Installation and Operation Of Electric Fences, Cow Trainers and Crowd Gates

A SELF-HELP GUIDE FROM...
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Electric fencers, cow trainers and crowd gates have been used on farms for many years to help manage animals. These devices are designed to produce avoidance behavior when the animal comes into contact with an energized object. Electric fencing technology has progressed over the years resulting in safer devices and improved animal control in both grazing and confinement systems.

Like any technology, however, if not installed properly or not used correctly, problems can occur. One potential problem is fencer shocks appearing in unintended locations. Field studies in Minnesota, Wisconsin and Australia have shown that improperly installed fencer systems are a common cause of short duration transient voltages in unintended locations on dairy farms.

This publication provides a review of the basic electrical concepts of fencer operation as well as guidelines for installing safe and effective electric fencer systems. Recommendations are also provided regarding fencer and trainer operation and maintenance. The information is presented in a question and answer format and is designed to address common questions and problems encountered by users and installers of these devices.
How do energizers work?

An energizer converts 120-volt electrical power or power from a battery into high voltage, short duration electrical pulses. These electrical pulses typically range from 2000 to 20,000 volts with durations of 1/1000 to 3/10,000 of a second. These short duration pulses may cause avoidance behavior but are not harmful to the animal.

There are two different electrical circuits involved in the operation of a typical energizer (Figure 1). The power circuit (60Hz) carries 120-volt electrical power from a service panel to the energizer. Most fencers are plugged into a receptacle. As with any electrical circuit, the electric current must flow in a loop.

The current path for the farm power circuit is out through one 120-volt (hot) wire and back on the neutral wire. The primary function of the grounding system is to conduct fault current and quickly operate protective devices.

The second circuit is between the energizer and the fence. The low voltage power coming into the energizer is converted to very short duration electrical pulses. The energizer pulse flows out through the high voltage lead-out from the energizer to the fence only if an animal or something else touches the wire to complete the circuit back through the earth. Once the current is in the earth it flows to an earth-return rod and earth-return wire back to the energizer. The energizer circuit is the same for battery powered energizers, except a 120-volt power circuit is not used.
What is the difference between an earth-return rod and a ground rod?

An earth-return rod is like an antenna that collects the high voltage energizer current from the earth and returns it to the energizer (Figure 1). The EARTH MUST be part of the return path of a fencer circuit. The earth-return part of the circuit is active only when an animal or other conductive object completes the electrical circuit by touching the energized wire.

A ground rod (also shown in Figure 1) is meant to be part of a different circuit. The purpose of the grounding system is to protect people, animals and the farm wiring from contact with lethal voltage from the electrical power system. Ground wires are designed to carry fault current back to the transformer so that circuit breakers can trip or fuses blow and shut off power. Electrical faults are caused by shorts, or an unintended contact between a 120-volt (hot) wire and any conductive object. The EARTH CANNOT be the sole return path for electrical system fault current. Ground rods are designed to keep contact voltage on the grounded-neutral system below harmful levels.

It is important to separate fencer earth-return rods from the farm grounding system so that fencer pulses will not appear in undesirable locations on the grounded-neutral system.

What is the most common reason for failure of an electric fence, cow trainer or crowd gate?

Improper earth-return systems are the most common cause of energizer problems. Two common installation problems are undersized and improperly located earth-return systems. Tips on correct installation will be covered later in this publication.

How can an improper earth-return system cause “stray voltage”?

An inadequate earth-return system can cause the energizer pulse that goes out on a fence to find other routes back to the energizer. If the earth-return wire is connected to a metal building or pipes, they can become part of the return path. Any conductive object, such as an electrically heated water trough can become part of the return path if the earth-return system is not properly installed.

What is the most important thing to remember about separating the fencer earth-return and farm grounding systems?

The two grounding circuits are doing two different things and should not cross paths. The energizer’s earth-return system needs to complete the fencer circuit and return HIGH VOLTAGE, short duration fencer pulses to the energizer. The farm grounding electrodes should keep the grounded-neutral system at a LOW VOLTAGE while ground wires provide a low resistance path for fault current back to the transformer.

“The HIGH VOLTAGE of the energizer and earth return circuit must never come in contact with the LOW VOLTAGE farm grounding circuit.”
Selecting an Energizer

Selecting an energizer can be confusing because manufacturers use different terminology for ratings for their devices. Let's have a look at some energizer terminology.

What is a low impedance energizer?

Low impedance energizers (also referred to as “New Zealand” style energizers) produce extremely high voltage but very short duration electrical pulses. These high voltage, short duration pulses lose less energy when objects such as grass or brush come into contact with the energized wire. This allows low impedance energizers to be effective on longer runs of fence. A good earth-return system is essential to make sure this electrical circuit functions properly.

How are energizers rated?

There are two common ways that energizer output is rated. The first is the number of miles of fence that the energizer can power. This is not a very accurate rating system because of the variability in soil resistance and the amount of unintentional contact by grass and weeds with the energized wire. An energizer rated at 25 miles of fence will not necessarily be effective on 25 miles of fence under all conditions but it will have more output than an energizer rated for at 15 miles of fence.

The second energizer rating method is the energy output, or joules, in each fencer pulse. This is also only a relative comparison; not all 5-joule energizers are exactly alike.

Two 5-joule pulses may have different effects on animals because of differing voltage level and pulse duration.

So how much power should my energizer have?

The required power of the energizer will depend on:
- the area to be fenced,
- the number of wires energized,
- the type of animal being controlled,
- use of higher resistance temporary fencing and
- weed pressure.

Provide a reputable energizer dealer with a description of your intended task, and it is likely that the recommended energizer will be sized correctly. Using a more powerful energizer than required increases the likelihood that the fencer pulses will occur at unacceptable levels and/or in unintended locations.

What is the best energizer voltage?

For most situations an output voltage between 2000 and 6000 volts is optimal. Most domestic animals will respect a properly installed low impedance fencer that is over 2000 volts. An energizer that delivers 10,000 volts is not necessarily more effective than a 6000 volt model. Some energizers that deliver more ‘energy’ or joules are actually lower voltage. The key to making any energizer work correctly is proper installation.

Should I use the same voltage for a fencer and cow trainer/crowd gate?

No! Do not use energizers intended for fencing inside buildings. They deliver far too much energy and increase the likelihood of problems. Higher voltages should only be used for electric fences. Voltages for cow trainers and crowd gates never be above 2500 volts.

Can I use the same ground rod for a fencer and a cow trainer?

No! Each energizer must have its own earth-return system. The ground rods return current to the energizer to complete the energizer circuit. Each energizer should work on its’ own closed loop circuit.

“Provide a reputable energizer dealer with a description of your intended task, and it is likely that the recommended energizer will be sized correctly.”
Why are energizers used for cow trainers and crowd gates easier to size than those used for a fencer?

The barn environment does not vary from farm-to-farm as much as fence length, soil conditions, earth-return distance and earth resistance in fencer applications. The range of design variables is thus much larger for fencer applications than for crowd gates and trainers.

Where should I install the energizer?

Although it may be more convenient to place fence energizers in a building, it is safer to install the energizer outside. Locating the energizer outside and some distance from buildings will eliminate the need to install lead-out wires with special high voltage insulation through the walls of a building. Outside installation will also make it easier to separate the energizer earth-return circuit from the farm grounding system.

When installing an energizer outside of a building make certain it is rated for outdoor use. Adding some protection from the weather will increase an energizer’s life. Keep the energizer at least 10 feet from any building to help protect the building and its wiring from lightning strikes on the fence wire.

How should power be supplied to the energizer?

Energizers can be powered by batteries, solar, 120 volt or 240 volt AC power. If you are using a 120-volt AC unit plug it into a three-wire 120-volt receptacle wired in accordance with the National Electric Code. The National Electric Code specifies separate neutral and grounding conductors from the point of use to the service entrance panel. A surge suppression receptacle or single plug surge suppressor is strongly recommended.

What about the UL rating?

Buy an energizer with a UL rating. There are many energizers manufactured outside of the United States that are not UL approved. The UL rating will ensure that the device complies with the National Electric Code.
Where should an earth-return system be located?

As discussed earlier, an earth-return system is like an underground antenna for picking up the electric current that is sent out on a fence by an energizer. Place the earth-return rods inside the perimeter of the fenced area if possible and well away (50 to 150 feet) from any other conductive objects buried in the earth (e.g. water lines, ground rods, and conduit) that may be part of the farm grounding system.

It is desirable to place the energizer outdoors and near the earth-return rods to keep the return lead a short as possible and to the reduce the possibility of interaction of the fencer circuit with the farm’s electrical circuit.

(Worksheet 2)

How many earth-return rods do I need?

The optimum number of earth-return rods depends on the power output of the energizer and the soil conditions. Manufacturers suggest from 3 to 6 feet of earth-return rod for every joule of energizer output. A 10-joule energizer would require from 30 feet of earth-return rod in wet, conductive soil to 60 feet of earth-return rod in dry or high resistance soils. Four earth-return rods at eight feet each equals a total of 32 feet of earth-return rod. Eight earth-return rods of 8 feet each equals a total of 64 feet of earth-return rod.

How far apart should the rods be placed?

For maximum effectiveness space earth-return rods at twice the rod length. For example, eight-foot ground rods should be placed 16 feet apart. (Worksheet 3)

What material should be used for an earth-return rods and wires?

The earth-return rods can be either galvanized or copper-clad steel from 1/2 to 3/4 inch in diameter. Copper-clad rods are more resistant to corrosion. Different types of cladding metals should not be used in the same earth-return system. The ground lead should be #8 copper wire or larger with 600 volt insulation.

How do soil conditions affect the performance of an electric fence?

Dry or rocky soil has a higher resistance than heavy wet soils. These high resistance soils require more earth-return rods.

These additional earth-return rods help to reduce the resistance of the energizer circuit and improve its effectiveness. The soil resistance may also be reduced by using an enhancement material around the rods; e.g., GEM®, coke or bentonite clay. Another way to solve the problem of high resistance soils is to use a continuous ground fence.

How do I know if my earth-return system is working?

Specialized meters are available to measure the strength of the electrical pulse at locations along the fence. Check the fencer pulse at locations near the energizer and far away from it. If the pulse strength is inadequate at locations far from the energizer the earth-return system needs improvement.
Connecting an Energizer to a Fence

How do I get electricity from the energizer to the fence?

The ‘lead-out’ wire that connects the energizer to the nearest energized fence wire should be size 12-gauge or larger.

If there is any possibility of the lead-out wire coming into contact with anything but the energized fence wire, high voltage insulation must be used. Never use standard electrical wire for the lead-out. Standard insulation is not rated to handle the high voltage pulses produced by an energizer. Most common wire is designed to carry 120 or 240-volt power and the insulation is commonly rated for 600 volts. Energizer voltage is much higher than the 600 volt rating on most common wire. Use special wire with a minimum insulation rating of 20,000 volts for the lead-out from the energizer to the energized fence wire.

If you are going to bury the lead-out wire, place it in non-corrosive, non-metallic electrical conduit to prevent physical damage to the wire and reduce the possibility of electrical leakage into the earth.

Do I need a cut-off switch?

An easily accessible cut-off switch is recommended. Most energizer manufacturers do not recommend continually unplugging the energizer to turn it off. A cut-off switch that is easy to see from a distance (i.e., whether it is on or off) will save time in maintaining the fence.

What is the best way to connect a lead-out wire to the energized fence wire?

There are several different devices sold for connecting lead-out wires to fence wire. The most important consideration is to make sure the connection is good and will not corrode easily. The poor connection created by twisting wires together will reduce the effectiveness of the fence and increase the probability of connection failure. It is a good idea to have a connection that can be removed for cleaning; or, to be able to change which wires on a fence are energized. Bolted connections perform well.

How many energized fence wires do I need?

The number of energized fence wires depends on the intended use of the fence. A single energized wire usually works well for older cattle and horses. If smaller and/or younger animals need to be controlled, additional energized wires may be required. Cattle and horses seldom need more than three energized wires. Sheep and goats never need more than five.
What is the difference between a standard and continuous ground fence?

A single wire fence with standard grounding is shown in Figure 4. This is the most common form of earth-return circuit used for electric fences. Only one energized wire is shown in the figure but more energized wires can be added if needed.

A two-wire continuous ground fence is shown in Figure 5. This type of fence is suggested for dry, sandy soils or other conditions creating a high resistance in the earth-return part of the fencer circuit.

In a continuous ground fence, the animal needs to touch both a hot wire and a return wire. When the animal touches both wires electrical current flows from the hot wire, through the animal and back toward the energizer on the return wire. The earth-return part of the circuit is created by a pair of earth-return rods located near each other to reduce the resistance of the earth-return path and maintain the voltage of the fencer pulse. If an animal touches only the energized wire it will experience a lower intensity shock.

Are there any disadvantages of a ‘continuous ground fence’?

There are two main disadvantages to continuous ground fence:

- If an animal touches only the return wire, it will not get shocked. If the bottom wire is the return wire the animals will eventually learn that they can go under the wire without getting shocked.
- If the energized and return wires come in contact with each other a short will occur rendering the fence ineffective. The wires can be shorted by events such as a branch falling on the fence.
Why should an electric fence system be protected against lightning?

An electric fence is a large antenna for lightning. During a thunderstorm the fence wire and its earth-return circuit provides an easy route for lightning to reach the earth – possibly through your energizer or other electrical equipment! It is important to protect fence energizers and all other sensitive electrical equipment on the farm from lightning strikes.

What is a lightning arrestor?

A lightning arrestor protects the energizer from lightning strikes on the fence wires. It is a simple device that is connected between the energized wire of the fence and an earth-return rod or dedicated lighting protection ground rod. Most lightning arrestors work like spark plugs with two metal electrodes near one another but not touching. During normal operation there is no electrical connection from the fence wire to the ground rod. If lightning strikes the fence wire the high voltage will cause an arc, or jump the gap between the two metal electrodes allowing the lightning strike to discharge through the rod into the earth. The arc produced by a lighting strike will usually destroy the arrestor and it must be replaced.

What is the best type of lightning arrestor?

An arrestor that allows you to see whether it has been hit by lightning is recommended. These models are generally a bit more expensive but they save time in determining if a lightning strike has destroyed the arrestor.

What is a lightning brake?

A lightning brake is a coil of wire that develops an electromagnetic field when electricity flows through it. This electromagnetic field acts as a ‘brake’ that provides a high resistance path between the lightning and the energizer in the event of a lightning strike. This high resistance protects the energizer by forcing most of the energy from the lighting to the lower resistance path through the arrestor and to the ground rod rather than thought the energizer.
What can be done to protect the power supply side of the energizer?

The energizer is a target for electricity from a lightning strike anywhere on the farm power supply side of the circuit, because it is connected to the excellent grounding network provided by the earth-return network. The energizer can be protected from lightning strikes on the farm power side of the circuit by installing a surge suppressor at the receptacle used to power the energizer.

It is a good idea to protect all of the sensitive electrical equipment on the farm with a surge protector.

Can lightning enter the energizer from the earth-return system?

Lightning can destroy the energizer due to improper installation of the earth-return system. Specifically, if anything above ground is connected to the earth-return system (e.g., fences, silos or anything made of steel), a lightning strike to any of these structures has an easy path to the energizer.

How many lightning arrestors should I install on my fence?

Each lightning arrestor should be attached to an 8-foot ground. The total length of lighting protection ground rods should be at least equal to — but preferably greater than — the total length of earth-return rods. For example, if you have a 10-joule energizer and 32 feet of earth-return rods, you should install at least 4 lightning arrestors around the perimeter of the fence with an eight foot rod at each.

Where should I install the lightning arrestors?

One lightning arrestor should be installed near to where the energizer is connected to the fence. The other arrestors should be placed evenly around the perimeter of the fence in places that are easily accessible for inspection. Other recommended locations include near gates, at fence corners and at the high point of hills—all places where lightning is most likely to strike.

Is it possible to be totally protected against lightning strikes?

Proper installation of an electrical fence system, along with protective measures on both sides of the energizer, will greatly reduce the probability of severe damage from a lightning strike. Unfortunately, it is not possible to be completely protected. High energy lightning strikes can overpower even the best safety measures.

“It is important to protect fence energizers and all other sensitive electrical equipment on the farm from lightning strikes.”
Cow trainers and crowd gates present several unique problems. A cow trainer is designed to train cows not to arch their back while defecating or urinating so that waste falls in the gutter. Cow trainers must be carefully adjusted for each individual cow in order to be effective. A great deal of stress and agitation will be produced if cows cannot easily avoid the trainer. With most cow trainer circuits, the barn floor is part of the earth-return path. It is likely, therefore, that the trainer pulses will appear at all locations in the barn whenever any cow touches a trainer bar. This makes it especially important that trainers be adjusted properly so that cows contact the trainers infrequently.

**What size energizer should be used?**

Never exceed a 2500-volt energizer for a cow trainer. Too much power can cause excessively nervous behavior in animals. Furthermore, higher voltage increases the likelihood of the energizer pulses traveling to undesired locations.

**How should cow trainers be adjusted?**

Adjust the trainer bars so they are approximately 3 inches above the cow’s shoulders, or until they are effective in training the cows to drop their manure in the gutter. [Note: This may be as close as 1½ inches in some cases.] It is essential that the trainer be fastened securely to eliminate the possibility of the unit sliding down onto the cow’s back. It is also important to make sure cows get back into their own stall which has had the trainer bar adjusted for them. If this cannot be done then the bars must be adjusted every time cows return to the barn.

**What type of wire should be used?**

Always use wire with 20,000 volt insulation for the lead-out from the energizer’s hot terminal to the trainer connections. Do not connect the high voltage output terminal to anything not associated with the energizer.
Electric crowd gates are designed to train cows to enter a milking parlor. These devices should be fitted with a bell or buzzer so the cows know when it will be moved. The potential for misuse of these devices is great. If an inattentive or overly aggressive operator makes it impossible for cows to avoid the crowd gate they will be frightened and agitated before being milked.

These devices work in a similar way to electric fence systems; however, extreme care must be taken in their installation, because the high voltage pulses are flowing in and around a barn. Special attention must be paid so that these pulses do not appear on parlor stalls, waterlines, or other conducting surfaces in the animal confinement areas.

**How can I improve the safety of an electric crowd gate?**

To improve the safety of electric crowd gates, use an energized wire alternating with a return wire similar to a continuous ground fence as described earlier in this publication. There are several electric fence supply companies that manufacture plastic/metal tape combinations that have both hot and return wires woven into the same material. Keeping the electrical flow in the wires rather than through the floor reduces the possibility of energizer pulses occurring in unintended locations.

**Where should earth-returns be installed for cow trainers and crowd gates?**

The recommended location and installation of the earth-return rods for a cow trainer and crowd gate is shown in Figures 8 and 9. Remember that each energizer (fencer, trainer, crowd gate must have its own dedicated earth-return system. DO NOT combine the earth-return systems from two different devices.

However, the same principles discussed in the section on building earth-return systems for fences (size, type, number and placement of earth-return rods and connection to the energizer) also apply for the earth-return systems for your trainer and crowd gate.

**Why should cow trainers and crowd gates be separated from electrical and water systems?**

It is essential that both the energized and return portion of the energizer circuit for cow trainers and crowd gates be electrically separated from all grounded objects so that the high voltage energizer pulses do not occur in undesired locations. Water systems are the most likely place for earth-return currents to appear, because they are usually part of the grounding system for the farms electrical system.
Should I keep energized wires away from other metal equipment?

Any metal object running parallel to an energized wire will pick up some of its voltage. This voltage can be kept to a minimal level if the metal object is grounded. The National Electric Code requires that any metal objects that could be come energized, such as water pipes, milklines and stall work should be grounded for safety reasons. The induced voltage can also be minimized by keeping the energized wire as far from long metal objects as possible and by keeping the length of parallel runs to a minimum.

What is the best type of insulator?

There is not a “best” type of insulator. There are many new models and styles on the market. Both porcelain and plastic insulators may perform adequately as long as they are kept clean. The most important differences between insulators have to do with their strength and durability.

Do wooden posts need insulators?

Yes. In wet or humid climates wooden posts should be fitted with insulators. Wet and treated wood posts provide an electrical path to ground and will reduce the effectiveness of an energizer.

Do fiberglass posts need insulators?

Some types of fiberglass posts require insulators and some do not. If the posts were manufactured specifically for electric fencing, they generally do not require insulators. Check the specifications of the post.

How often should I inspect the electric cow trainer and crowd gate?

These systems should be inspected every six months to ensure their proper operation.

Can electric fences cause death or injury?

Any type of wire fence has the potential of causing death or injury to animals. The primary danger occurs if an animal becomes entangled in the fence. Smooth high-tensile wire is recommended for permanently installed electric fences for three reasons. First, they are relatively easy to install and maintain. Second, they can stand up to the abuse of animals and equipment without breaking. And third, animals are not as likely to become entangled in them. BARBED WIRE SHOULD NEVER BE USED on an electrified fence.

Can electrical transmission lines cause problems with a fence?

Voltage can be induced on any conductive element, such as a fence wire, that is running parallel to a high voltage transmission line. If a fence is installed next to a transmission line and voltage can be detected even when the energizer is turned off, it may have to be moved or replaced with a different type of fence. If you are receiving shocks from a fence that is not energized, and the fence is located near a transmission line, call your utility and discuss this with a field representative.
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References


Installation of Electric Fence Controllers, ASAE EP568, April 1997

Safe and Effective Electric Animal Controllers: Fencers, Cow Trainers & Crowd Gates. Prepared in cooperation with the Wisconsin Public Service Commission and University of Wisconsin Extension. WDATCP, 2811 Agriculture Dr., Madison, WI 53704.
Checklist for each Energizer

**Energizer**
- Select properly sized Energizer
  - See pages 4 and 5 for fencers or page 11 for cow trainers or crowd gates

**Earth-Return System**
- Earth-return Rods 8-foot Copper clad or galvanized
  - See page 6 to determine the number of rods needed for each energizer
- Wire from energizer to the earth-return rods:
  - #8 stranded copper wire with Insulation rated for at least 600 volts
- Bolt-on-lug or “acorn” connectors to attach wire to earth-return rods (one for each rod).

**Connect Energizer to energized wire, trainer or crowd gate**
- High voltage lead-out wire from Energizer to fence, trainer or crowd gate
  - High voltage wire with insulation rated for at least 20,000 Volts long enough to connect energizer to nearest energized wire.
- Bolt-on lug, screw terminal or other compression type connector to attach lead-out wire to the energized fence trainer, or crowd gate wire

**Lightning Protection**
- Lighting Arrestors - one for each ground rod
- lighting protection ground rods - same number and size as earth-return rods
- Surge Arrestor

**Cut-off switch**
Notes...
Mission Statement

This publication was developed by the Midwest Rural Energy Council.

The mission of the MREC is to initiate, develop, support, and coordinate education, research, and communication programs on significant and emerging rural energy issues for the consumer, energy suppliers, and allied industries through cooperative efforts of council members.

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