

Preventing Injuries Involving Electrical Cords Near Animal Pens

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Two recent incidents illustrate how electrical cords can be damaged near animal pens at county fairs:

Eleven lambs were accidentally electrocuted in a row of metal pens in a barn at a county fair. A youth discovered the dead lambs at about 6:30 in the morning. An investigation revealed that during the night, a lamb had chewed on an electrical cord, exposing the bare wires. The bare wires then touched one of the metal pens, electrocuting the lambs.

The lambs were housed in a row of 8 double pens (16 pens total). The interconnected pens were constructed of metal railing. A box fan belonging to a participant was being used to keep the lambs cool during hot weather. The fan was ungrounded and was attached to the pen with baling wire. The fan was plugged into an overhead receptacle, and the fan's electrical cord was lying on top of one of the pens.

One of the lambs apparently stood up with its front feet on the side of the pen in order to reach the cord. The incident occurred overnight, and the electrical breaker tripped before the youth arrived—thus, no people were injured. Ground fault circuit interrupters (GFCIs) have since been installed to prevent similar incidents in the future.

Five pigs were electrocuted and several people were shocked when an electrical extension cord was pinched by a metal gate at a county fair barn. The pigs were housed in a row of metal pens. An extension cord belonging to a fair participant was hanging down near the gate by one of the pens. A youth was tending to his pigs on Saturday morning. As the youth shut the gate, the extension cord was pinched between the gate and the pen. The gate cut the electrical insulation, and the cord's exposed electrical wires touched the metal pen.

Several pigs were killed immediately. Others were trembling and obviously agitated. A group of nearby adults saw that there was a problem and rushed to help. At first, they thought the pigs were fighting. Soon, however, the youth and two adults felt an electrical shock. The 20-amp circuit breaker then tripped, shutting off the power. Emergency personnel evaluated the youth and the adults, none of whom requested further medical treatment. One surviving pig was later euthanized because of its injuries.

The extension cord was described as a medium-duty cord. It is unknown whether the cord had a grounding prong. The interconnected pens were constructed of metal panels and each pen had a hinged metal gate. Prior to incident, the fair board had made several electrical safety improvements due to concerns about a similar event that occurred at another fairground.

GFCIs are being considered in order to prevent similar incidents in the future.

Summary of key issues:

1. In both incidents, the electrical cords and equipment were owned and supplied by fair participants. Traditionally, fair participants bring electric fans, radios, extension cords and other equipment necessary for animal and human comfort during long, hot days at the fair. It is difficult for fair boards to inspect and regulate all of this equipment.
2. In both incidents, electrical cords became damaged during activities at the fairs. Since the cords were presumably brought to the fairs in good condition, prior inspection of equipment would not have prevented the incidents.
3. The electrical cords were damaged because they were located in or near pens, within reach of animals or in pinch points caused by gates. This finding suggests that cords suspended from overhead outlets should be supported so they do not hang freely where damage is likely to occur.
4. In the first incident, the electrical appliance (a fan) was not grounded. In the second incident, no information concerning grounding was available. *Although equipment grounding will prevent many types of accidental electrocutions, such grounding might not have helped in the two incidents reported here.* Equipment grounding can protect against electrocution if an electrical problem affects the *body* of a tool or appliance (such as the body of a fan). In both cases reported here, however, problems occurred in the electrical *cords* and did not affect the appliance bodies. In instances such as these, a grounding wire in the electrical cord might not safely divert the stray electricity. On the other hand, a ground fault circuit interrupter (GFCI) could be expected to quickly shut off power and prevent serious injury in these situations.

Recommendations to prevent future incidents involving electrical cords in animal pens:

1. Keep drop-down cords out of reach of animals and out of pinch points by supporting the cords so they do not hang freely.
2. Install ground fault circuit interrupters (GFCIs). GFCIs are designed to detect small leakages of electrical current that occur when electricity is flowing where it shouldn't. (e.g., through a person, animal, or metal pen, for instance). When a current leakage is detected, the GFCI interrupts power fast enough to prevent serious injury from electrical shock. There are several possible strategies for installing GFCIs. Each strategy has advantages and disadvantages:

Strategy A: Install permanent GFCI breakers in the facilities.

i. Advantages:

1. As long as GFCI breakers are operating correctly, participants can not easily bypass their protection. In other words, GFCIs are almost (but not completely) foolproof.
2. One GFCI breaker will provide protection on an entire electrical circuit.

ii. Disadvantages:

1. Personnel must be assigned to test and maintain GFCIs on a regular schedule to ensure protection. GFCIs do malfunction, and the only way to know if they are operating correctly is to test them. In facilities that are used frequently (e.g., 4-H meeting rooms), GFCIs should be tested monthly and after electrical storms. In facilities that are used only a few times per year (e.g., fair barns), GFCIs should be tested prior to all events and after any electrical storms that occur during an event.
2. A GFCI breaker will be tripped by leakage of electrical current anywhere in the circuit. The only way to locate and correct the *source* of the current leakage is to unplug everything on the circuit and then systematically plug in each item until the GFCI trips again. For instance, if the GFCI trips when a participant's radio is plugged in and turned on, it is likely that the radio is the source of the problem (perhaps due to a loose wire inside the radio, the radio cord lying in water, etc.).
3. Current leakage anywhere in the circuit will result in a loss of electricity to the entire circuit, including all lights and outlets controlled by that breaker. Thus, many participants will be inconvenienced when one individual's faulty electrical equipment trips the GFCI.
4. Nuisance tripping of GFCIs may occur due to the use of long extension cords, especially during damp weather.
5. People who do not understand the purpose of GFCIs may continue to plug in faulty equipment and trip the GFCI repeatedly. If an extension cord or appliance repeatedly trips a GFCI, that cord or appliance should be considered hazardous, and it should not be plugged in again until checked by a qualified electrician.
6. GFCIs function by detecting an imbalance between the outgoing electrical current in the "ungrounded" black wire and the returning current in the "grounded" white wire. Thus, a GFCI will *not* prevent electrocution if the outgoing and returning current are the same. To illustrate: Imagine that you have grabbed the exposed end of a black electrical wire in one hand and the exposed end of a white electrical wire in the other hand. In this case, the GFCI will not trip *if* all of the current passes through your body *and* none of the current leaks through your body to the ground. If this happened, you would probably be electrocuted even though there is a GFCI protecting the circuit. Instances such as this are extremely rare, however.

Strategy B: Install permanent GFCI outlets in facilities

i. Advantages:

1. See advantage 1 for GFCI breakers, above.
2. Installation strategies are more flexible with GFCI outlets, compared with GFCI breakers:
 - a. The circuit can be wired so that one GFCI outlet protects the entire circuit at less cost than a GFCI breaker.
 - b. Alternatively, the circuit can be wired so that each outlet is protected by its own separate GFCI. In this case, nuisance tripping on one outlet will *not* affect other outlets.

ii. Disadvantages:

1. If many GFCI outlets are installed, correspondingly more materials and labor are required to install, test, and maintain them all.
2. Also see disadvantages 1, 4, 5, 6 for GFCI breakers, above.

Strategy C: Require participants to supply their own portable GFCIs for all personal items they plug in.

i. Advantages:

1. No cost to the county or to the fair board.
2. Nuisance tripping does not affect multiple participants.

ii. Disadvantages:

1. Considerable cost to participants.
2. Some participants may not comply, thus endangering themselves and others.
3. Also see disadvantages 1, 4, 5, 6 for GFCI breakers, above.

3. When building new livestock facilities, install equipotential planes where required by the National Electrical Code to protect animals and people from stray electricity.

Other general electrical safety recommendations:

1. Damaged or spliced electrical cords should not be used.
2. Keep cords & appliances away from water.
3. Keep cords off the ground so they will not be damaged by foot traffic.
4. All electrical tools and appliances should either be grounded or double insulated.
5. All extension cords should be grounded and have adequate capacity for the electrical load (compare the listed wattage of plugged-in appliances with the rated wattage of the extension cord).
6. All extension cords used outdoors should bear a UL label for outdoor use.
7. For more electrical safety recommendations for fairs and festivals, see:
<http://www.oznet.ksu.edu/agsafe/Manual/ElectricalSafetyPublic.htm>