Living with Predators
Resource Guide

Practical Electric Fencing Resource Guide: Controlling Predators

2009 Edition

Produced by the Living with Wildlife Foundation

In cooperation with

Montana Fish, Wildlife & Parks

Living with Predators Project

Produced by

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and

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Foreword

The Living With Predators Resource Guides were compiled by the Living with Wildlife Foundation in cooperation with the Montana Fish, Wildlife & Parks' *Living with Predators Project*. The guides are intended to help minimize conflicts between people and black bears, grizzly bears, wolves, coyotes and mountain lions. Information has been compiled into four separate volumes:

Techniques and Refuse Management Options for
Residential Areas, Campgrounds,
and Other Group-Use Facilities,

Recreating in Bear, Wolf and Mountain Lion Country,

Predator Behavior Modification Tools for Wildlife Professionals,

And

Practical Electric Fencing Resource Guide: Controlling Predators

The guides provide ideas on how to reduce bear attractants, deter bears and other predators from developed areas, and information about where to obtain bear-resistant products.

Care has been taken to ensure the accuracy and completeness of the information contained in the Living With Predators Resource Guides; however, the author and Montana Fish, Wildlife and Parks are not responsible for errors contained in these guides and does not guarantee the performance of the products and techniques included in the resource guides.

Not all of the electric fencing products and designs listed in the resource guides have been tested and proven to be predator-resistant. The Living with Wildlife Foundation and Montana Fish, Wildlife & Parks have recently implemented a new field testing and evaluation program to document the long-term effectiveness of the designs included in this guide as well and alternative fencing designs.

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Introduction

The purpose of this resource guide is to provide specific information about using electric fencing to deter predators, including bears and wolves, from various types of attractants. While this guide is concerned with predator exclusion, it should be noted that electric fencing is very effective in controlling livestock and often reduces many of the injuries to livestock that are associated with conventional barbed wire fencing.

This guide is not intended to be a "how to" guide for the concepts involved in power fence systems or as a general electric fencing installation guide. There are however several guides available from electric fence manufacturers that cover the basics about how electric fencing works to control animals as well as information about how to install electric fencing.

A very thorough guide is available from Gallagher Power Fence Inc. The guide, titled "Power Fence Systems Manual," provides complete information about electric fence components and how to construct an electric fence. Please contact Gallagher at www.gallagherusa.com to obtain a copy of the guide.

Another excellent reference is available from Zareba. The guide is titled "Do-it-Yourself Electric Fence System Planning Guide" and can be downloaded in .pdf format directly from their web site at www.zarebasystems.com.

Both of these manuals provide information necessary to gain a thorough understanding of how electric fencing works and what options are available. If the reason for your electric fence is solely to control livestock, either of these manuals would provide the information necessary for you to implement your project. If your objective is to exclude predators, this reference guide highlights some of the important considerations for choosing various electric fence components and provides examples of predator-specific designs.

The designs and information presented in this guide have been provided by wildlife professionals who are actually using the designs in the field. It should be noted however, that not all of these designs have been in use long enough to be able to state conclusively that they are proven effective for controlling various types of predators.

The Living with Wildlife Foundation is collecting information about the effectiveness of these and other electric fencing designs. This reference guide will be updated periodically to include this information as well as new designs that are being utilized to control predators. We welcome any new information about electric fencing for predator exclusion and would appreciate submission of the design specs for inclusion in this reference.

Uses of Electric Fences

Electric fences can be used to deter bears and other predators from areas where they are not welcome. Some examples are listed below.

- Beehives
- Compost piles
- Garbage containers
- Orchards and crops
- Landfills
- Livestock feed storage
- Livestock grazing areas
- Sheds
- Greenhouses
- Recycling Bins
- Campsites
- Children's play areas
- Fish cleaning stations
- Freezers
- Gardens
- Outfitter camps
- Garages
- Birdfeeders
- Goat pens
- Rabbit hutches
- Seasonal or remote cabins
- Pig pens
- Sheep bedding areas
- Calving areas
- Chicken coops
- School playgrounds
- Food grease storage
- Dog kennels
- Aviaries

Be creative!

Almost anything can be rigged to deliver an electric shock to an unwanted predator. And the use of solar-powered energizers has made it possible to erect electric fences and to "electrify" attractants in more remote areas where access to power may be limited or not available.

But keep in mind that the same principles of electric fencing still apply when electrifying other objects. You will still need an energizer and a good grounding system to make the system work.

Planning Your Electric Fence

In this resource guide, we present basic guidelines and considerations for using electric fencing to exclude grizzly bears, black bears, wolves, coyotes, and mountain lions. Be aware that predator behavior is very complex and each animal may react differently based upon its own unique life experiences.

Before you begin planning your fence project, it is important to consider the following:

- What type(s) of predators are you trying to exclude?
- Is your need for electric fencing temporary or permanent?
- What kind of access will the enclosed area need? Will people need frequent access to the area? For example: dumpsters, community gardens, or public-use sites.
- How big is the area you need to enclose? Measure the area in acres, linear feet , or miles.
- Draw up a map of the area to be fenced.
- Check local ordinances on electric fencing. Some areas require warning signage.
- Your local wildlife officials or electric fencing retailer are good contacts for more information.

Electric Fencing Components

Each electric fence consists of an energizer, grounding system, posts, insulators, and wire. Other components such as switches, lightning diverters, gate handles, etc. are also part of a system, however are not necessarily required. When designing a fence for predator exclusion, there are certain characteristics that must be considered when choosing each fence component. Each of these critical fence components is listed below along with a brief description of key characteristics that must be considered when fencing to exclude predators.

Energizers

Energizers are the power source for the electric fence and come in a wide variety depending on the species to be controlled, the size of the area to be fenced, and the location of the fence. Energizers store energy and deliver a pulse of electricity throughout the fence system. The stored energy is measured in joules which is the energizer's "horsepower."

Energizers (cont.)

The Importance of Joules!

Joule rating is the single most important factor in choosing an energizer. It is critical that your energizer has enough shocking power for the species you are controlling, **REGARDLESS** of the size of area you are fencing. Bears, for example, require a minimum joule rating of .7 joules. Many predators have thick fur which can make it difficult to deliver a shock adequate to deter the animal. Using an energizer with a high joule rating can help provide a shock strong enough to turn the animal away.

Most manufacturers rate their energizers in joules in addition to acres or miles of fence. For smaller projects, such as small gardens, dumpsters, or night sheep pens, select an energizer based on the joule rating necessary for the species you are trying to deter. For larger projects such as pastures or paddocks, you will have to consider not only a minimum joule rating. You will also have to choose an energizer that is capable of electrifying a larger area. In other words, the energizer must be powerful enough to deliver an adequate charge over a longer distance.

There are two basic types of energizers: plug-in and battery-operated. Plug-in energizers connect directly into a 110 volt or standard household electrical outlet, or a 220 volt outlet.

Battery-operated energizers connect to a 12 volt deep cycle or marine battery and come with alligator teeth for quick connection. Battery-operated units do require close monitoring for sufficient battery charge.

Solar panels can be added to battery-operated units to charge the battery. Many battery-operated units, such as the Gallagher B100 unit in the picture to the right above, are self-contained and come with a solar panel. It is important that the fenced area receives enough sunlight to ensure the panel can maintain an adequate charge for the battery.

Energizers that plug-in are recommended whenever possible because they tend to be more consistent in their output, generally require less maintenance, and are less expensive than comparable battery powered units. Some situations may require the use of a battery-operated or solar energizer in remote areas that do not have access to 110 or 220 power. There are several battery or solar units that are adequate for predator exclusion—just make sure to choose one that has a joule rating high enough for the species you are trying to deter.

Wire

Wire for electric fencing is typically made of galvanized smooth steel or aluminum. Polywire and polytape have been used effectively for domestic animals, but these materials are not recommended for predator exclusion. Polywire has been used, especially for temporary and backcountry fencing to deter predators from camps. Polytape, however, has not been effective. The polytape could be used for the top strand in a system for a visual reference for humans or trained livestock.

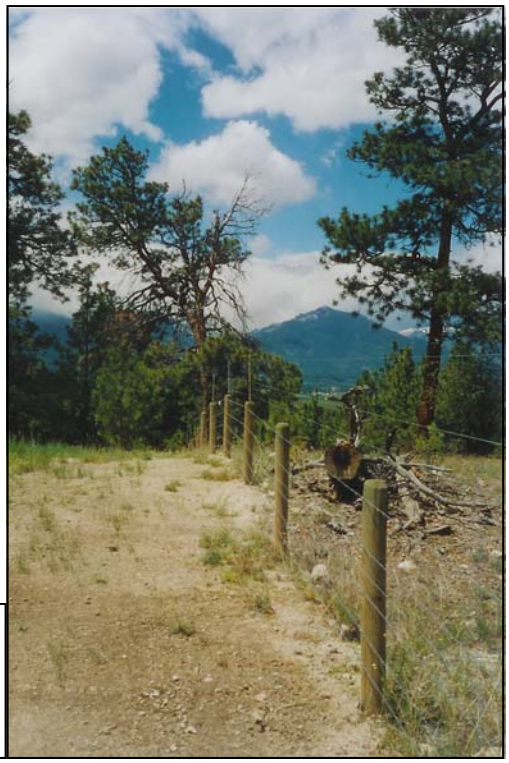
All-metal wire is recommended for predator exclusion. Steel wire is more difficult to work with but is much stronger and lasts longer. Aluminum wire is more conductive and more user-friendly; however, it tends to break with repeated bending and is not as durable over time. Most successful electric fences are made of 14Ga or 12Ga hi-tensile galvanized steel wire. Aluminum should be at least 14Ga and should be used for temporary or seasonal fencing.

Posts

Electric fences can be erected using a number of different types of posts including fiberglass posts, wood posts, and metal t-posts. While all of these work, wood posts set several feet into the ground tend to be the sturdiest. If the fence you're constructing is intended to be permanent, it is best to use treated wood posts, or a combination of wood and another type of post to add stability to the fence. Less permanent fences can be constructed using fiberglass posts or t-posts with wood posts used only on the corners.

The above fence is constructed using fiberglass posts.

Photo courtesy of Larry Feight.



The fence in the picture at the right is constructed using wooden posts.

Photo courtesy of Larry Feight.

Posts (continued)

The important thing to remember is to use a non-conductive material such as fiberglass or plastic for posts. If wood or metal is used, make sure to use good insulators between the wire strands and the posts.

Grounding the Fence

How grounding works

Grounding essentially is what makes electric fencing effective for controlling animals and is therefore an extremely important component in every electric fence system. The quick explanation of how grounding works is that electrons (electrically-charged particles) travel from the animals' feet to the ground rod and then to the ground terminal of the energizer. In a sense, the animal completes the circuit of the electrical current.

Without proper grounding, the fence will fail and damage can be done to the energizer. Grounding the energizer requires that at least one ground rod be installed and wire run from the ground rod to the ground terminal of the energizer. Ground rods should be 1/2" or 3/4" diameter galvanized steel and at least 6' in length. If possible use ground rods 10' long to maximize contact between the ground rod and the soil. Non-galvanized metal rusts quickly and causes resistance. Therefore, most manufacturers recommend galvanized ground rods.

Painted rods and t-posts will not work to ground the energizer because the paint acts as a barrier preventing contact between the grounding rod and the ground wire. Water pipes and rebar are also not recommended for use as ground rods. **Be sure to adhere to recommendations made by the energizer manufacturer.**

Ground rods should be driven as far into the ground as possible using a t-post pounder or other suitable pounding implement. The more exposure the ground rod has to moist soil, the better the ground will be. If the soil is rocky, the ground rods can be driven in at an angle.

A ground rod clamp is needed to attach the ground wire running from the energizer's ground terminal to the ground rod. Margo Supplies sells a 3/8" bronze clamp to ensure a proper connection between ground rod and ground wire.

If the soil is very dry in the area where the electric fence is being installed, a minimum of three (3) six to ten-foot ground rods should be used. The rods should be placed approximately ten feet apart. In sandy, rocky or clay soils, additional ground rods should be installed to ensure adequate grounding. A ground wire can also be buried the length of the fence and should be attached to each of the ground rods. If metal t-posts are used in the fence construction, the ground wire should also be attached to them underground.

Types of Grounding Systems

All Hot System

In an all hot (+) system, all of the fence strands are electrified (hot). In other words, all of the strands are connected to the hot (usually indicated in red) terminal on the energizer. An all hot system is generally not recommended for predator control unless the fence will only be needed seasonally, during wet and rainy times of the year, or if the ground around the fence is moist and the soil is highly conductive. If the soil is dry, frozen, or rocky, the soil will not adequately conduct the electrons and will not supply a sufficient ground for the animal to receive a substantial shock.

An example of when an all-hot system would work well is enclosing an irrigated garden or fruit tree stand to exclude bears during the spring and summer months.

Hot/Ground System

The hot (+)/ground (-) system consists of alternating hot and ground wires and operates on the principle of the direct return of electrons at the wire. Insulated wire and L-clamps are used to "jump" and connect wires. Ground wires are connected to the ground rod(s) and the energizer's ground terminal. Hot wires are connected to each other and are connected to the red or "hot" (+) terminal on the energizer.

The hot/ground system overcomes poor soil conditions or grounding issues by providing a return for the electrons through additional grounded wires. Rather than relying on ideal soil conductivity conditions, this system utilizes a direct return at the fence wire. The animal must touch both the hot wire and the ground wire simultaneously to receive a full shock from the energizer.

Permanent predator exclusion fences should all be hot/ground systems in order to ensure 100% effectiveness throughout the year regardless of the soil or weather.

This five-wire electric fence was constructed near Ovando, Montana to deter grizzly bears (below).

Bullnose insulators (white plastic) are used on the hot wires only. The ground wires can touch the fence post and are connected to the fence's ground system.

Note that the ground and hot wires alternate. Care should be taken to make sure that the space between hot wires isn't large enough to allow predators to slip through the fence. In general, hot wires should not be more than 12 to 15 inches apart. The lowest wire should be located approximately 6 to 7 inches above the ground.

Temporary Fencing

Temporary electric fencing is an effective and economical way to deter predators from various attractants and can be taken down quickly and easily when no longer needed. The only difference between temporary electric fencing and permanent electric fencing is the type of fence post used and the extent to which the posts are installed in the ground. There seems to be almost no limit to the number and types of temporary electric fence configurations that can be used to address a wide range of applications, including some that are pretty unusual.

Typically t-posts or rigid wire cattle panels are used to construct a temporary electric fence enclosure. Both install quickly, don't require significant digging or bracing, and can be easily removed and stored for future use. Temporary fencing is usually cheaper to install but doesn't hold up as well as fencing that utilizes wooden posts and H-braces.

This doesn't necessarily mean that temporary electric fencing will last only a short time however. Temporary electric fence enclosures constructed around apiaries, compost piles, sheds and sheep pens have been known to last throughout the season, and in warmer climates, for a year or more.

The fence to the right shows how cattle panels can be secured to t-posts and electric "Turbowire" attached to the fence with offset brackets. This design uses three wires in an all hot or hot/ground system.

This photo shows a temporary fence design that uses rigid wire cattle panels. The fence is an 8' X 8' enclosure that can be expanded for many uses by simply adding additional cattle panels.

The panels on the ground are grounded to the energizer, while the panels that are attached to the fiberglass posts are insulated by the fiberglass posts and are therefore "hot."

Temporary Fencing (cont.)

This design uses 16' cattle panels and fiberglass posts. The panels are electrified and insulated by the fiberglass posts. The electrified panels are held off the ground by wire clips.

The panels on the ground are grounded to the energizer's ground rod to implement the hot/ground system.

This system is easily constructed, inexpensive and has been effective in keeping bears out of compost piles, dumpsters, and away from fruit trees.

Temporary electric fencing has also been used to secure lure that was used as bait for trapping grizzly bears in Northwestern Montana.

The lure barrels were stored in the back of the truck while being used for the project.

The photo on the left shows how electric fencing was used to secure the lure.

Photo courtesy of Derek Reich

Bear management specialists in Montana are also currently working on ways to use temporary electric fencing to prevent bears from staging on train tracks after large-scale grain spills. More information on this application will be provided in updates to this resource guide.

Portable Electric Fencing

Portable electric fencing is an effective way to secure your backpacks, cooler, campsite and/or game carcass. Studies in Wyoming and Montana have demonstrated that electric fences, when properly constructed and functioning, can be very effective in deterring bears (Brian DeBolt, Wyoming Game & Fish, personal communication).

Several companies sell portable electric fencing that can be packed into the backcountry or set up anywhere there is something that might attract bears. The fences are easy to set up, relatively inexpensive, and can be easily taken down when the bears are hibernating or the attractant has been removed.

Photo courtesy of Patti Sowka

Hot (+) leads (usually red in color) can be used to connect strands of wire or polytape. Leads can be attached to each strand to make the fence "all hot" or to alternating strands for a hot/ground system.

The picture below shows the leads attached to every other strand thus making the fence alternating hot (+) and ground (-). This design is very effective when the ground is dry. This design also tends to be more effective in delivering a shock to an animal with dense fur such as a bear or a wolf.

When using an alternating hot (+) and ground (-) system, it's best to use at least a 6-strand fence. An 8-strand alternating hot-ground fence is recommended when trying to exclude predators, including bears.

An alternating hot (+) and ground (-) fence delivers a maximum shock since the animal is more likely to touch the hot and ground wires at the same time. This guarantees a full earth contact and transfer of the electric shock.

This photo shows another example of an easy portable electric fence design utilizing welded wire cattle panels and fiberglass posts. These wire panels are available at many feed stores and can be used when a fence has to be constructed quickly.

This photo shows an example of a portable electric fence that was used by a hunter in Alaska to deter bears from game meat. Portable fences such as this one are currently being evaluated for deterring bears from game carcasses and other attractants.

Photo Courtesy of Montana Fish, Wildlife & Parks

Portable Electric Fencing Kits

(Pre-Engineered Kits with all of the Necessary Components)

Fi-Shock
5360 N. National Drive
Knoxville, TN 37914-6695
865-524-7380
www.fishock.com
"Portable Paddock"

Gallagher
130 W. 23rd Ave.
P.O. Box 7506
North Kansas City, MO 64116
1-800-531-5908
www.gallagherusa.com

UDAP Industries Inc.
P.O. Box 10808
Bozeman, MT 59719
406-763-4242
www.udap.com
"Bear Shock Lightweight Electric Fence

Zareba Systems
Ellendale, MN 56026
1-800-272-9877
www.zarebasystems.com
Kwik Korral and EZEE Corral

Margo Supplies Ltd.
403-654-1932
www.margosupplies.com

Premier 1
2031 300th St..
Washington, IA 52353
800-282-6631 or 319-653-7622
www.premier1supplies.com

Parmak Precision
2000 Forest Ave.
Kansas City, MO 64108
www.parmakusa.com

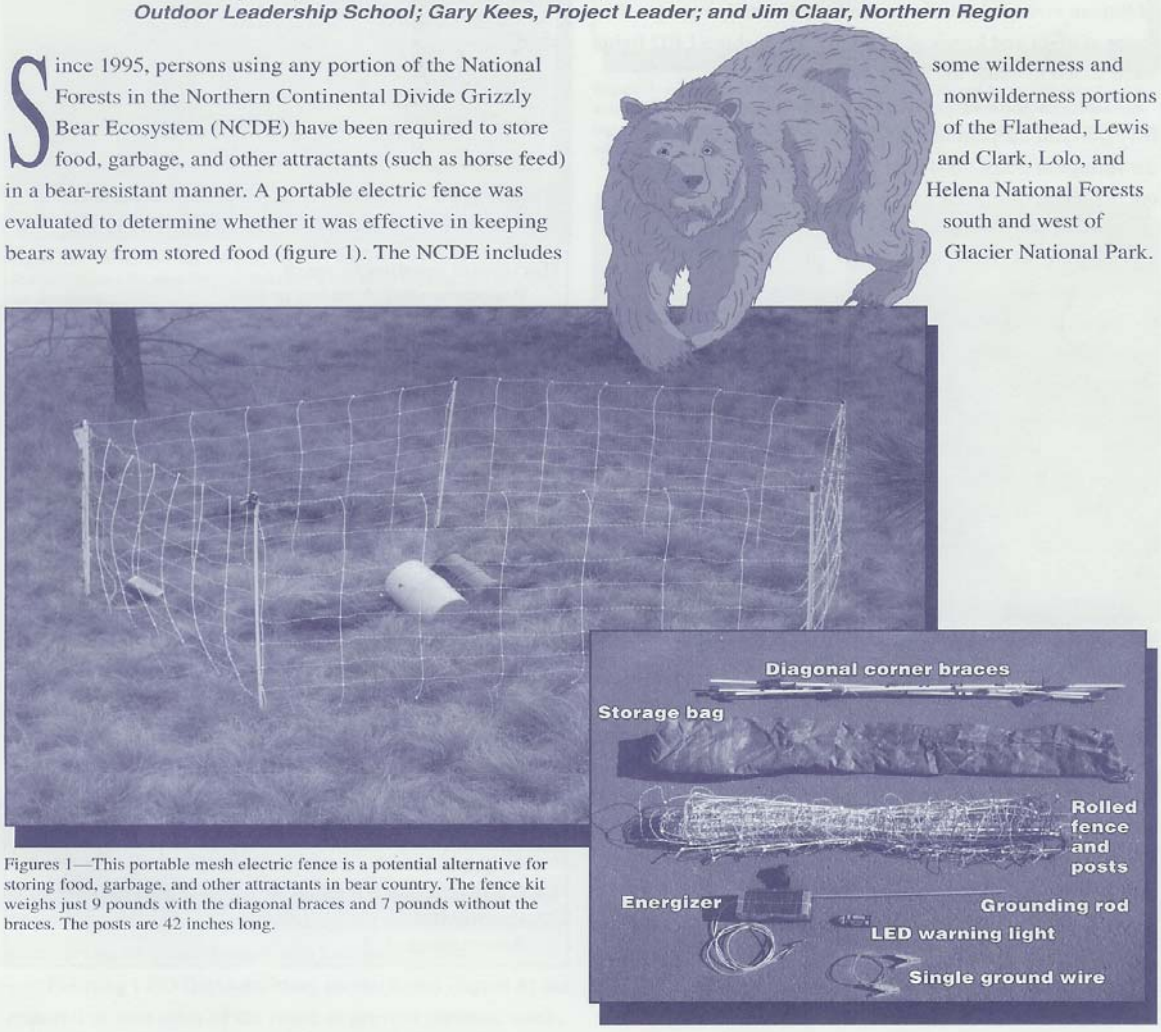
Recreation Tech Tips

United States Department of Agriculture
Forest Service
Technology & Development Program
November 2005
2300 0523-2307-MTDC

Specifications for Portable Mesh Electric Fences Used as an Alternative Method for Food Storage

Dick Karsky, Project Leader; Kim Barber, Rocky Mountain Region; John Gookin, National Outdoor Leadership School; Gary Kees, Project Leader; and Jim Claar, Northern Region

Since 1995, persons using any portion of the National Forests in the Northern Continental Divide Grizzly Bear Ecosystem (NCDE) have been required to store food, garbage, and other attractants (such as horse feed) in a bear-resistant manner. A portable electric fence was evaluated to determine whether it was effective in keeping bears away from stored food (figure 1). The NCDE includes some wilderness and nonwilderness portions of the Flathead, Lewis and Clark, Lolo, and Helena National Forests south and west of Glacier National Park.



Figures 1—This portable mesh electric fence is a potential alternative for storing food, garbage, and other attractants in bear country. The fence kit weighs just 9 pounds with the diagonal braces and 7 pounds without the braces. The posts are 42 inches long.

For additional information, contact: *Dick Karsky, project leader; USDA Forest Service, MTDC; 5785 Hwy. 10 West; Missoula, MT 59808-9361. Phone: 406-329-3921; fax: 406-329-3719; e-mail: rkarsky@fs.fed.us*

Similar requirements have been in place since 1990 in the Greater Yellowstone Grizzly Bear Ecosystem (GYE). The GYE includes some wilderness and nonwilderness portions of the Beaverhead-Deerlodge, Bridger-Teton, Custer, Gallatin, Targhee, and Shoshone National Forests. The area where these special orders apply is being expanded.

The National Outdoor Leadership School (NOLS) in Lander, WY, developed a portable backpacker fence as an alternative method of storing food in bear country. They have tested different configurations of the fence over the past few years. The fence has failed only a few times, usually because of human error or because animals accidentally ran into the fence at night and knocked it down. The flashing LED lights were added to make the fence more visible.

The Missoula Technology and Development Center (MTDC) and the Northern Region tested these fences during the springs of 2003, 2004, and 2005 when bears were coming out of hibernation. A carcass was placed inside the fence and remote cameras monitored black bears and grizzly bears that visited the sites during the day and night.

Portable mesh electric fence systems are being considered for approval as an acceptable means of meeting the requirement for storage in a bear-resistant manner. The fence kit weighs about as much as a heavy backpacking tent. The complete kit with five diagonal braces weighs 9 pounds, Without the braces, the kit weighs 7 pounds. The energizer alone weights 1.8 pounds and the fence alone weighs 4 pounds.

This document does not authorize the use of these fence systems to meet requirements of the various Forest Service food storage orders.

Several other portable fence systems have been tested that did not keep bears out. Energizers and fences that are not listed here must be evaluated by MTDC before approval.

These fences are intended to keep bears away from food, garbage, and other attractants in the backcountry.

They are not intended to protect campers from bears and have not been tested for such uses.

Electric Fence System Requirements

Table 1 summarizes the specifications of the fence system that has been proven effective for food storage. As new components for electric fence systems are developed, they will require testing and approval.

Table 1—Summary of electric mesh fence specifications.

Fence height
Required: 33 inches
Recommended: 42 inches
Post length
Required: 42 inches
Recommended: 48 inches
Post construction
Required: Polyethylene
Recommended: Fiberglass
Strands of stainless steel wire per horizontal wire
Required: 3
Recommended: 9
Number of horizontal wires
Required: 8
Recommended: 12 or more
Horizontal opening in mesh
Recommended: 6 inches or less
Maximum: 11 inches
Length of ground rod (earth ground is mandatory)
Required: 1 foot
Recommended: $1\frac{1}{2}$ feet
Energizer output
Required: 0.11 joules
Recommended: 0.2 joules
Tested peak output voltage (on every hot conductor, with no load other than the fence)
Required: 5,000 volts
Recommended: 7,000 volts
Minimum pulse duration (with a 10,000-ohm load applied)
Required: 0.05 milliseconds
Minimum shocks per minute
Required: 35
Recommended: 45
Distance between fence and items inside
Required: 1.5 feet
Readable placard indicating fence is electrified
Required: 1
Maximum fence length
60 feet
LED lights
Required: 2
Recommended: 3

A ground wire return fence (with alternating hot and ground wires) must be used. Mesh with semirigid stays (figure 2a) is recommended to keep the mesh from drooping, which could allow the hot wires to short out against the ground wires below them (figure 2b).

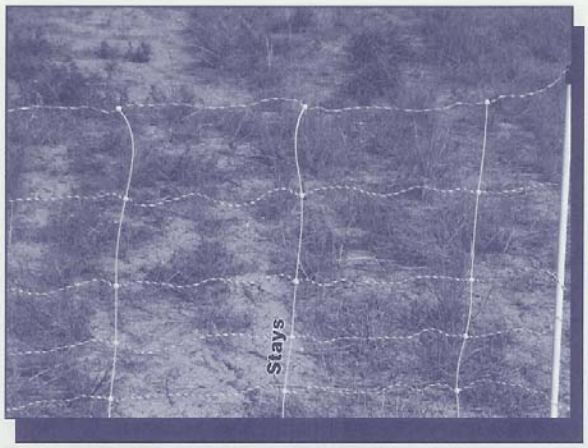


Figure 2a—Semirigid vertical stays (above) are preferred to flexible vertical strands (below) because they prevent hot wires from sagging and shorting out the fence.

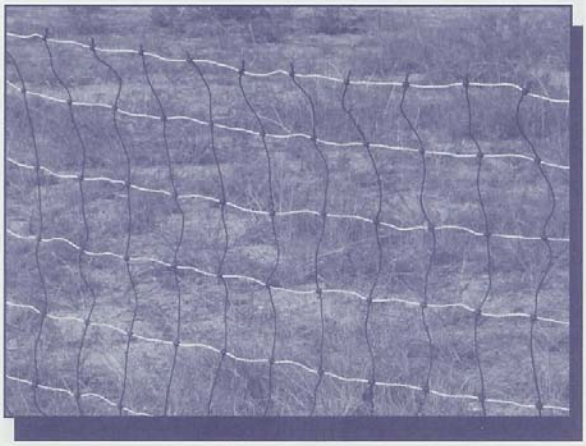


Figure 2b—Unless this fence is kept tight, the flexible vertical strands may allow hot wires to sag, shorting out the fence.

The recommended size for fences is 6 feet per side with five sides for the backpacker version (figure 3) and a maximum of 12 feet per side with five sides for the outfitter's version. The outfitter version must have diagonal braces on the corner posts. It can be created using two backpacker fences.

Flashing LED (light-emitting diode) lights (figure 4) are required on two sides of the fence to prevent persons, stock, and wild game from running into the fence and knocking it over.

Make sure that the fence's bottom wire is near the ground, so that bears cannot crawl or reach under the fence without getting shocked.

If the fence is installed on wet snow, the snow must be packed down beneath the fence to prevent the snow from shorting out the fence.

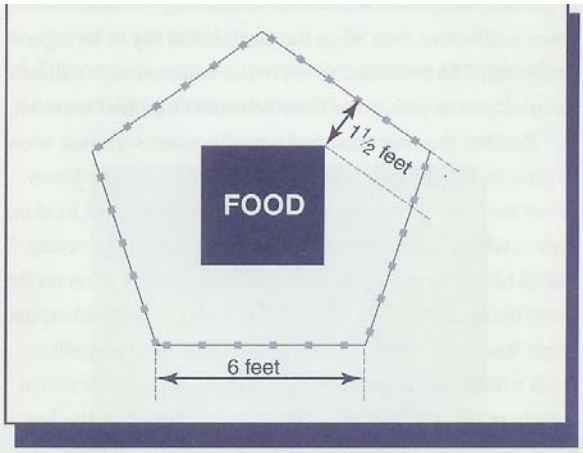


Figure 3—A fence enclosure for backpackers should have five 6-foot-long sides. Food must be stored at least 1½ feet away from the fence.Outfitters needing to protect more food can combine two of these fences to enclose an area with 12-foot-long sides.

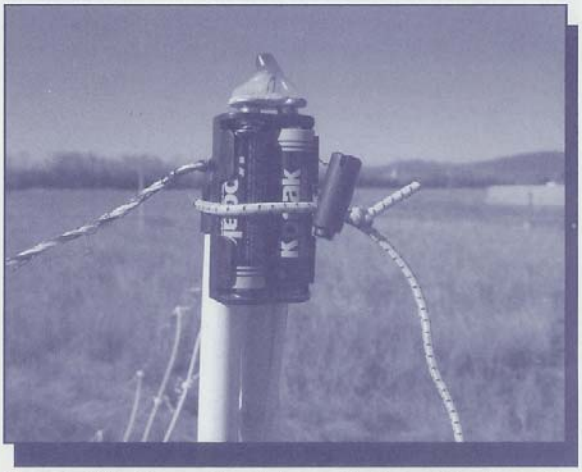


Figure 4—LEDs (light-emitting diodes) attached to two sides of a portable electric mesh fence can warn campers or animals before they touch or run into the fence.

A ground wire return fence with alternating ground and hot wires is effective even when the earth is too dry to be a good conductor. The grounded wires in the fence provide a direct electrical return path to the fence controller's ground terminal.

Because the bear must make good contact with two wires to get a shock, the bear may apply some force to the fence before the conductors work through the fur and contact its skin. This is why it is recommended that the ground wire return fences have inside diagonal braces for the corner posts on the small backpacker fence. Diagonal braces are required on the larger fences, (outfitter version, figure 5). Mesh, especially mesh without the semirigid vertical stays, needs to be pulled tight to prevent it from sagging, which could allow the hot wires to short out against the ground wires below them.

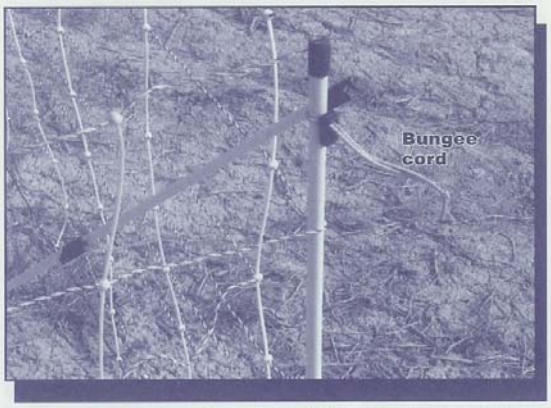


Figure 5—Bungee cords can be used to hold diagonal braces against corner posts.

The ground rod provides an electrical circuit using the earth as the return path when the soil is moist. A bear will get shocked when it contacts any hot wire while standing on moist soil or when it touches a hot wire and a ground wire.

Grass and weeds should be clipped or removed around the fence's perimeter so moist vegetation does not contact hot wires, even in windy conditions. Wet vegetation conducts some of the electric current to the ground and will decrease the shock delivered to a bear. Fences that contact wet vegetation are unlikely to produce the 5,000 volts required. Use a fence tester that indicates voltage on the fence (Gallagher Model G50104 or equal). Place one lead on one of the energized wires and the other lead on a ground wire. If the voltage reading is higher than 5,000 volts, the fence is working properly. If the voltage reading is lower than 5,000 volts, vegetation probably is shorting out the fence. Clear the obstructions and retest. Another possible cause of low fence voltage is a discharged battery.

Installing the Fence

Choose a spot to install the fence where the ground is flat, no trees or brush hang over the fence, and where the fence does not block an established game trail. Gather up and store the fence in accordion fashion by collecting the posts with loops of mesh drooped between them (figure 6). To install the fence:

Figure 6—If the fence mesh has been gathered accordion style, the fence will be easy to install.

1. Hold the posts and allow the fence mesh to drop.
2. Insert one of the end posts into the ground at your starting point.

3. Insert each of the remaining posts into the ground to lay out the five sides of the fence (figure 3).
4. At the end, push the last post into the ground next to the first post.
5. Reposition individual posts until you are satisfied with the fence's tension and shape.
6. Attach diagonal braces to the fence posts, if required.
7. Ensure that the energized hot wires are on the outside of the posts (figure 7).

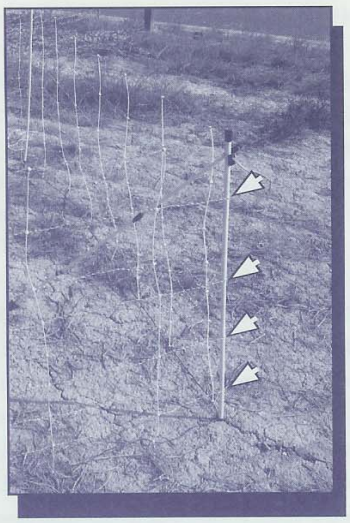


Figure 7—Ensure that the hot wires are on the outside of the fence posts. Otherwise, a bear could knock the post over without getting shocked.

8. Place the energizer next to the posts just inside the fence where animals cannot damage it. Drive the ground rod near the energizer (figure 8).
9. Electrical wires clip to metal tabs crimped on the fence mesh near the end post (figure 9).
10. Connect a separate green (ground) wire from the ground rod to the fence. Attach the energizer's green wire (ground) (figure 8) to the ground rod.
11. **Connect the white or red (hot) wire from the energizer to the proper metal (hot) tab on the fence mesh.**
12. **Connect the green wire (ground) to the proper metal (ground) tab connected to the ground wires on the fence. CAUTION: Be sure to connect the hot lead from the energizer to the proper metal (hot) tab on the fence, and the ground lead to the proper metal (ground) tab on the fence or the energizer will not operate.**
13. Use adjustable bungee cords to attach the LED lights on two of the posts.
14. If the soil is very dry, pour water over the ground rod to provide a good earth ground.

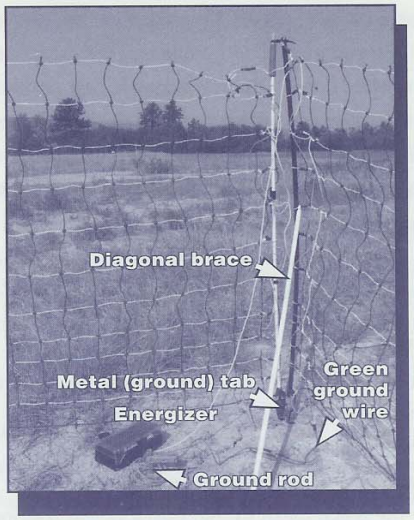


Figure 8—Connect the ends of the fence and attach the energizer to the fence and the ground rod. The ground rod should be at least 1 foot long. If the soil is dry, pour water near the rod to ensure a good electrical ground.

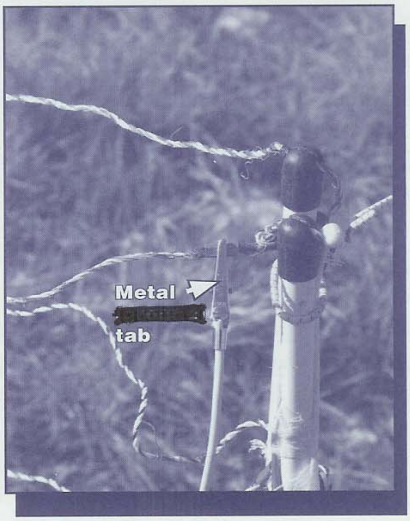


Figure 9—Connect the clips on the leads from the energizer to the hot wire (shown) and ground wires of the fence.

Using the Fence

1. After food has been placed in the middle of the enclosure, connect the fence and turn on the energizer (which must be inside the fence).
2. Use a fence tester that indicates voltage on the fence (Gallagher Model G50104 or equal). Place one lead on one of the energized (hot) wires and the other lead on a ground wire. If the voltage reading is higher than 5,000 volts, the fence is working properly. If the voltage reading is lower than 5,000 volts, food must be stored by another approved means, such as hanging the food properly from a tree.

Removing the Fence

1. Disconnect the energizer and electrical fence connections.
2. Remove LEDs.
3. Remove the diagonal braces, if they were used.
4. Lift each post as you walk down the line.
5. Allow the fence mesh to fold into loops accordion style as you proceed.
6. Lay the fence flat on the ground and ROLL the mesh around the POSTS.

Approved Energizers

Power Innovations (Models: Sureguard S4-Plus, S4, S10, and M-4)
110 Barton Rd. • Lismore, NSW2480, Australia
Phone: 61–2–6628–2000 • Fax: 61–2–6628–2022
Web site: *http://www.sureguard.com.au*
E-mail: *help@sureguard.com.au*

Gallagher Power Fence (Models: B11, B75, and B80)
18940 Redland Rd. • San Antonio, TX 78270–8900
Phone: 800–531–5908
Web site: *http://www.gallagher.com.au*

Stafix (Models: B0.5 and AN90)
Web site: *http://www.stafix.co.nz/stafix_new/*

PEL (Models: 901B and 110B)
Web site: *http://www.pel.co.nz/pel_new2/*

Approved Electric Mesh Fences

J.L. Williams Co. (Models: Electro-Web P-75 and P-89)
P.O. Box 209 • Meridian, ID 83680
Phone: 800–843–3702 • E-mail: *freeinfo@safefence.com*
Web site: *http://www.safefence.com*

Kencove Farm Fence, Inc. (Models: NGS, NSG, and NSG12X)
344 Kendall Rd. • Blairsville, PA 15717-8707
Phone: 800–536–2683 • E-mail: *fence@kencove.com*
Web site: *http://www.kencove.com*

Premier 1 Supplies (Model: Electronet)
2031 300th St. • Washington, IA 52353
Phone: 800–346–7992 • E-mail: *info@premier1supplies.com*
Web site: *http://www.premier1supplies.com*

Recommended Fence Improvements

The fence's alligator clips and metal tabs allow electrical connections to be made improperly. If the fence had polarized connectors (figure 10), they would always connect hot to hot, and ground to ground properly.

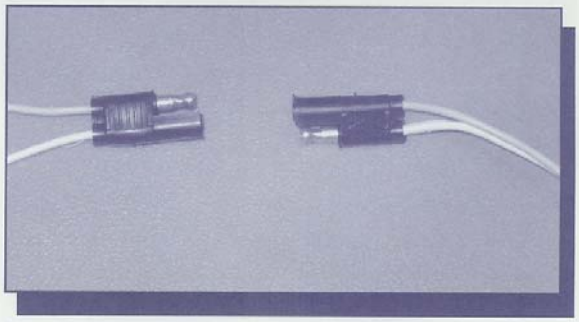


Figure 10—Polarized connectors could prevent improper electrical connections.

Maintenance Tips

VOLTAGE

- Clip grass, weeds, and branches around the fence's perimeter so moist vegetation will not contact hot wires, even in windy conditions. Retest the fence's voltage.

- Clip the hot lead to the solid metal connector rather than a piece of plastic twine and ensure that the ground lead is connected to the ground clip on the fence. A separate wire should connect the ground clip to the ground rod.
- Locate a good ground by probing with the ground rod to find damp soil.
- Clean all battery contacts with a pencil eraser.
- Use dry silicone on the charger in humid areas. Silicone will reduce the possibility that moisture will allow the high voltage current to arc to the case.
- During cold conditions, use new batteries and replace them more often.
- Solar energizers, such as the Sureguard S4–Plus, may not keep the batteries fully charged from November through February, when days are short and temperatures are low.
- **Make sure that the ground and hot leads are connected properly or the fence will not operate.**

CARE

- Care for the charger the way you would care for a cell phone, radio, GPS receiver, or other electronic device.
- Place the charger in a dry, foam-padded case before transporting it.
- Clean the battery contacts with a pencil eraser as needed.
- Keep your charger dry. If it falls in water, open the charger and dry it in the sun or expose it to a breeze before turning it on.

TROUBLESHOOTING

- Are the batteries holding a charge? Use new batteries to see whether they fix the problem.
- Is anything corroded? If so, try cleaning the battery contacts with a pencil eraser.
- Are the hot and ground lead wires connected properly?
- Are the wires intact?
- Is the charger dry? If it looks wet, try opening the charger and drying it in the sun or exposing it to a breeze before turning it on.
- Does the ground wire go from the ground clip to the ground stake?
- Does the red (hot) wire go from the energizer to the white (hot) wire tab on the fence?
- Is anything inside obviously broken or disconnected because the charger has been dropped?
- Have you tried tinkering? If you do, remember that the first rule of intelligent tinkering is not to lose any parts.

Acknowledgments

The authors would like to thank:

- NOLS staff for developing this fence and providing materials and data for the laboratory and field tests.
- Mark Hinschberger, Shoshone National Forest, for his work with NOLS in developing the backpacker fence and in obtaining funding.
- Dan Carney, Blackfeet Tribe, for field testing prototype fences and sharing his knowledge of bear behavior.
- Mike Madel and Mike Maples of the Montana Department of Fish, Wildlife, and Parks in Choteau, MT, for allowing us to test the prototype fence on the Rocky Mountain Front and helping us monitor the test sites.
- Brian Castaldi, MTDC, for helping install the camera monitoring system.

About the Authors

Dick Karsky has been program leader of forest health protection, GPS, and the air portion of the watershed, soil, and air program since the fall of 1999. Dick has been a project leader at MTDC in the resource areas of GPS, range, cooperative forestry, engineering, fire, reforestation and nurseries, residues, recreation, and forest health protection. He received a bachelor's degree in agricultural engineering from North Dakota State University and a master's degree in agricultural engineering from the University of Minnesota. He worked for private industry before coming to the Missoula Technology and Development Center in 1977.

Kim Barber has been the grizzly bear and wolf biologist for the Rocky Mountain Region of the Forest Service since 1992. Kim, who is based in Cody, WY, represents the six National Forests in the Greater Yellowstone Area (GYA) on the Interagency Grizzly Bear Study Team, leads the Grizzly Bear Cumulative Effects Modeling Team for the GYA and serves on various technical teams for the Interagency Grizzly Bear Committee. He has also worked for the Forest Service in Utah, Nevada, and Alaska. He received a bachelor's degree in zoology from Weber State College and a master's degree in wildlife management from Utah State University.

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Lake Forest College in Chicago, IL. He taught high school sciences and was a U.S. Marine before joining NOLS in 1981.

Gary Kees is a project leader specializing in reforestation and nurseries, facilities, recreation, and GPS projects at MTDC. He received his bachelor's degree in mechanical engineering from the University of Idaho. Before coming to MTDC in 2002, Gary worked for the Monsanto Co. in Soda Springs, ID, as a mechanical/structural engineer and project manager.

Jim Claar joined the Forest Service in 1989 and has helped establish standards for food storage and other techniques for living and recreating in bear country. He has been the carnivore program leader for the Northern Region since 1999. Jim also serves as the team leader for the national lynx biology team, team leader for the interagency wolverine biology team, and regional lead for interagency gray wolf coordination. He has a bachelor's degree in wildlife biology from the University of Montana and a master's degree in wildlife management from the University of Idaho.

Library Card

Karsky, Dick; Barber, Kim; Gookin, John; Kees, Gary; Claar, Jim. 2005. Specifications for portable mesh electric fences used as an alternative method for food storage. Tech Tip 0523–2307–MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 8 p.

Describes the specifications of portable electric fences for storing food, garbage, and other attractants (such as horse feed) in the Northern Continental Divide and Greater Yellowstone Grizzly Bear Ecosystems. Those ecosystems include portions of National Forests near Glacier and Yellowstone National Parks in Idaho, Montana, and Wyoming. Special orders have been issued for these areas requiring that food, garbage, and other attractants be stored in a bear-resistant manner. This tech tip specifies the portable electric fences and energizers for this use and how they must be installed.

Keywords: backcountry, black bears, camping, energizers, food, garbage, grizzly bears, refuse, regulations, special orders, storage, Ursidae

Additional single copies of this document may be ordered from:
USDA Forest Service, MTDC
5785 Hwy. 10 West
Missoula, MT 59808–9361
Phone: 406–329–3978
Fax: 406–329–3719
E-mail: *wo_mtdc_pubs@fs.fed.us*

Electronic copies of MTDC's documents are available on the Internet at:
http://www.fs.fed.us/t-d/ (Username: t-d, Password: t-d)

For additional information about portable electric fence specifications, contact Dick Karsky at MTDC.
Phone: 406–329–3921
Fax: 406–329–3719
E-mail: *rkarsky@fs.fed.us*

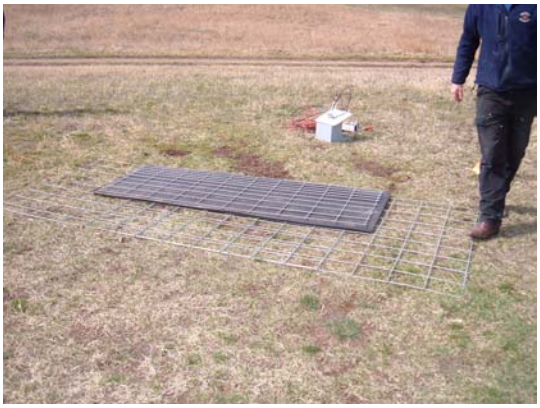
Forest Service and Bureau of Land Management employees can search a more complete collection of MTDC's documents, videos, and CDs on their internal computer networks at:
http://fsweb.mtdc.wo.fs.fed.us/search

How to create an "electrified unwelcome mat"

This series of photos shows how cattle and hog panels are used with horse stall mats to construct an electrified pad. Electrified pads, which we call "electrified unwelcome mats," can be handy for keeping bears off of porches or decks, away from doors, out from underneath bird feeders, or away from dumpsters. Keep in mind that anything, or anyone, who steps onto the mat also receives the "unwelcome" message! They probably would not be appropriate for areas where a lot of people or pets walk. They are good for modifying the behavior of bears that have become repeat offenders and routinely visit the same place over and over.

The 34 inch hog panel is electrified and insulated by the rubber stall mat. The 52- inch cattle panel is the ground for the system in this example.

Use plastic ties to stabilize the hog panel on the mat. Drill holes in the mat and secure the mat to the hog panel by tying the two together with plastic "zip" ties, baling twine or wire. This will prevent the wire panel from shifting off of the mat.



This design has several practical applications including:

- The entrance to a deck or patio
- The entry to a granary or feed shed.
- Blocking off a garbage storage area.

Note that a rubber-tired vehicle can drive over this system eliminating having to open or close gates.

Heavy-Duty Portable Fencing

The pictures below were provided by Margo Supplies to show examples of what they refer to as "heavy-duty portable" electric fencing. The difference between these designs and permanent fencing design is that the electric wire is attached to fiberglass posts that are fairly easy to move or remove. In other words, the posts used in these designs are meant to be easy to take down and are not buried, set in concrete or otherwise permanently installed.

Photos courtesy of Margo Supplies

The portable system pictured below is made with 52-inch welded-wire cattle panels. Offset brackets with Gallagher's Turbowire are attached to use the hot/ground return system with three wire strands.

This design has been used effectively for compost piles and smaller fruit trees, and could also be used to exclude predators from hog or sheep pens. This design is inexpensive and easily moved for rotational grazing or 4H projects.

Photo courtesy of Patti Sowka

Electrifying Dumpsters and Garbage Containers

One solution to keep bears out of dumpsters is to electrify them or put some temporary electric fencing up around them. The following pictures show some ways of temporarily electrifying dumpsters or garbage cans to discourage bears. These designs can be especially helpful when a food-conditioned or young bear is just beginning to "visit" certain containers. These electrified containers can actually act as an aversive conditioning tool to "teach" the bears to avoid refuse containers.

This photo illustrates the cattle panel design for use around garbage dumpsters.

The upright panels are electrified by suspending them a few inches above the ground suspended on fiberglass poles. The panels on the ground are not electrified and act as the ground for this system.

Photo courtesy of Jamie Jonkel

The two photos below show a temporary electric fence that was constructed in less than two hours at a restaurant in Montana. Bears were regularly accessing the dumpster and grease container that sit on a concrete pad. T-posts were driven at each corner and four hot strands were attached. Three electrified bungee cords manufactured by Gallagher Power Fence Systems made a convenient (but electrified!) gate for front dumpster access.

Photos courtesy of Patti Sowka

Montana Fish, Wildlife & Parks

Living with Predators Project

The "Electric Fence Dumpster Kit" and "Hot Dumpster Kit"

Recognizing the value of being proactive in dealing with situations involving bears and mountain lions, Montana Fish, Wildlife & Parks (FWP) created the "Living with Black and Grizzly Bears, and Lions" (LBGL) project to help residents live with black and grizzly bears, as well as lions. LBGL is a program that aims at decreasing the number and severity of problems associated with humans coexisting with bears and lions.

As part of the project LBGL began researching different styles of electric fence in hopes of developing a method of bear-proofing garbage dumpsters. Electric fence has been a proven method of deterring bears from natural and unnatural food sources (Madel 1996.) This spring, in cooperation with Gallagher Fencing Systems and Cennex, FWP developed two methods of bear proofing garbage dumpsters with electric fence systems and developed a new style of electric fence for bee apiaries.

The first method of bear proofing garbage dumpsters consists of an electric fence design that is portable, user friendly and durable. The fence can be electrified with an energizer that has a 110-20 volt A.C. power cord or an energizer with a 12-volt battery and solar panel. The design consists of electrified cattle panels suspended above the ground on fiberglass posts that are grounded to a cattle panel pad and a ground rod (Photograph 1).

Photograph 1: "Electric Fence Dumpster Kit."

The bear receives a direct shock when it stands on the ground pad and touches the electrified panels. The design has been tested on black bears and grizzly bears that were getting into garbage.

Photograph 2: Wild grizzly approaching.

In early August 2000 a grizzly bear was photographed, with a remote camera, while attempting to reach a fenced deer carcass (Photograph 2.)

In May 2001 the fence was taken to the Grizzly Bear Discovery Center in West Yellowstone, Montana and tested on eight captive grizzly bears (Photograph 3). In all cases this style of electric fence deterred the bears.

Photograph 3: Captive grizzly approaching electric fence.

This style of electric fence kit can be erected around garbage cans, metal garbage dumpsters, 300 gallon round plastic dumpsters, cooking grease containers, pet or livestock food, small buildings, compost piles, fruit trees, game pole and meat caches, tents and small vehicles or campers.

Three sizes of this style of electric fence design have been erected and by FWP. The 8' x 8' "electric fence dumpster kit" is appropriate for one dumpster; the 16' x 16' "electric fence dumpster kit" and the hexagon "electric fence dumpster kit" with 8' sides will enclose three to four 3 square yard garbage dumpsters. The most positive aspect of this fence style is that the electric fence is free-standing on fiberglass posts, thus allowing the entire fence to be picked up and moved to adjacent sites.

A similar style of fence, using insulated steel T-posts can be erected around bee yards. This electric fence design is expensive to erect, but it ensures that bears receive a direct shock when they stand on the ground pad and touch the electrified panels. This more permanent form of the cattle panel fence style can be erected around larger buildings, chicken coops, horse trailers, calving sheds, sheep bedding grounds, gardens and orchards.

The second method consists of an electrified dumpster on an insulated pad that is grounded to a cattle panel pad and ground rod. The dumpster can be electrified with an energizer that has a 110-20 volt A.C. power cord or 12 volt battery with a solar panel. The bear receives a direct shock when it stands on the ground pad and touches the electrified dumpster.

The design has been tested for several years in the town of Seeley Lake, MT and appears to be an affective means of deterring bears. The same technique can be used on horse trailers, and small metal storage sheds.

There are a variety of energizers available on the market. Based on testing and observations, fence energizer voltage output should be a minimum of 6000 volts with a stored energy rating of 0.7 Joules or greater (Madel 1991.) The LBGL project found that the Gallagher 110 volt Fence Master Energizer worked well with the "hot dumpster kit" and 8' x 8' "electric fence dumpster kit" when a power source was available.

The solar powered Gallagher SuperCharger S17 worked well with the "hot dumpster kit" and the 8' x 8' and 16' x 16' "electric fence dumpster kits. The solar powered Gallagher B200 and the Parmak Mag. 12 Solar worked well with the 32' x 32' bee yards. For information on what energizers are appropriate for larger fence structures contact your local Gallagher and Parmak fencing system dealers.

The "Electric Fence Dumpster Kit":

The following directions are for the **8' x 8' and 16' x 16'** fence kits.

Materials:

Eight 8' or 16' cattle panels (two 8' cattle panels instead of one 16' cattle panel make a more effective gate); one bag of Gallagher Insultimber Dropper Clips (G702); five 5' 1 ¼" diameter fiberglass posts (the 16' x 16' fence may require two to three additional posts for the 8' panel gate); one 3' ground rod with a clip; one piece of 10' to 20' of insulated cable; 3 line clamps; 2 electric fence spring loaded gate handles, two electric fence signs; one 6' T post to mount energizer (optional) and the energizer of your choice.

Directions:

•Find an appropriate location for your electric fence. If the fence energizer requires a direct power source make sure the distance corresponds to the length of the power cord. The site should be flat and cleared of vegetation.

- Lay four cattle panels down on the ground and form a perfectly square 12.5′ x 12.5′ or 20.5′ x 20.5′ pad. Wire the ends and sides of the four cattle panels where they connect. Use Gallagher Insultimber Dropper Clips (G702) to wire the panels together (Diagram 1).

Diagram 1: ground pad

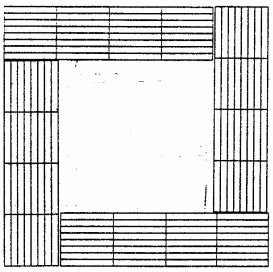
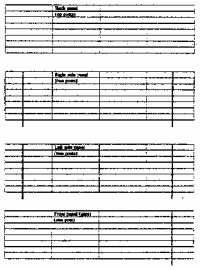


Diagram 2: fence post placement



- Attach the four remaining cattle panels end to end in three places with insultimber clips and stand the fence up in the form of a perfect 8′ x 8′ or 16′ x 16′ square in the center of the cattle panel pad. Using the insultimber clips wire the fiberglass posts (slightly offset) to the inside corners of the fence (Diagram 2).

- The corner with two posts next to each other will be your gate. (If you are using the 8′ gates on the 16′ x 16′ fence you will need to wire two additional posts onto the fence where the two 8′ panels come together.) Wire the two gate handles on the bottom and the top of the left cattle panel. Using the insultimber wire clips make two catch loops for the gate handles on the right cattle panel. Open up the gate by picking up the right cattle panel and walking back. The opening of the gate can be larger by picking up the left cattle panel and walking back. The gate opening should be large enough to allow a dumpster to be pulled in and out of the fenced area. Close and latch the gate.

- Choose the location of your energizer and determine how you will turn it on and off. The energizer can be mounted on a wall, tree or metal T-post inside the fenced area. After mounting the energizer cut two pieces of insulated cable for the hot wire (+) connection and ground wire (-) connection. The (+) wire will need to go from the (+) connection on the energizer to the back of the fenced area opposite the gate. The insulated cable needs to be attached with a line clamp and strung or woven in such away that the connections will not be pulled loose by a bear walking around the fence.

- Pick a spot on the cattle panel pad that is closest to the energizer and pound in the ground rod. The (-) insulated cable will need to go from the (-) connection on the energizer to the spot where the ground rod and the cattle panel pad come together. The insulated cable needs to be attached to the cattle panel and the ground rod with line clip and then strung or woven in such away that the connections will not be pulled loose by a bear walking around the fence. Place two electric fence signs at the site.

The "Hot Dumpster Kit"

The following directions are for electrifying a 2 to 4 square yard metal garbage dumpster.

Materials:

Two 8' cattle panels; one bag of Gallagher Insultimber Dropper Clips (G702); one 3' ground rod with a clip; one piece of 10' to 20' of insulated cable; 3 line clamps; one 4' x 6' rubber horse trailer pad; two electric fence signs; one 6' T-post to mount energizer (optional) and the energizer of your choice.

Directions:

•Find an appropriate location for your electrified dumpster. If the fence energizer requires a direct power source make sure the distance corresponds to the length of the power cord. The site should be flat and cleared of vegetation. In some areas dumpsters are required to be placed on concrete pads.

•Lay two 8' cattle panels side by side on the ground or concrete pad and form a perfectly square 8' x 8.5' pad. Wire the sides of the cattle panels where they connect. Use Gallagher Insultimber Dropper Clips (G702) to wire the panels together.

•Place the rubber horse trailer pad in the middle of the cattle panel pad and roll the dumpster onto the horse trailer pad.

•Choose the location of your energizer and determine how you will turn it on and off. The energizer can be mounted on a wall, tree or metal T-post. After mounting the energizer cut two pieces of insulated cable for the hot wire (+) connection and ground wire (-) connection.

•The (+) wire will need to go from the (+) connection on the energizer to the alligator clamp that attaches to the dumpster. It is important that the paint be removed where the (+) end attaches to the dumpster. The insulated cable needs to be strung or woven in such away that the connections will not be pulled loose by a bear walking around the fence.

•Pick a spot on the cattle panel pad that is closest to the energizer and pound in the ground rod. The (-) insulated cable will need to go from the (-) connection on the energizer to the spot where the ground rod and the cattle panel pad come together.

•The insulated cable needs to be attached to the cattle panel and the ground rod with line clip and then strung or woven in such away that the connections will not be pulled loose by a bear walking around the fence. Post two electric fence signs at the site.

These two dumpsters were enclosed using a temporary electric fence that was also constructed in about two hours.

Metal t-posts supported welded wire cattle panels that acted as the ground for the fence. Plastic off-set insulators held the four hot (+) strands on the outside of the cattle panels.

Three electrified bungee cords manufactured by Gallagher Power Fence Systems stretched across the front of the enclosure acted as the gate and provided easy access for the hauler when emptying the dumpsters.

The garbage can in the photo on the left is enclosed by electrified welded wire cattle panels.

This is a quick and fairly inexpensive way to keep bears out of garbage cans. Note that multiple garbage cans can be protected using this enclosure.

The garbage can in these two photos is electrified using a battery-operated B60 energizer connected directly to the cattle panel. The rubber stall mat prevents the wire panel from grounding out (see photo at right).

The design could be altered to use rubber tires instead of cinderblocks to set the cattle panel platform.

The panels on the ground act as the ground mat. By suspending the can on the wire panel, the can itself can be made "hot" (see photo at right).

Permanent Fencing

Permanent electric fencing differs from portable electric fencing in how long the fencing will be in place and therefore in some of the materials used to construct the fence. The same general components are found in both permanent and portable fencing: posts, wire, energizer, grounding system and insulators. Permanent or semi-permanent heavy duty portable fencing is often constructed with large-diameter wooden posts which are treated to prevent them from rotting too quickly. Permanent fencing is usually constructed using wire strands instead of welded–wire cattle panels.

One last major difference is that permanent fencing often involves securing a large area and therefore requires the use of a stronger energizer to ensure that a sufficient flow of electricity is present along the entire length of the fence.

The photos in this section of the guide show examples of permanent electric fences that have been constructed to exclude bears and wolves.

This permanent bear exclusion fence is located near Choteau, Montana. This fence was constructed using treated wood posts for added strength and stability.

Photos courtesy of Larry Feight, Gallagher USA

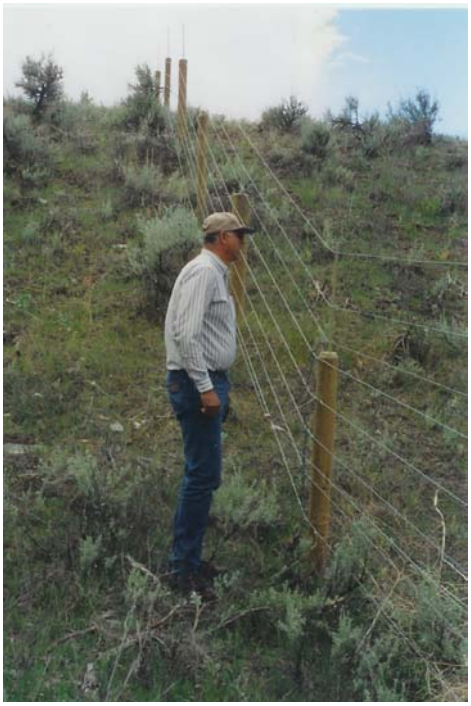
The fence to the right was built in 1987 for bear, wolf, and coyote exclusion. Located near Meteetsie, Wyoming, this nine-wire alternating hot/ground fence was one of the first of its kind built in the area in 1987. A hot/ground system was important in this area due to the dry soil conditions.

The photo to the left shows another example of a permanent electric fence.

Permanent electric fencing often utilizes wooden posts for structure as shown in these photographs.

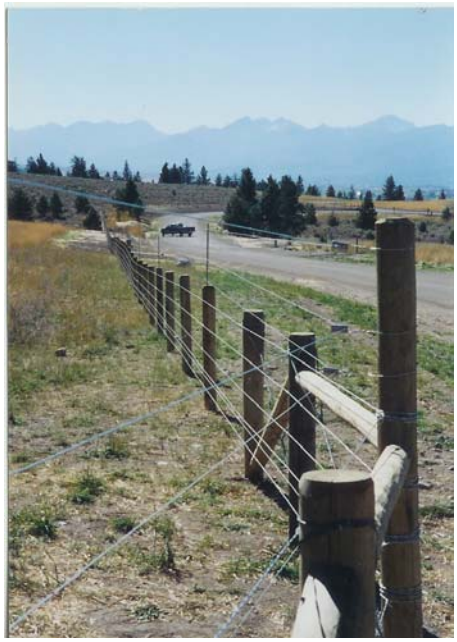
Note in the photo at the left that insulators must be used to secure the hot strands to the posts.

The other wire strands are attached directly to the wooden posts (as seen in the same photo) and act as ground wires. This is referred to as an alternating hot/ground fence design.



HINT:

It's best to use treated posts since they tend to last longer when subjected to harsh weather conditions.



This photo shows a ranch gate that has been modified with electric fencing. The hot strands above the gate discourage predators from trying to go over the top of the gate.

Photo courtesy of Larry Feight of Gallagher.

Contract Fencing by Margo Supplies

Margo Supplies, located in Canada, specializes in the design and installation of electric fencing to deter wildlife, especially bears, from landfills, outfitter camps and other areas. The following group of pictures was provided by Margo Supplies to illustrate some of the fencing applications that Margo has addressed. Most of the enclosures pictured were built for bear exclusion but could work for wolf exclusion as well.

Please contact Jeff Marley at Margo Supplies for information about the electric fencing products they carry or for information about the contract electric fencing services Margo Supplies offers. Visit them at www.margosupplies.com or phone them at (403) 652-1932.

This picture shows an eight-strand alternating hot/ground fence. Note how close the first hot wire is to the ground—this is to prevent predators from going under the fence. (The wire closest to the ground is a ground wire).

This installation involved blasting holes into the rock to insert the fence posts.

This set-up utilizes an energizer with a solar panel to provide a power source where electricity is not available.

Permanent fencing utilizing two different types of posts...

Photos courtesy of Margo Supplies

Margo Supplies Contract Electric Fencing (cont.)

The following sequence of photos shows electric fencing in combination with cattle guards, otherwise known as "Texas Gates." Electrified cattle guards are another way to deter predators and livestock from livestock pastures, landfills or other areas.

The photo above shows a "Texas Gate" with a walk-through gate for convenient access for people.

The cattle guards are constructed of 5.5" O.D. (.304 wall thickness) cross members, 8.5" x 2" rectangular tubing mud sills and 10.75" O.D.(3/16" wall thickness) main support pipes. The runners (pipe bed) are 3.5" with .156 wall thickness. These guards can withstand the heaviest of trucks and are designed to require little maintenance.

The photo on the right shows other electric fence configurations.

Photos courtesy of Margo supplies.

Deterring Grizzly Bears with Electric Fencing

Electric fencing has become an integral part of non-lethal management of grizzly bears. Montana Fish, Wildlife & Parks Bear Management Specialist Mike Madel was instrumental in testing and promoting the use of electric fencing for reducing livestock depredations and other grizzly-related conflicts along the Rocky Mountain Front in Montana. He also conducted research to establish specifications for effective grizzly bear exclusion fences.

The specs presented here were derived as a result of that research. These specs are now considered to be minimum requirements for building electric fencing for grizzly exclusion and are now the standard used by the U.S. Forest Service and state grizzly bear management specialists.

Electric Fencing Specifications — Grizzly Bear Exclusion

Minimum joule requirement :	.7 or more
Minimum voltage requirement :	6,000 or more
Recommended fence polarity :	hot/ground
Minimum # of wires :	6 or more
Wire spacing :	6”
Height of fence :	4’
Gauge of wire :	14, or 12

Applications for electric fencing for grizzly exclusion include:

- Apiaries
- Night sheep holding pens
- Calving pens
- Smaller goat, sheep, and llama pens
- Poultry operations
- Sheds and greenhouses
- Backcountry camps
- Orchards
- Gardens
- Compost piles
- Dumpsters/garbage containers

Bears and Birdfeeders

Bird feeders are a major bear attractant and as more people move into bear country, they are becoming a major issue for bears and bear managers. Bears cannot pass up an opportunity for an easy, tasty, high calorie meal. Once bears become conditioned to visiting bird feeders, it's usually just a matter of time before they encounter other attractants near residences and become "nuisance" bears. Often, these bears end up being removed from the population—permanently.

Electrified Bird Feeders

The bird feeder in the photos to the left has been electrified to discourage bears. Jamie Jonkel of Montana Fish, Wildlife & Parks helped develop the design for use as an aversive conditioning tool to teach bears not to visit bird feeders.

The bird feeder is suspended high above the ground, preferably at least 10 feet, and above a welded wire cattle panel. The wire panel on the ground has been connected to the grounding system of the energizer. Insulated cable (shown here with black coating) is used to connect the energizer (not shown here) to the feeder.

Birds that land on the feeder are not shocked because they are not grounded. Bears *are* shocked however when they stand on the grounded wire panel and touch their tongues or noses to the feeder!

Electrified bird feeders can be made out of steel or aluminum—aluminum feeders are much lighter weight and therefore easier to hang and re-fill.

NOTE: *DO NOT PAINT electric bird feeders because this will lower the conductivity of the feeder.*

Photos by Patti Sowka

Bears and Bees

Apiaries (bee hives) are another significant bear attractant. The honey produced by bees is definitely tempting to a hungry bear that might be passing through. Many bee keepers place apiaries in the same location year after year, and once a bear finds the hives, that location is locked into the bear's memory.

Electric fencing is being used effectively to deter bears from bee hives. The fencing can be more temporary so it can be taken down and stored in the off-season, or if the location will be used year after year, a more permanent fence can be constructed. Either way, electric fencing can be an effective and relatively inexpensive way to protect hives from bear predation.

Many wildlife management agencies recommend electric fencing to bee keepers. The designs may vary slightly, but the concept is the same. We have included electric fencing designs that are currently being recommended by several state wildlife agencies.

The information presented on the next two pages illustrates one possible design and specifications for electric fencing to deter bears from apiaries. For more information, contact Montana Fish, Wildlife & Parks and request a copy of the "bears and the bees" brochure.

Photo courtesy of the Living with Wildlife Foundation.

Please report any frequent or continued bear activity on your property to the bear manager for your area. Even if the bear's activity isn't a problem at the time, the behavior often escalates to a point where it requires management action, such as the relocation and/or ultimately, the killing of the bear.

Montana Fish, Wildlife & Parks

Living with Predators

The "Electric Bee Yard Kit"

The following directions are for the **30' x 30'** bee yard.

Materials:

- Sixteen 16' cattle panels
- one bag of Gallagher Insultimber Dropper Clips (G702)
- thirteen 6.5' T posts
- two 5" 1 ¼" diameter fiberglass posts
- thirty-nine 2" electric fence T-post insulators
- two 3' ground rod with a clip
- one piece of 30' to 40' of insulated cable
- 5 line clamps
- 2 electric fence spring loaded gate handles
- four electric fence signs
- one 6.5' T-post to mount energizer (optional)
- energizer of your choice

Directions:

- Find an appropriate location for your electric fence. If the fence energizer requires a direct power source make sure the distance corresponds to the length of the power cord. The site should be flat and cleared of vegetation.

- Lay eight cattle panels down on the ground, two per side, and form a perfectly square 36.5' x 36.5' pad. Wire the ends and sides where the four wings of the ground pad come together. Do not overlap the cattle panels. Use Gallagher Insultimber Dropper Clips (G702) to wire the panels together.

- Using the eight remaining cattle panels, two per side, build a 30' x 30' erect fence over the ground pad. Each side, except for the gate, will consist of two 16' cattle panels over-lapped and wired together with insultimber clips to form a 30' side. The two remaining 16' cattle panels will be used for the gate. Wire the corners together with insultimber clips and position the fence in the middle of the ground pad.

- Drive the thirteen 6.5′ T posts at panel ends and centers (except for the gate) leaving 8″ to 10″ above the cattle panel. The posts should be evenly spaced at four 7.5′ wide intervals. Using three T post insulators per post attach the cattle panel fence to the T-posts.

  The insulators should be attached in such a way that the cattle panel fence is suspended at least five inches off the ground. Bring the two panels that form the gate together and attach the two fiberglass posts to the ends of the cattle panels with insultimber clips. The two posts should be slightly offset and positioned in such a way that the gate handles will snugly pull the ends of the gate together.

- Wire the two gate handles on the bottom and the top of the left cattle panel near the post. Using the insultimber wire clips make two catch loops for the gate handles on the right cattle panel near the second post.

  Open up the gate by picking up the right cattle panel and walking back. The opening of the gate can be larger by picking up the left cattle panel and walking back. The gate opening should be large enough to allow a flat bed truck to be pulled in and out of the fenced area. Close and latch the gate.

- Choose the location of your energizer and determine how you will turn it on and off. The energizer can be mounted on a wall, tree or metal T-post inside the fenced area. After mounting the energizer cut two pieces of insulated cable for the hot wire (+) connection and ground wire (-) connection.

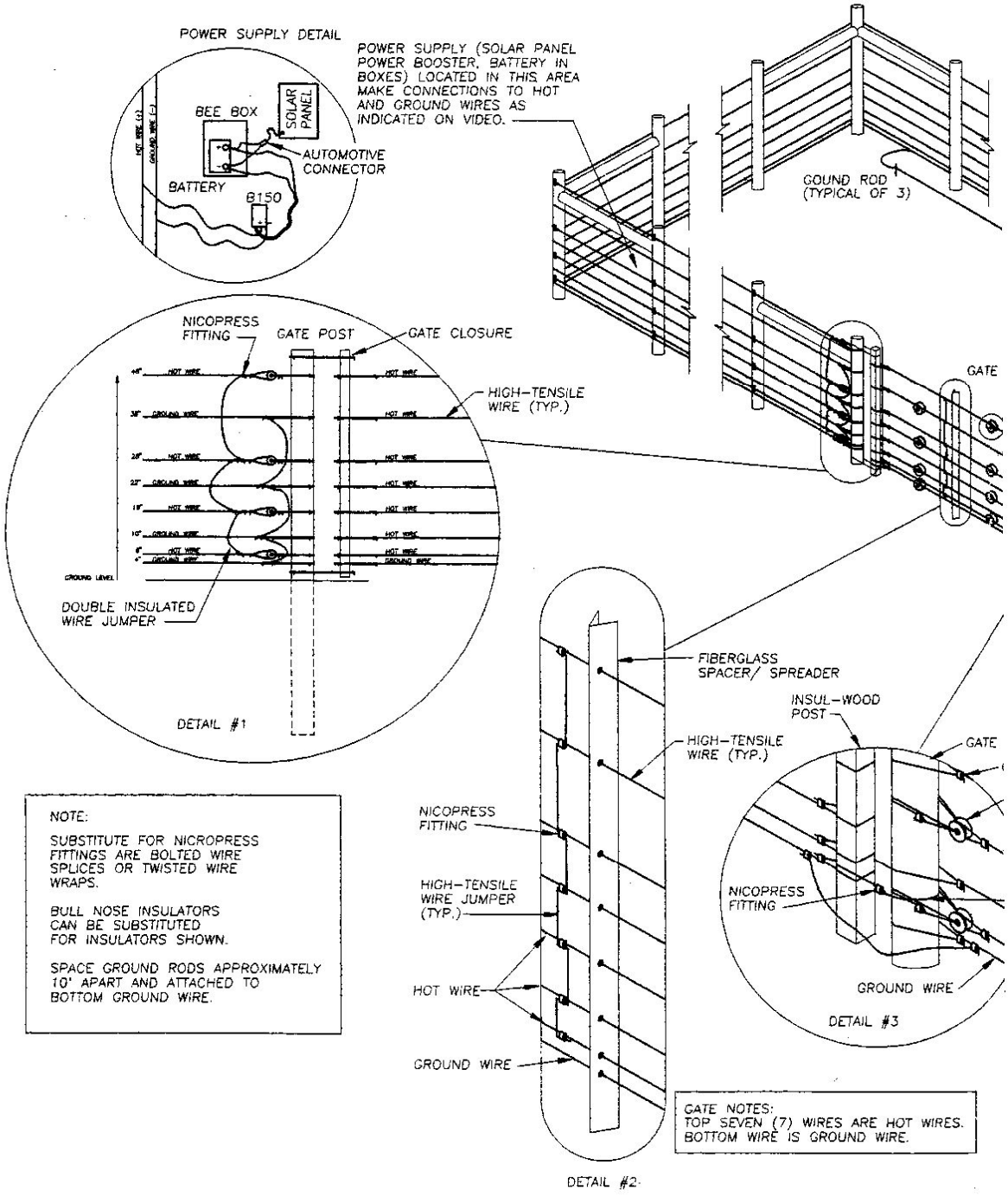
  The (+) wire will need to go from the (+) connection on the energizer to the back of the fenced area opposite the gate. The insulated cable needs to be attached with a line clamp and strung or woven in such away that the connections will not be pulled loose by a bear walking around the fence.

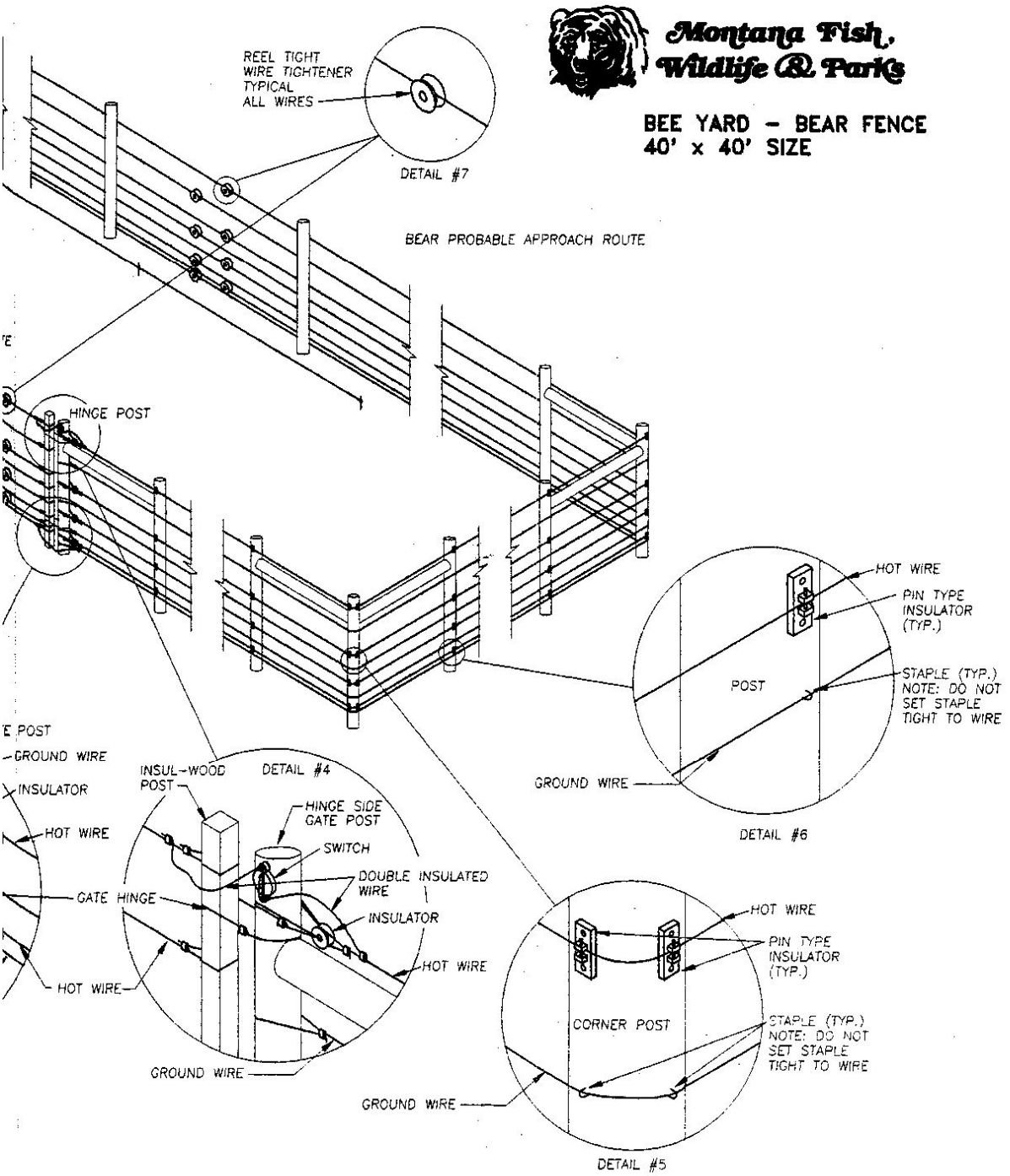
- Pick a spot on the cattle panel pad that is closest to the energizer and pound in one ground rod. Pound the second ground rod ten feet from the first ground rod. The (-) insulated cable will need to go from the (-) connection on the energizer to the spot where the first ground rod and the cattle panel pad come together.

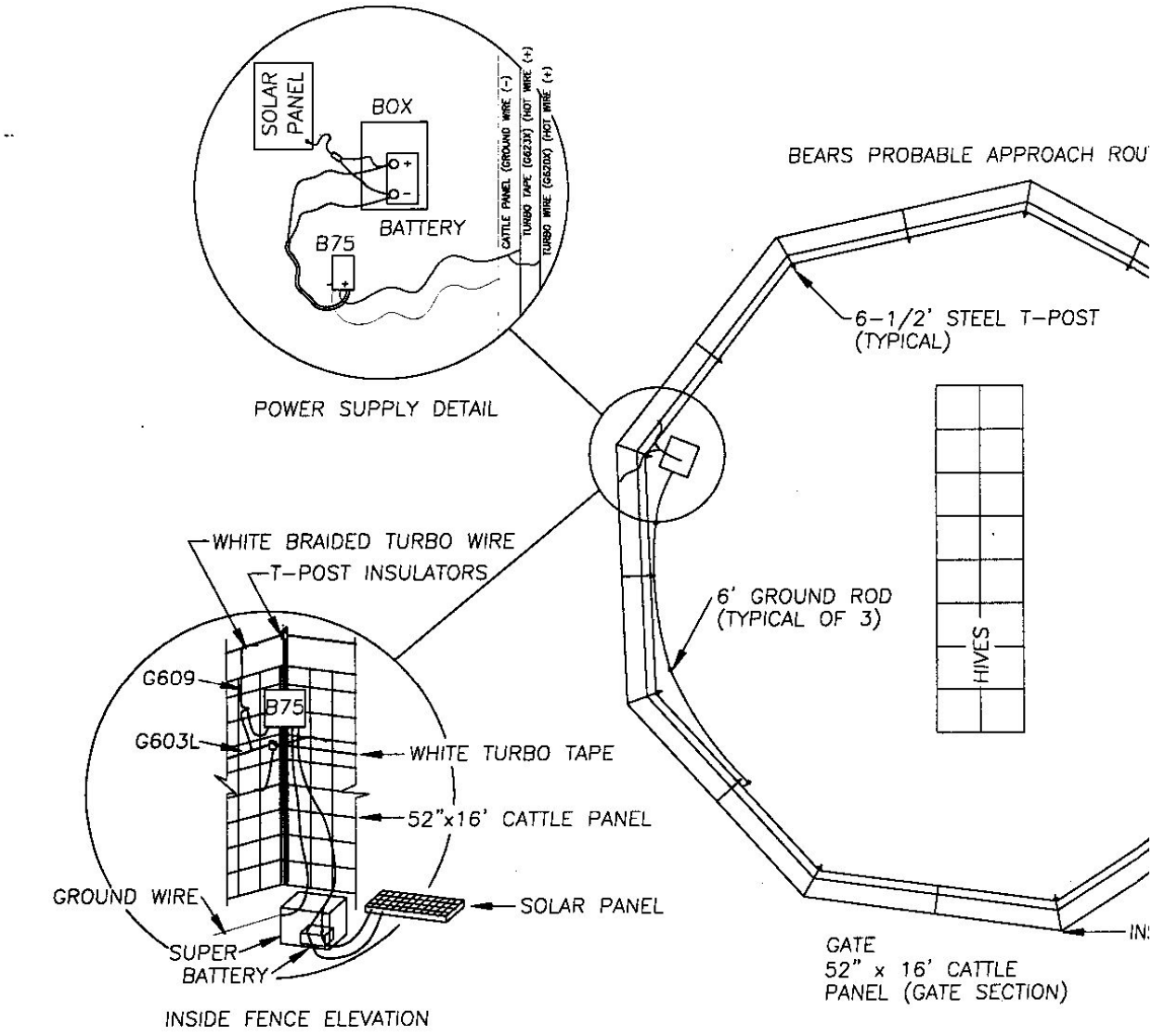
  The insulated cable needs to be attached to the cattle panel and the ground rod with line clip and strung or woven in such away that the connections will not be pulled loose by a bear walking around the fence. Using the remaining insulated cable and last two line clamps connect the second ground rod to the first ground rod. Post four electric fence signs at the site.

Deterring Bears From Bee Yards

Information Courtesy of Montana Fish, Wildlife & Parks



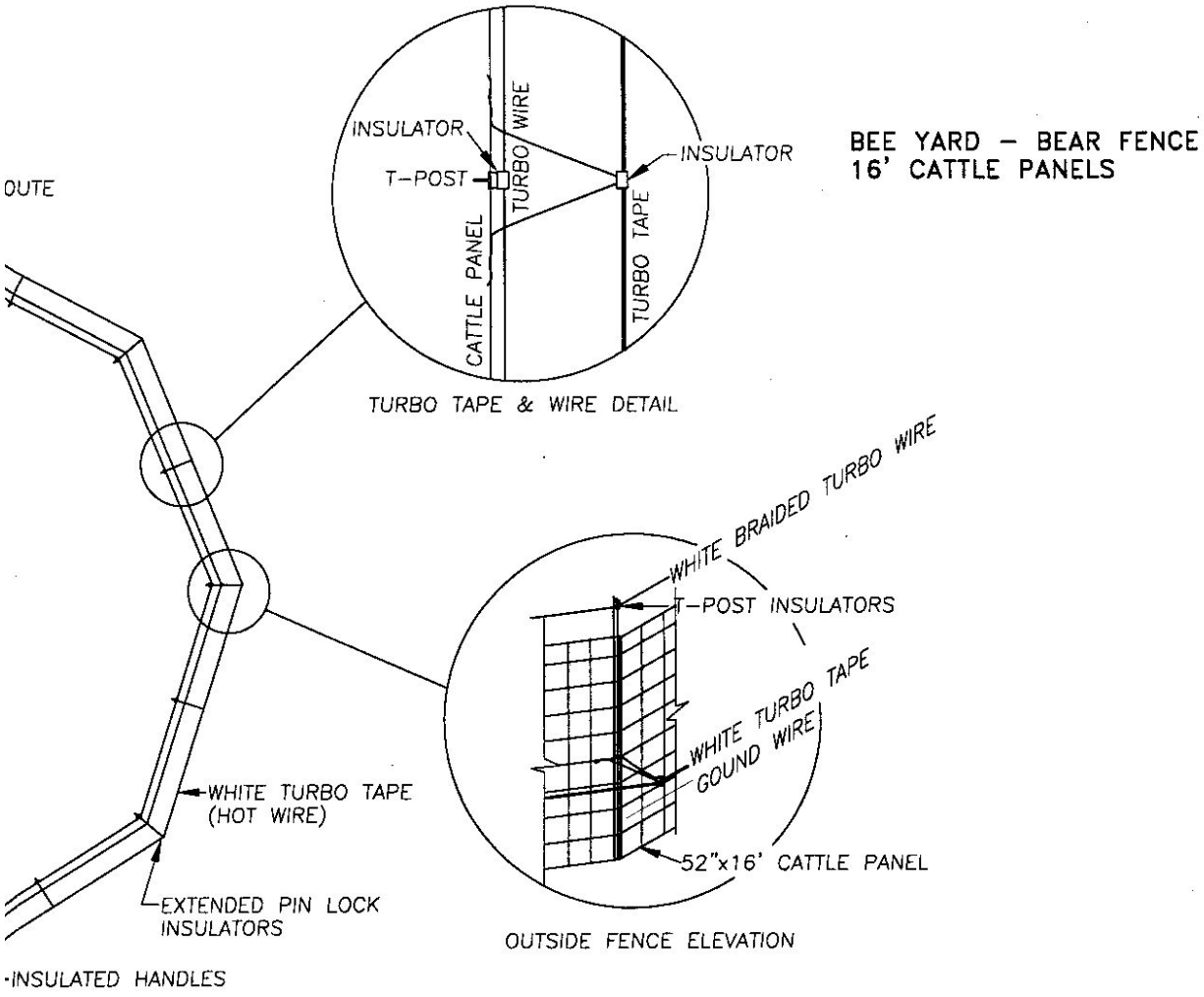

Montana Fish, Wildlife & Parks
BEE YARD – BEAR FENCE
40' x 40' SIZE
REEL TIGHT WIRE TIGHTENER TYPICAL ALL WIRES
DETAIL #7
BEAR PROBABLE APPROACH ROUTE
HINGE POST
HOT WIRE
PIN TYPE INSULATOR (TYP.)
POST
STAPLE (TYP.) NOTE: DO NOT SET STAPLE TIGHT TO WIRE
GROUND WIRE
DETAIL #6
E POST
GROUND WIRE
INSULATOR
HOT WIRE
GATE HINGE
HOT WIRE
INSUL-WOOD POST
DETAIL #4
HINGE SIDE GATE POST
SWITCH
DOUBLE INSULATED WIRE
INSULATOR
HOT WIRE
GROUND WIRE
HOT WIRE
PIN TYPE INSULATOR (TYP.)
CORNER POST
STAPLE (TYP.) NOTE: DO NOT SET STAPLE TIGHT TO WIRE
GROUND WIRE
DETAIL #5



NOTE:

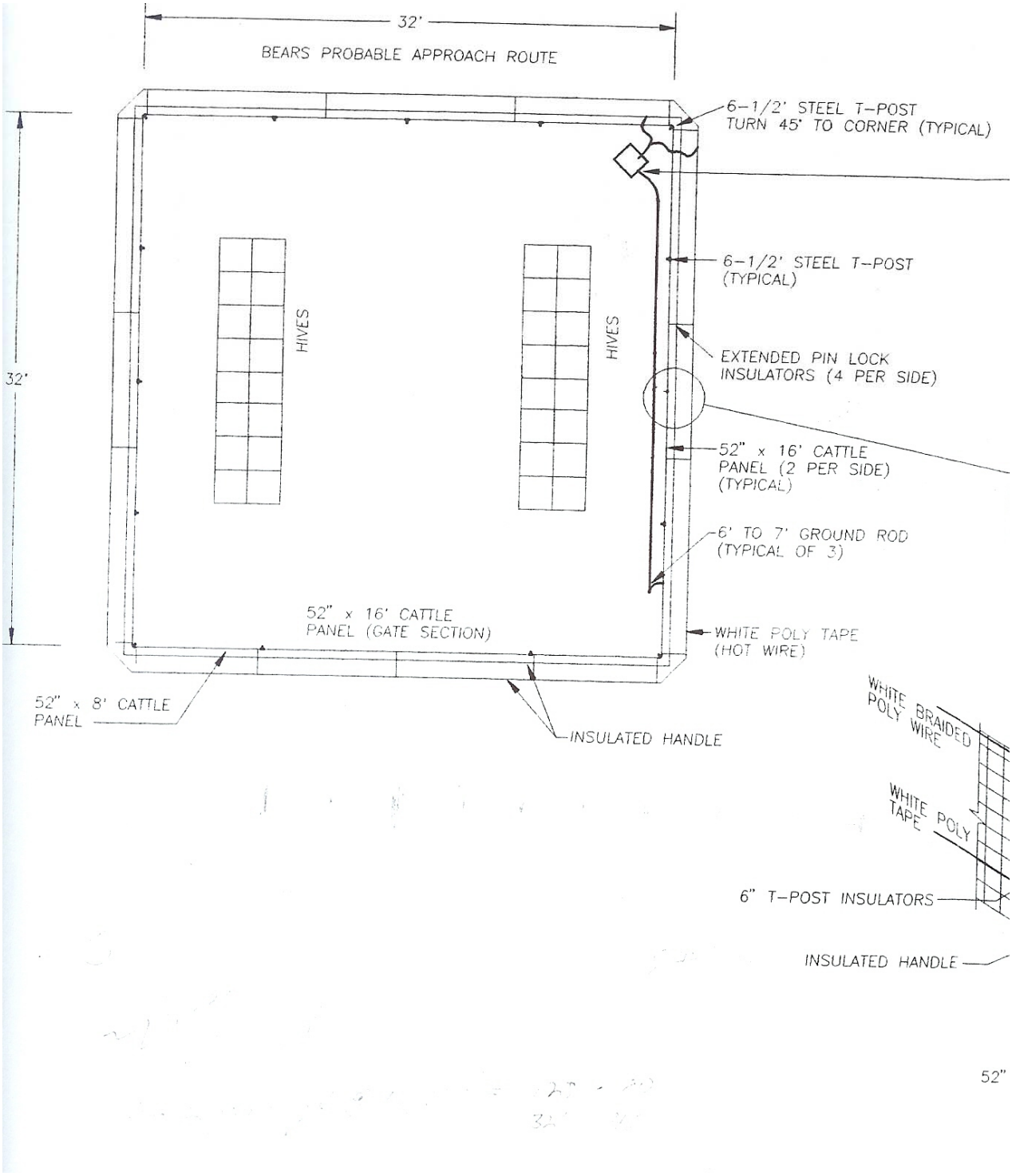
PRODUCTS REFERED TO ARE GALLAGER.

1. LAY WELDED CATTLE PANELS IN A CIRCLE.
2. DRIVE A 6-1/2' TO 7' STEEL T-POST AT PANEL ENDS AND CENTERS LEAVING 8"-10" OF POST ABOVE PANEL.
3. CONNECT PANELS TO T-POST WITH GALVANIZED CLIPS OR DOUBLE GALVANIZED WIRE. GALVANIZED TIE-WIRE TO BE TIED FROM INSIDE. TIE AT THREE (3) PLACES EACH T-POST.
4. INSTALL OFFSETS (G659P) AND INSULATORS (G681L) ON FENCE T-POSTS AND WELDED PANELS.



5. INSTALL TURBO PRODUCTS IN OFFSETS (G659P) AND INSULATORS (G681L).
6. INSTALL GROUND RODS AND CONNECT THE 6' GALVANIZED RODS WITH A GALVANIZED WIRE (G609). SPACE GROUND RODS AT LEAST 10' APART. ATTACH TO BOTTOM OF CATTLE PANEL.
7. CONNECT TURBO WIRE (G620X) TO TURBO TAPE (G623X) WITH DOUBLE INSULATED, GALVANIZED CABLE (G609) AND JOINT CLAMPS (G603L).
8. INSTALL BATTERY AND B–75 ENEGIZER IN SUPER.
9. CONNECT SOLAR PANEL TO BATTERY CLAMPS.
10. CONNECT B–75 ENEGIZER TO TURBO PRODUCTS AND HOOK B–75 ENEGIZER TO BATTERY.

Bee Yard—Bear Fence 32' x 32' size



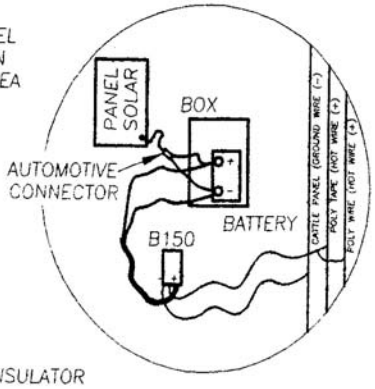
Bee Yard—Bear Fence 32' x 32' size (continued)

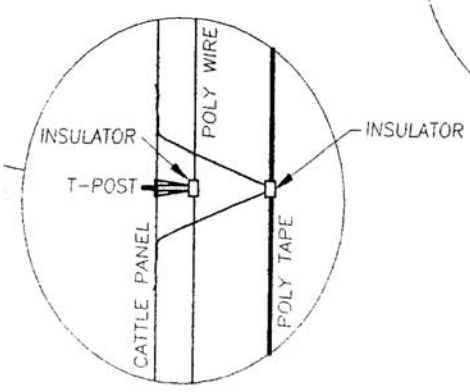
Montana Fish, Wildlife & Parks

BEE YARD – BEAR FENCE
32' x 32' SIZE

POWER SUPPLY DETAIL

POWER SUPPLY (SOLAR PANEL POWER BOOSTER, BATTERY IN BOXES) LOCATED IN THIS AREA MAKE CONNECTIONS TO HOT AND GROUND WIRES AS INDICATED ON VIDEO.

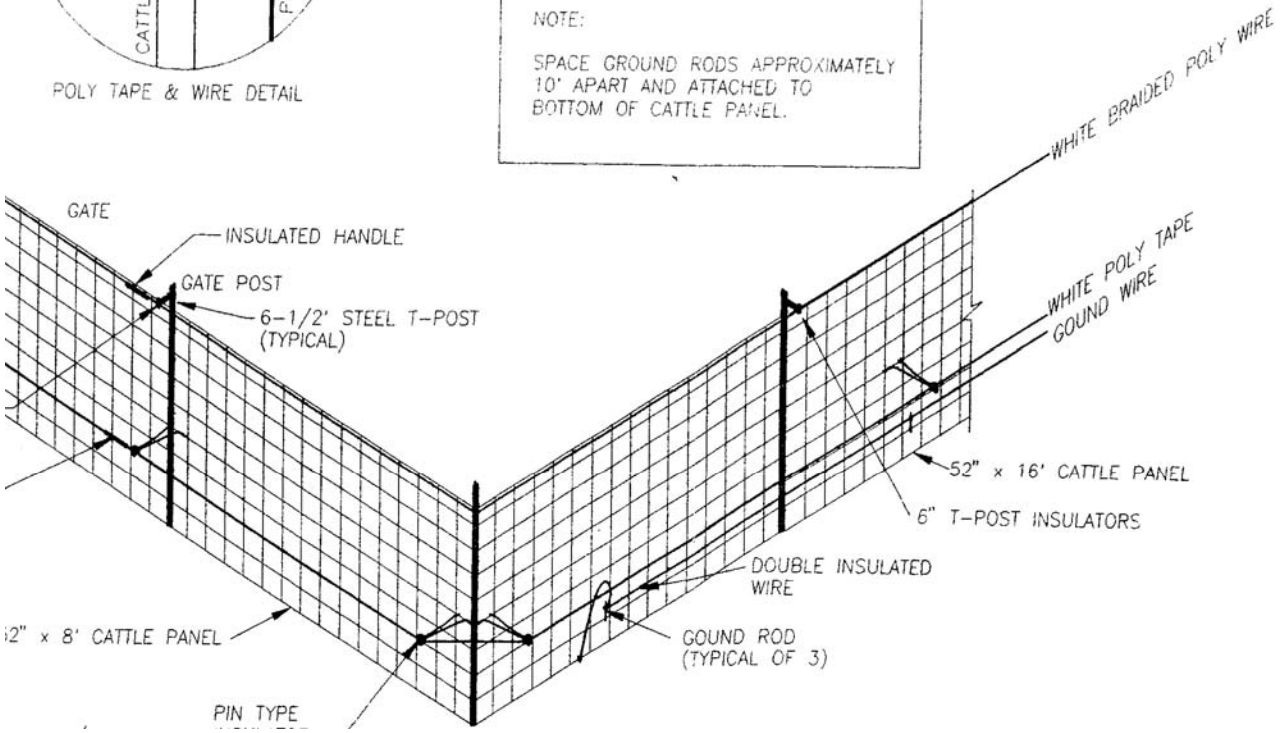




POLY TAPE & WIRE DETAIL

NOTE:

SPACE GROUND RODS APPROXIMATELY 10' APART AND ATTACHED TO BOTTOM OF CATTLE PANEL.



December 2001

Florida Fish and Wildlife Conservation Commission
Technical Information Bulletin

Use of Electric Fencing to Exclude Bears and Prevent Property Damage

Electric fencing has proven effective in deterring bears from entering landfills, apiaries (beehives), livestock pens, gardens, orchards, and other high-value properties. Numerous electrical fence designs have been used with varying degrees of success. Design, quality of construction, and proper maintenance determine the effectiveness of an electric fence. The purpose of this technical bulletin is to assist the property owner in understanding and implementing electrical fencing as a tool to exclude and prevent damage caused by black bears.

Understanding Electric Fencing

Electric fencing provides an electrical shock when an animal comes into contact with the electrically charged wires of the fence. People unfamiliar with electric fencing often are afraid that it will injure, permanently damage, or kill an individual or pet that contacts the fence. **This is not true!** A properly constructed electric fence is safe to people, pets, and bears.

Components of Electric Fencing

An electric fence is composed of four main elements: a charger, fence posts, wire, and the ground rod.

Fence Charger.

On a small scale electric fence (like that typically needed for bear exclusion), the largest cost is normally the fence charger. A fence charger's job is to send an electrical pulse into the wire of the fence. Contrary to popular belief, there is not a continuous charge of electricity running through the fence. Instead the charger emits a short pulse or burst of electricity through the fence.

The intensity and duration of the electrical pulse varies with the type of charger or controller unit. Chargers with a high-voltage, short duration burst capacity are the best because they are harder to ground out by tall grass and weeds. These types are also the safest, because, even though the voltage is high (5 kilovolts) the duration of the burst is very short (2/10,000 of a second) (FitzGerald, 1984).

Two basic energy sources for chargers are batteries (12-volt automotive type) and household current (110 volt). Battery-type chargers are typically cheaper to purchase but require more maintenance because of the necessity of charging the battery. The advantage of a battery powered charger is that it can be used in a remote location where 110-volt current is not available. Most units that are powered by a fully charged 12-volt deep-cycle batteries can last three weeks before needing a charge. Addition of a solar trickle charger will help prolong the duration of effective charge in 12- volt batteries.

Fence Posts.

On small scale fences, the posts are normally the second largest expense involved in construction. Therefore, when planning an electric fence it is a good idea to utilize existing fencing in order to save money. If no existing fence is available, posts will need to be placed around the area needing protection. Posts may be wood, metal, plastic, or fiberglass. Wood and metal posts will need to have plastic insulators attached to them which prevent the electric wire from touching the post causing it to ground out. Plastic and fiberglass posts do not need insulators, the wire may be affixed directly to these posts. Wood and metal posts are typically more expensive and require the added expense of insulators, however, they are more durable and generally require less maintenance.

Wire.

Fourteen to seventeen gauge wire is the most common size range used in electric fencing. Heavier wire (a lower gauge number) is more expensive but carries current with less resistance and is more durable (FitzGerald, 1984).

The two most common types of wire are galvanized and aluminum. Galvanized wire is simply a steel wire with a zinc coating to prevent rust, which makes the wire last longer. Some wire is more galvanized than others. The degree or amount of zinc coating that is around the core steel wire is measured in three classes. A class I galvanization means the wire has a thinner coating of zinc than a class II galvanization. Class III galvanized wire has the heaviest zinc coating and will last longer than the class I and class II wire (FitzGerald, 1984). In general, the cost of galvanized wire increases as the class or amount of galvanization increases.

Aluminum wire is typically more expensive than the galvanized wire. Some advantages of aluminum wire are: it will not rust, it conducts electricity four times better, and it weighs one-third less than steel wire.

The Ground Rod.

The ground is an often overlooked, but critical part of an electric fence. Without a good ground, electricity will not flow through the wire. When an animal touches a charged wire, the body of the animal completes the electrical circuit and the animal feels the "shock". The current must travel from the charger through the wire to the animal and then back through the ground to the charger if the animal is to feel the shock. The soil acts as the return "wire" (ground) in the circuit. However, if a bird was to land on a charged wire without touching the soil the bird would not complete the circuit and would be unaffected (FitzGerald, 1984). Some fence configurations use actual grounded wires within the fence to enhance the grounding system.

The ground may be a commercial ground rod or a copper tube or pipe driven six to eight feet in moist soil. Copper is expensive, so a copper coated steel pipe or any other good conducting metal pipe will work also. Very dry soil can effect the ability to create a good ground and has sometimes been a problem during drought conditions. Pipe may be a better choice than a solid rod during drought conditions, because water may be poured down the ground pipe to improve the ground. Some fence configurations use wires as the grounding system, rather than relying solely on the soil as a ground.

Recommended Electric Fence to Deter Black Bears

Conditions at fence sites will vary and will determine what the most effective fence configuration will be. Commission biologists welcome the opportunity to visit sites and provide custom tailored advise on constructing an effective electric fence. The following recommendation will cover most situations with low to moderate pressure from black bears. Use a five strand aluminum wire fence that is 40 inches high with wire spacing every eight inches apart using the previously mentioned wired grounding system (see Figure 1).

The wire closest to the ground level (the lowest wire) should be a charged or "hot" wire. The second wire should be grounded. The third wire should be hot. The fourth wire should be grounded and the fifth wire should be hot. If using metal or wood posts, insulators must be used to keep the hot wires from grounding out. The cost of this type of electric fence utilizing fiberglass posts and a 110 volt fence charger is approximately $200 for a 40' x 40' area (160 linear feet of fence).

Materials:

1 - 1, 312 foot roll (1/4 mile) 14 gauge aluminum electric fence wire
1 - 50 foot roll 12 gauge insulated wire
20 - 5 foot 5/8 inch dia fiberglass fence posts
5 - plastic gate handles
1 - 110 volt fence charger
1 - 10 foot ground pipe
4 - plastic electric fence signs

Installation.

These instructions are for a square shape fence exclusion, but the process would be very similar for other applications.

- Drive 4 corner posts 1-foot deep into ground and stake with guy wires.
- Clip, rake, and keep clear any vegetation in a 15-inch wide strip under the fence and apply herbicide.
- Attach and stretch the aluminum wire at 8-inch increments starting 8 inches from ground level. A loop of wire should be left on each wire at the first corner post. Once the wire has been stretched around the outside of all the corner posts back to the first post a plastic gate handle should be attached to each wire and the gate handles should be attached to each corresponding loop on the first corner post.
- Drive in the remaining 16 posts to the same depth at 8-foot intervals between corner posts.
- Secure each of the five wires to each of the posts with additional wire. Attach four plastic electric fence signs (one on each side) to the top wire of the fence.
- Attach a 12-gauge strand of insulated wire to the positive terminal of the fence charger and attach it to the first, third, and fifth wires of the fence.
- Attach another 12 gauge insulated wire to the negative terminal of the charger and attach this wire to the ground pipe which has been driven into the ground 6 to 8-feet deep.
- Attach another 12 gauge insulated wire from the negative terminal of the charger to the second and fourth wires on the fence.
- Plug the charger into a 110 volt power supply and the fence is in operation.

Tips to improve the effectiveness of your electric fence to deter black bears:

1. If using a 12-volt fence charger, ensure that the battery is charged; check every two weeks.

2. Make sure terminals on the charger and battery are free of corrosion.

3. Make sure hot wires are not being grounded out by tall weeds, fallen tree branches, broken insulators, etc.

4. If fence wires have been broken and repaired, make sure wires are corrosion free where they have been spliced together. Also, tighten the fence at each corner post as wires that have been spliced and are loose make poor connections.

5. Be sure to rake vegetation from under and around the outside of the fence as this may act as an insulator.

6. To improve the ground around the perimeter of the fence add a piece of 24 inch chicken wire laying on the ground around the outside of the fence. This should be connected to ground.

7. During periods of drought pour water down the ground pipe and around the ground pipe to improve the ground. Digging a 6 inch deep 6 inch diameter hole around the ground pipe and back filling with rock salt will also improve the ground. Additional ground pipes may also be added to portions of the fence farthest from the charger.

8. To ensure that the bear solidly contacts the charged portion of the fence, a bait like bacon strips, a can of sardines, or tin foil with peanut butter may be attached to one of the top hot wires. Make sure these do not contact the ground, thus shorting out the fence.

9. When protecting a specific structure (like a shed or rabbit hutch), the fence should be placed 3 to 5 feet away from the structure (rather than on it) so that the bear encounters the fence before reaching the attractant.

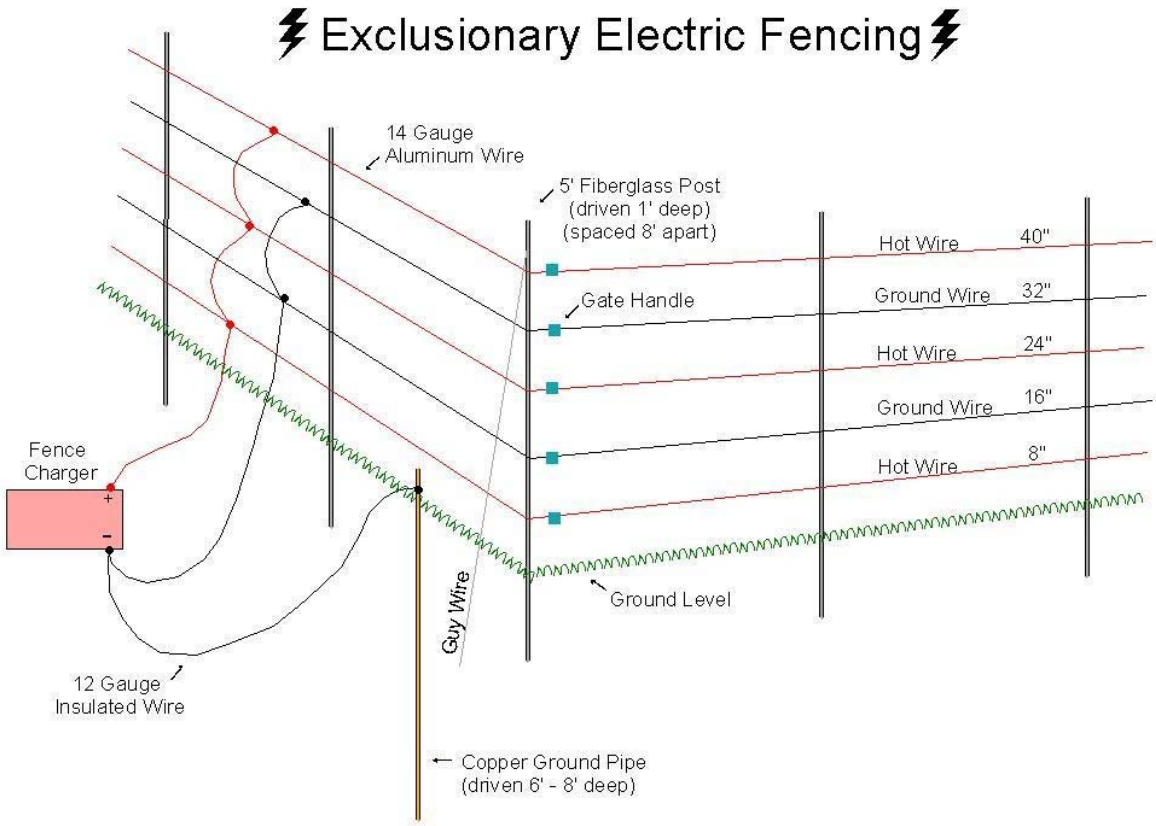
10. Protect the fence charger from the elements by covering it with a plastic bucket or a wooden box.

11. Place plastic electric fence signs around the perimeter of your fence to improve visibility and to warn other people.

LITERATURE CITED

FitzGerald, James (1984), *The Best Fences*. Storey Publishing Bulletin A-92, Pownal, Vermont. p. 14-16.

Figure 1. Diagram of properly constructed electric fence to exclude bears.



This information is provided by the Florida Fish and Wildlife Conservation Commission and is available through their web site. Please visit :

http://www.myfwc.com/WILDLIFEHABITATS/Bear_brochures.htm

ELECTRIC FENCING FOR BLACK BEARS **

Electric fencing has proven effective in deterring bears from landfills, apiaries, cabins, and other high-value properties. Fencing, however, is a relatively expensive abatement measure. Consider the extent, duration, and expense of damage when developing a prevention program.

Numerous fence designs have been used with varying degrees of success. Electric fence chargers increase effectiveness. Electric fences must deliver an effective shock to repel bears. Bears can be lured into licking or sniffing the wire by attaching attractants (salmon or tuna tins and bacon rinds) to the fence. Depending on the amount of bear pressure, use an electric polytape portable fence or a permanent fence. An innovative technique for beekeepers is to place hives on a fenced (three-strand electric) flatbed trailer (8 feet x 40 feet). Though expensive, this method makes hives less vulnerable to bear damage and makes moving them very easy.

Materials. Do not buy cheap materials to reduce costs. This will only reduce the effectiveness and life span of the fence. We recommend using:

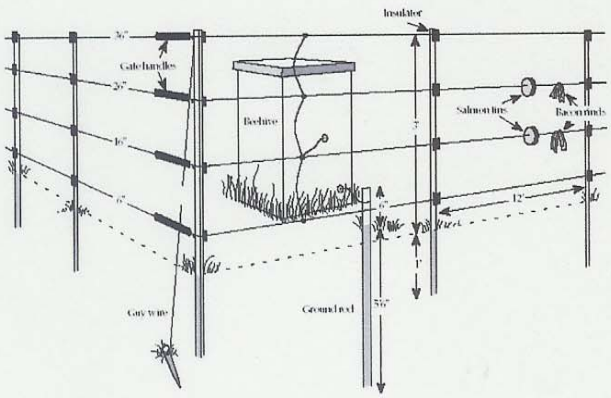
(1) Round fiberglass or treated wood posts.
(2) High-quality galvanized wire and steel components. For high-tensile fences, use 11- to 14-gauge wire (minimum tensile strength of 200,000 pounds and a minimum breaking strength of 1,800 pounds, tension springs, and in-line tensioners.
(3) Compression sleeves for splicing wires and making electrical connections.
(4) Lightning arresters and diverters to protect chargers.
(5) High-quality fence chargers. To energize the fences, use a 110-volt outlet or 12-volt deep cell (marine) battery connected to a high-output fence charger. Chargers must be approved by Underwriters Laboratories (UL) or the Canadian Standards Association (CSA). We highly recommend 110-volt chargers. Six and 12-volt chargers require battery recharging every 2 to 4 weeks. Use solar panels in remote areas to charge batteries continuously. For high-tensile fences, use high-voltage, low-impedance chargers only (3,000 to 5,000 volts and current pulse duration of at most 1/1,000 second). Place the fence charger and battery in a case or empty beehive to protect them against weather and theft.
(6) Gates. There is no universal gate design because of the many different fence types. Gates should be electrified, well insulated, and practical for the type of farming operation. Gates range from single strands of electrified wire with gate handles to electrified panel or tubular gates.

Fence Construction. Fences must be properly constructed--do not deviate from fence construction guidelines.

(1) Prepare fence lines before construction. It is easier and less expensive to install and maintain fences on clear, level runs. Minimize corners to increase strength and reduce costs.
(2) Ensure that the electrical system is well grounded at the fence charger and every 1/2 mile of fence line. To ground high-tensile fences, drive four to six ground rods 5 to 6 feet deep and 6 feet apart. Connect the ground post of the fence charger and the negative (-) wires of the fence to the grounding rod with a wire and ground clamp. Grounding may be increased, especially in dry, sandy soil, by laying grounded chicken wire around the outside perimeter of the electric fence.
(3) A positive-negative fence is especially useful with dry or frozen ground. A fence with all positive (hot) wires may be advantageous under general crop and soil moisture conditions. Use connectors to ensure good contact. Connect the positive fence terminal to the fence with a short piece of fence wire.
(4) Rigid brace assemblies—corners, ends, and gates—make up the backbone of all high-tensile fence systems. They must be entirely rigid, constructed of the best materials, and strictly conform to design guidelines. The single-span brace assembly is the basis of all high-tensile strainer assemblies, regardless of location in the fence or fence design. This basic design is then modified to create double-"H" braces, swing corners, and gate ends.
(5) Allow wires to slide freely through insulators on fence posts. Fence flexibility is necessary to endure frequent temperature changes, deer hits, and obstructions.
(6) Identify an electric fence with warning signs.

Maintenance. Regular inspection and maintenance are necessary to ensure the effective operation and longevity of most fences.

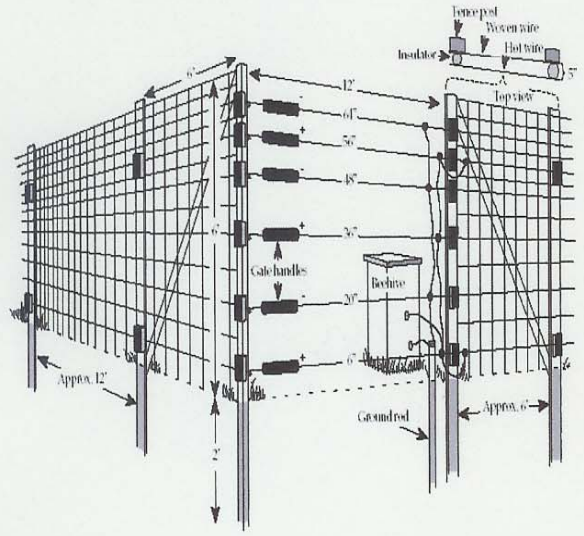
(1) Control vegetation near fences by mowing or applying herbicides to avoid excessive fence grounding by weeds.
(2) On slopes or highly erodible soils, maintain a good sod cover beneath fences to avoid fence line erosion.
(3) Always keep the fence charger on. Check the fence voltage weekly with a voltmeter. Maintain at least 3,000 volts at the furthest distance from the fence charger. Always recharge the batteries during the day so that the fence is energized at night.
(4) To protect against voltage loss, keep the battery and fence charger dry and their connections free of corrosion. Disconnect the lower wires if they are covered by snow. Make certain all connections are secure and check for faulty insulators (arcing between wire and post).
(5) Each month, check the fence tension and replace baits with new salmon tins and bacon rinds.
(6) In late fall and early summer, adjust the fence tension (150 to 250 pounds) for high-tensile fences.



Polytape portable electric fence. One person can easily and quickly install this fence. It is economical and dependable for low to moderate bear pressures. The fence consists of four strands of electric polytape that are attached to posts with insulators. Various forms of polytape or polywire, such as Visible Grazing Systems® (VGS), Baygard®, and Turbo-tape® are very strong and portable. The cost per fence (33 x 33 feet) is about $200. (~ $1.50/linear ft)

1 200-yard roll of polytape
12 4-foot fence rods (5/16-inch diameter)
48 Insulators or clips
4 Gate handles
1 12-volt fence charger
1 12-volt deep cycle battery
Herbicides

To install: Drive in four corner posts 1 foot deep and attach a guy wire. Clip vegetation in a 15-inch-wide strip under the fence and apply herbicide. Attach insulators on the inside of corner posts and stretch the electro-plastic wire from the four posts at intervals of 6, 16, 26, and 36 inches from ground level. Hand tighten the polytape and join the ends with four square knots. Drive in the remaining posts at 12-foot intervals, attach insulators (on the outside of line posts), and insert polytape.



Woven-wire permanent electric fence. This fence, best used under high bear pressure, is the most durable and expensive barrier. Two people can install it in 8 hours. The fence consists of heavy, 5-foot woven wire, supported by wooden posts, ringed by two additional electrified wires. Cost per fence (33 x 33 feet) is about $400. (~ $3.00/linear ft)

1 50-yard roll of 6-inch square mesh, 5-foot woven wire
1 150-yard roll of high-tensile (14-gauge) smooth wire
24 8-foot treated wooden posts
40 Porcelain strain-insulators (screw-in types)
1 2-pound box of 1 1/2-inch fence staples
6 gate handles
1 12-volt fence charger
1 12-volt deep cycle battery
Herbicides

To install: Set posts 6 to 12 feet apart in 2-foot-deep holes. Align four corner posts at 5° angles from the vertical. Brace corner and gate posts from the inside with posts set at 45° angles. Clip a 15-inch-wide strip clear of vegetation under the fence and apply herbicide. Place one length of welded wire vertically into position and staple the end to a corner post. Pull the entire length of wire taut with a vehicle and staple the welded wire to the line posts. Continue until all sides, except the gate opening, are fenced. Fasten two strands of high-tensile wire to insulators positioned 5 inches away from the welded wire, at intervals of 6 and 56 inches above ground level. For a 12-foot gate opening, attach three strands of high-tensile wire to insulators on the gateposts. Space the wires at intervals of 6, 36, and 56 inches above ground level. Connect them to the two strands previously strung around the fence. These wires will be connected to the positive fence charger terminal. Attach three more wires to gatepost insulators at intervals of 20, 48, and 64 inches above ground level. These three wires will be connected together and to the ground rod. Fit insulated gate handles to the free ends of all six gate wires.

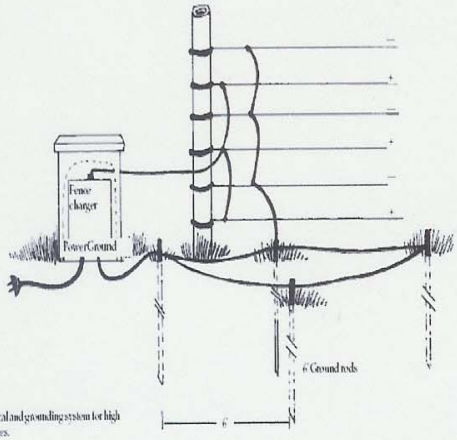
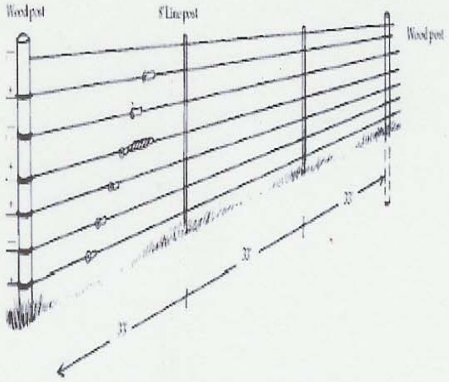


Fig. 13. Electrical and grounding system for high tensile fences.



High-tensile permanent electric fence. High-tensile fencing can provide year-round protection. Many designs are available to meet specific needs. All require strict adherence to construction guidelines concerning rigid corner assemblies and fence configurations. Frequent inspection and maintenance are required. High-tensile fences are expected to last 20 to 30 years. Vertical fences are effective at protecting large areas from moderate to high pressures. There are a wide variety of fence materials, wire spacings, and specific designs you can use. Barbed wire (3-4 inches between barbs) will help provide more electric contact through the insulating fur than will smooth wire. Costs, excluding labor, range from $0.75 to $1.50 per linear foot.

To install: Install rigid corner assemblies where necessary. String a 12 1/2-gauge high-tensile wire around the corner assemblies and apply light tension. Set 8-foot line posts along. Attach a wire to insulators at 4-6 inches above ground level and apply 150 to 250 pounds of tension. Attach the remaining wires to insulators at a 10-inch spacing and apply 150 to 250 pounds of tension. Connect the second, fourth, fifth, and seventh wires from the top, to the positive (+) post of a well-grounded, low-impedance fence charger. Connect the top, third, and sixth wires directly to ground. The top wire should be negative for lightning protection. Clear and maintain a 6- to 12-foot open area outside the fence. Maintenance includes weekly fence inspection and voltage checks.

** Adapted from Hygnstrom, S. E., R. M. Timm, and G. E. Larson. 1994. Prevention and control of wildlife damage. University of Nebraska Cooperative Extension Service, US Department of Agriculture, Animal and Plant Health Inspection Service.

Fore more information, visit the Virginia Department of Game & Inland Fisheries web site at:

http://www.dgif.virginia.gov/wildlife/bear/

Recreation Tech Tips

United States Department of Agriculture
Forest Service
Technology & Development Program
March 1999
2300 9923-2321-MTDC

Electric Fence Systems

Requirements for Meeting the NCDE Food Storage Special Order

Dave Gasvoda, Project Leader

Since 1995, persons using any portion of the National Forests in the Northern Continental Divide Grizzly Bear Ecosystem (NCDE) have been required to store food, garbage, and other attractants (such as horse feed) in a bear-resistant manner (Special Order No. F10014S95). The area includes wilderness and nonwilderness portions of the Flathead, Lewis and Clark, Lolo, and Helena National Forests south and west of Glacier National Park (see attached map).

Electric fence systems are an acceptable means of meeting the requirement for storage in a bear-resistant manner. Electric fence systems can be used alone or to supplement other forms of bear-resistant storage, such as using bear-resistant containers, or suspending attractants from a support.

Inspection

It is the user's responsibility to operate the system in the field at the required levels. Forest Service employees will inspect electric fences when they are set up in the field.

Fence System Requirements

Fence systems must meet the following minimum requirements:

- The minimum height shall be 1.2 meters (4 feet). Posts shall be at least 1.3 meters (5 feet) long and spaced not more than 2.4 meters (8 feet) apart. The fence shall be constructed with seven wires spaced 15 to 25 centimeters (6 to 10 inches) apart as shown in the illustration on page 2. The bottom wire should be no more than 2 inches from the ground and it may touch the ground.

- The conductors (wires) may be either smooth metal fence wire (16 gauge minimum) or Polywire (polyethylene interwoven with at least six strands of stainless steel wire). In order to make the fence more visible, the top wire may be Polytape (polyethylene ribbon interwoven with at least five strands of stainless steel wire and at least 1.2 centimeters ($^1/_2$ inch) wide).

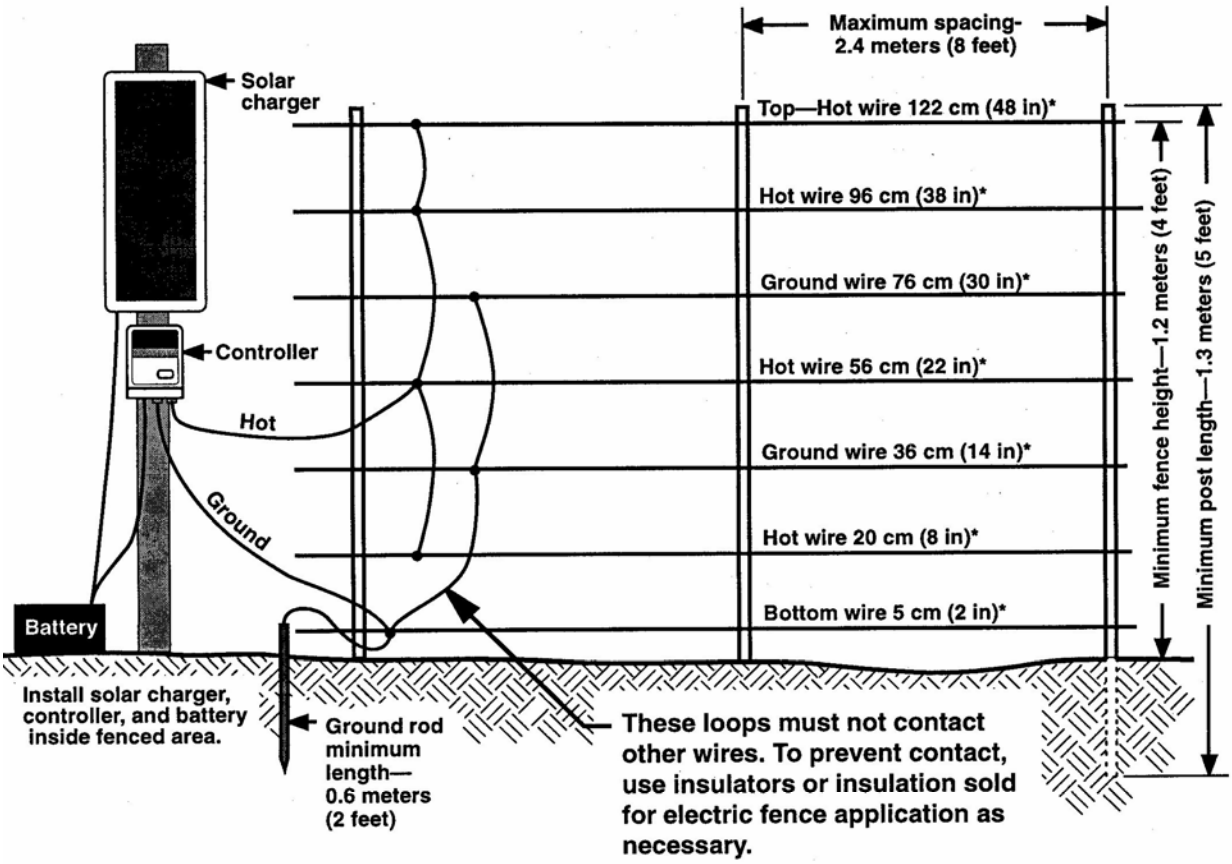
- The fence shall be no closer than 1 meter (3 feet) from the items it is protecting.

- A ground wire return fence shall be used. This fence uses alternating hot and ground fence wires. The top two wires are connected to the fence controller's hot terminal. The third wire down connects to the fence controller's ground terminal. The next wire connects to the hot terminal, and so forth. The bottom wire must be a grounded wire and may touch the earth. The ground terminal connects to an earth ground.

- An earth ground shall be constructed using a metal rod 0.6 meters (2 feet) long or longer. The rod should be driven into the earth as deep as practical. Allow a few centimeters (inches) to remain above the ground so the ground lead wire can be attached. The ground rod should be located in a wet spot if one exists.

- Fence conductors (wires) must be under tension, not loose or sagging. Corner supports (posts, trees, etc.) must be sturdy enough to not deflect excessively under the tension. Fiberglass or plastic corner posts may be used, provided that they are

For additional information contact: *Dave Gasvoda, Project Leader, Missoula Technology & Development Center, Building 1, Fort Missoula, Missoula, MT 59804-7294. Phone: (406) 329-3986; Fax: (406) 329-3719; IBM: dgasvoda/wo,mtdc*



** Height above ground; distance between wires may vary from 6 to 10 inches.*

adequately braced. All fence wires connected to the hot terminal of the fence controller must be supported using suitable electric fence insulators. Separate insulators are not required on fiberglass or plastic supports.

- The fence controller must be specified by the manufacturer to have a minimum stored energy of 0.7 joules. Its minimum peak output voltage must be specified as being at least 6000 volts.
- The user must have an electric fence tester on site that is capable of displaying voltage measurements from 600 to 5000 volts. Both multiple glow lamp and digital display types are acceptable. The digital display units are likely to be more accurate and easier to read. The inspection testing shall be made using a Forest Service digital meter. It shall be used to determine that the minimum requirements are met.
- Test the fence voltage as far as possible from the fence controller. Connect the meter's ground terminal to one of the fence's ground wires and touch the meter's hot terminal to a hot fence wire. Test each hot wire by touching the meter's hot terminal to the wire. Test each ground wire by connecting the meter's ground terminal to the ground wire being tested while touching the meter's hot terminal to any hot wire.

Each conductor must have a tested minimum of 5000 volts. The voltage must appear at least 40 times a minute.

Discussion of Requirements

The fence must be high enough that a bear cannot walk or jump over it. The wires must be close enough together so that a bear cannot get its head through without contacting the wires.

The top fence conductor may be high-visibility fence ribbon (Polytape) to decrease the chances of accidental human contact.

A ground wire return fence is effective when the earth is too dry to be a good conductor and make a good electrical connection to the bear's feet. The grounded wires in the fence provide a direct electrical return path to the fence controller's ground terminal. Because the bear must make good contact with two wires to get a shock, the bear may apply considerable force to the fence before the conductors work through the fur and contact its skin. This is why the ground wire return configuration requires strong fence wire and sturdy corner posts. Also, Polywire needs to be pulled tight to prevent sagging that could short hot conductors to ground conductors.

The ground rod provides an electrical circuit using the earth as the return path under wet conditions. A bear will get shocked when it contacts any hot conductor while standing on wet soil.

Grass and weeds should be cut short so most vegetation around the fence perimeter does not contact any hot wires, even in windy conditions. Wet vegetation conducts some of the electric current to ground and will decrease the shock delivered to a bear. Fences that contact wet vegetation are unlikely to produce the 5000 volts required by the inspection test.

Choosing an Electric Fence Controller

Manufacturers refer to fence controllers as "energizers," "chargers," and "fencers." It is difficult to compare the controllers from different manufacturers because specifications have not been standardized. The controllers being marketed for pet control are not likely to be suitable.

Gallagher Model B50 (which has been superseded by Model B75) and Model B150 have been used successfully for bear fences by the Montana Department of Fish, Wildlife & Parks.

Other models stated by their manufacturers to meet the 6000 volt and 0.7 joule specifications are:

Fi-Shock ____ *Model SS-7000*

Parmak _____ *Model MAG.-12 SP*

Red Snap'r ___ *Model LIB-15*

Speed-Rite ___ *Model SB 1000*
Model SB 1500
Model SB 5000

Manufacturers whose literature does not specify stored energy in joules must specify in writing the models that meet the minimum stored energy requirement of 0.7 joules.

Very high energy controllers are not recommended because they are expensive, large, and heavy, especially when the battery requirements are considered. They can deliver a nasty or perhaps even fatal shock to humans who might accidentally contact the fence.

Solar-powered fence controllers are recommended for most installations. The battery life for most non-solar powered controllers depends on the capacity of the battery and the power used by the fence controller. Solar panels will usually eliminate the need to charge or replace batteries, allowing smaller, lighter batteries to be used.

A solar-powered unit should be located so it will be in direct sunlight most of the day.

Choosing a Fence Tester

Two types of suitable electric fence testers are available. The least expensive types use five to eight glow lamps that progressively light for increasing voltage. They can not be read in direct sunlight.

Digital volt meters are more expensive, but are considerably more accurate and are easy to read. Some digital meters are considerably better than others. Units that are polarity sensitive are not recommended. These require that the meter leads be reversed to obtain an accurate reading with some fence controllers. Therefore, the ground lead must be connected to the hot fence wire. This is awkward and greatly increases the chances of the operator being shocked.

The Gallagher Model G503 Digital Volt Meter is recommended for use by Forest Service personnel when they inspect the bear fences.

Summary of Fence Specifications

Minimum fence height _____ *4 feet*

Minimum post length _____ *5 feet*

Maximum spacing between posts _____ *8 feet*

Conductors must be:

Smooth metal fence wire (16 gauge minimum)

or

Polywire (at least six strands of stainless steel wire)

For visibility, the top conductor may be Polytape (at least five strands of stainless steel wire, at least 1/2-inch wide)

Minimum distance between fence and items inside ____ *3 feet*

Ground wire return fence must be used (alternating hot and ground wires)

Minimum length ground rod (earth ground mandatory) __ *2 feet*

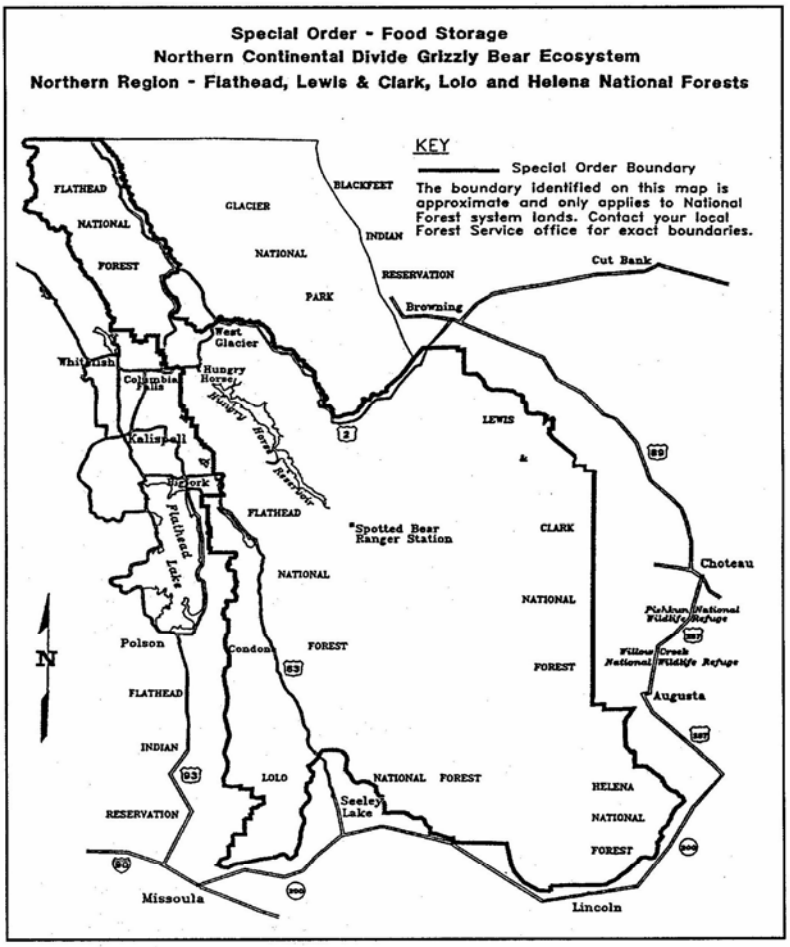
Minimum stored energy of the fence controller ____ *0.7 joules*

Minimum tested peak output voltage on every conductor _____ *5000 volts*

Minimum shocks per minute ____ *40*

Minimum number of wires _____ 7

Distance between wires _____ 6 to 10 inches



Acknowledgments

The author would like to acknowledge the contributions of Mike Madel, Bear Management Specialist for the Montana Department of Fish, Wildlife and Parks in Choteau, Montana. Mike's work helped establish the requirements that must be met to successfully deter grizzly bears.

Additional single copies of this document may be ordered from:

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IBM: dgasvoda/wo,mtdc
E-mail: dgasvoda/wo_mtdc@fs.fed.us

An electronic copy of this document is available on the Forest Service's FSWeb intranet at:

http://fsweb.mtdc.wo.fs.fed.us

TD

Deterring Wolves and Coyotes with Electric Fencing

Electric fencing has been used by some wolf managers in depredation cases, however, its use has been rather limited. With the reintroduction of wolves to the Yellowstone ecosystem and Idaho, depredation on livestock has occurred. In most cases it is impractical and not cost effective to fence an entire pasture or grazing allotment to exclude wolves. However, small or temporary paddocks, bedding areas or holding pens have been enclosed by electric fencing with some success.

Fladdry, a type of flagging from Europe, has been used in combination with other management tools to alleviate depredation. Fladdry is a single wire fencing with 3" by 18" red flagging attached which acts as a psychological barrier for the wolf.

The use of "Turbo" fladdry, a single strand of Gallagher's Turbowire with red flagging attached, is also being tried in Idaho. The shock from the Turbowire may repel wolves while also preventing livestock from chewing on the flagging. There is ongoing research and experimentation using electric fencing to deter wolves, and "Turbo" fladdry shows promise.

Fences constructed of five or six, alternating hot and ground wires are being used effectively to deter wolves and coyotes from livestock in Montana.

Fences should be at least 40" high and the bottom wire should be no more than 6" from the ground to prevent the animals from going under the fence.

The fence pictured on the left was constructed near Choteau, Montana and has been effective in excluding wolves and bears.

The fence is modified field or woven sheep fence with a 5-wire alternating hot/ground system. Offset brackets hold the bottom hot wires and two hot and one ground at the top.

Photos courtesy of Larry Feight, Gallagher USA

This fence in western Montana is used as a night holding pen for llamas and sheep. This ranch had previously experienced depredation by wolves and the fence was constructed to provide a secure place to hold the llamas. Grizzly bears had also been seen on the property, so the fence protected the llamas from both kinds of predators.

The fence design consists of seven strands of wire, alternating hot and ground.

The gate was modified with fiberglass post extensions at each end to allow for hot wires to be strung above the top of the gate. This modification prevented predators from accessing the pen by going over the gate.

The photo on the right shows the same fence with rapid wire tighteners.

Photos above and right courtesy of Patti Sowka.

Photo below courtesy of Wyoming Game and Fish

Electric netting has been used with mixed results for temporary sheep pens. The main difficulty lies in herding sheep into the enclosure at night. The netting does however hold up and deter predators well. The photo to the left is an electric net fence around a sheep allotment in Wyoming.

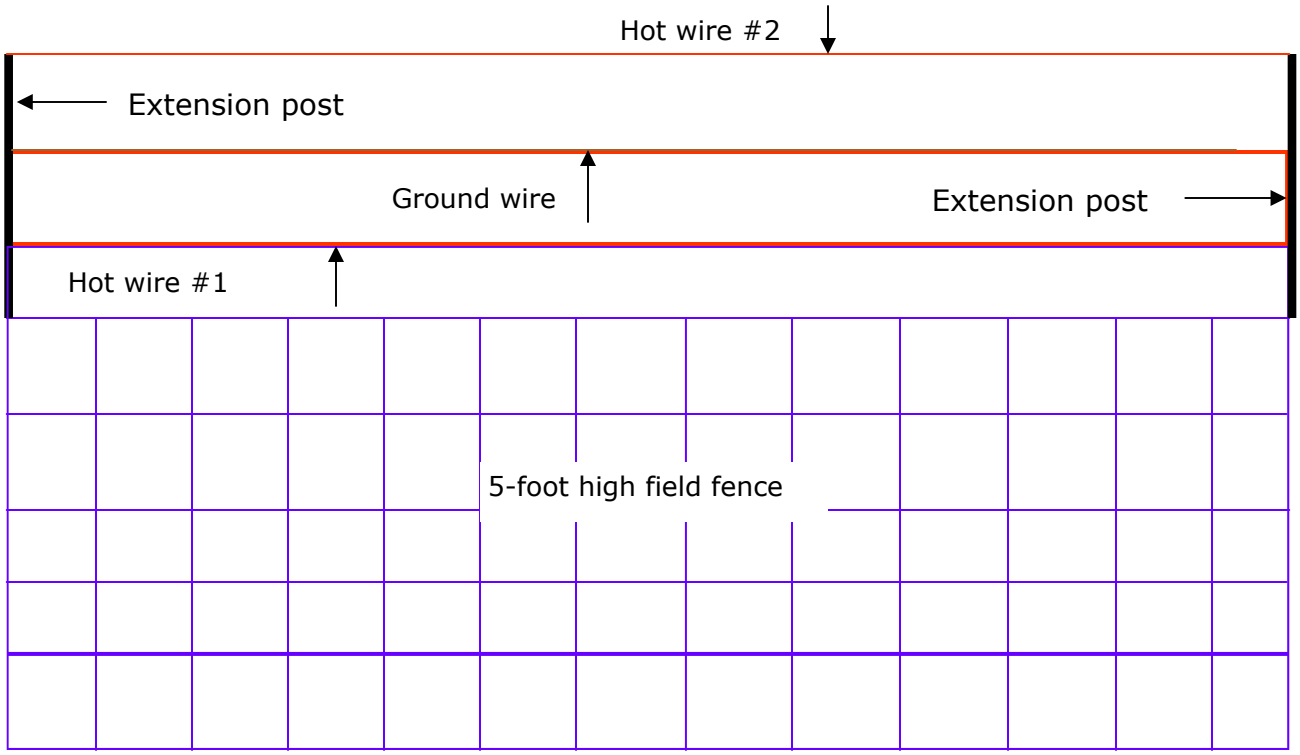
Non-electric net fences have also been used to deter coyotes. The fence should be between 5 or 6 feet high and the mesh openings should be no greater than 4 to 6 inches. One or two strands of hot wire should be strung just above the net fence to prevent animals from climbing up or jumping over the net fence. If digging appears to be a problem, a wire mesh apron can be buried just below and in front of the net fence.

Deterring Mountain Lions with Electric Fencing

Electric fencing can also be used to deter mountain lions, or cougars, from chicken coops, pig pens, calving pens, and animal stalls. The authors of this guide have successfully used one strand of hot wire installed at the top of a non-electric convention non-climb field fence to exclude mountain lions from a chicken pen in Northwestern Montana. It should be noted that additional research is needed to determine the most effective way to construct electric fencing to deter this species.

Our design utilized one hot wire strung approximately six inches above the top of a 5-foot high field fence that enclosed a small pond and shed that housed chickens and ducks. Mountain lions were climbing the field fence at night and preying on the chickens inside the pen. To deter the mountain lions, we installed extension posts approximately every 6 to 8 feet along the entire perimeter of the enclosure fence. Insulators attached to the extension posts prevented the hot wire from grounding out.

Although one hot wire worked for our enclosure, we recommend a minimum of 2 hot wires. To ensure that the lion receives a shock, installation of three strands, two hot wires with ground wire in between, is recommended. The ground wire in between would ensure that the lion is adequately grounded as it makes contact with at least one of the hot strands, and thereby increases the likelihood that the animal receives an adequate shock.



Electric Fencing Manufacturers and Vendors

Fi-Shock Inc.
5360 N. National Dr., Knoxville, TN 37914
865-524-7380 Fax 865-673-4770
www.fishock.com

Gallagher
P.O. Box 7506 Kansas City, MO 64116
1-800-531-5908
www.gallagherusa.com
info@gallagherusa.com

Margo Supplies Ltd.
P.O. Box 5400, High River, Alberta
Canada T1V 1M5
403-652-1932 Fax 403-652-3511
www.margosupplies.com
info@margosupplies.com

Premier 1 Supplies
2031 300th St., Washington, IA 52353
319-653-6304
www.premier1supplies.com
info@premier1supplies.com

Max-Flex Fence Systems
Lindside, WV 24951 1-800-356-5458
www.maxflex.com

Parmak
Parker McCrory Mfg. Co.
2000 Forest Ave., Kansas City, MO 64108
816-221-2000 Fax 816-221-9879
www.parmackusa.com
info@parmackusa.com

Wyoming Outdoor Industries Inc.
1-800-725-6853
www.wyomingoutdoor.com

Zareba Systems
13705 26th Ave. N., Suite 102
Minneapolis, MN 55441
763-551-1125 Fax 763-509-7450
www.zarebasystems.com

UDAP Industries Inc.
P.O. Box 10808, Bozeman, MT 59719
406-763-4242
www.udap.com

Safe Fence by J.L. Williams Company
P.O. Box 209, Meridian, ID 83680
1-800-843-3702
www.safefence.com

Other Sources of Information About Predators

Montana Fish, Wildlife & Parks

www.fwp.state.mt.us

Interagency Grizzly Bear Committee

www.fs.fed.us/r1/wildlife/igbc

Alaska Department of Fish and Game

www.state.ak.us/adfg/adfghome.htm

U.S. Forest Service

- www.southernregion.fs.fed.us/resources/features/Feature-bears-p2.htm
- www.fs.fed.us/r3/coronado/scrd/nathist/nature/blackbear.htm

Pitkin County Government, Roaring Fork Bear Awareness Team

www.pitkingov.com/sitepages/pid154.php

Colorado State University Cooperative Extension

www.coopext.colostate.edu/wildlife/vendors_of_supplies.html

Sierra Interagency Black Bear Group

www.sierrawildbear.net

Northwest Territories Resources, Wildlife and Economic Development

www.nwtwildlife.rwed.gov.nt.ca

Govt. of British Columbia, Ministry of Water, Land and Air Protection, Bear Smart Program

Http://wlapwww.gov.bc.ca/wld/bearsmart/bearsmintro.html

Center for Wildlife Information

www.BeBearAware.org

Brown Bear Resources

406-549-4896

www.brownbear.org

Bear Info. Site

www.bearinfosite.com

Defenders Of Wildlife

www.defenders.org

Bear Aware Initiative

C/o Sierra Club

P.O. Box 263

Jackson, WY 83001

The Tahoe Donner Association

www.tahoedonner.com

City of Juneau, Alaska

www.juneau.org

The following information was summarized and provided by Seth Wilson of the Blackfoot Challenge.

Natural Resources Conservation Service (NRCS) Offers New Predator Deterrent Fencing under the Environmental Quality Incentive Program (EQIP)

Overview:

The Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers. These programs are designed to maintain agricultural production and environmental quality. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land.

An emerging effort in the state of Montana under EQIP provides livestock producers and beekeepers with a 75% cost-share payment for high-powered electric fences designed to non-lethally deter bears and wolves. The NRCS in collaboration with the Blackfoot Challenge and MT Department of Fish, Wildlife & Parks is experimenting with fencing designs on several new projects. At this time, the NRCS has specified that electric fences have the following design specifications:

Summary of Current Specifications:

Energizer: Minimum 6,000 volt delivered to the fence

H-Braces: Set minimum 10-foot long wooden posts every 1,320 feet, buried 3 feet

Line-posts: Set minimum 8-foot line posts along 20-foot intervals (experimenting with 40-foot interval)

Wires: 9-wire, high tensile steel

Height: 6-feet

Spacing: Top 72"(+), 2nd 62"(-), 3rd 52"(+), 4th 42"(-), 5th 32"(+), 6th 24"(-), 7th 18(+), 8th 12"(-) 9th 6"(+)

For More Information:

Please contact the NRCS Deer Lodge Office: (406) 846-1703