire, especially when entering farm building sites and driveways. There are several things you can do to protect yourself from entanglement with overhead power lines. One thing you can do is to insure that all augers, dump trucks beds, machinery 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 in agriculture is the dusty, moist and corrosive environments of many retail ag businesses. There are waterproof, dust proof and explosion proof electrical boxes, outlets, and motors available for use in the troublesome environments of grain elevators and feed mills. These materials insure safe and reliable use of electricity throughout your facility.

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 over-current 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 eave the machine then you can also become a path to ground. If 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.