

2005 Edition Living with Predators Resource Guide

Practical Electric Fencing Resource Guide: Controlling Predators



2005 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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*Cover photos Courtesy of (clockwise from top left): Tom Mangelsen, Patti Sowka, Derek Reich, and Montana Fish,
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This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is sold with the understanding that the publisher is not engaged in rendering legal, accounting or other professional advice. If legal advice or other expert assistance is required, the services of a professional should be sought.

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 alterna-

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NOTE: The next edition of this electric fencing manual will include designs for excluding bears from landfills and dump sites

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 observed when conventional barbed wire fencing is used.

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. All of the designs have been proven to be successful to some degree already and so they are included in this guide for consideration.

The Living with Wildlife Foundation has begun a new research program to collect 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 information about 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.

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 certain 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 where the fence will be located. Energizers store energy and deliver a pulse of electricity throughout the fence system. The stored energy is measured in joules which is considered as energizer 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.

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, are self-contained and come with a solar panel. It is important that the fenced area receives adequate 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, they generally require less maintenance, and they 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 steel or aluminum. Polywire or polytape have been used effectively for domestic animals, but have not been as successful 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, while more difficult to work is the strongest and longest lasting. Aluminum wire is more conductive and more user-friendly; however, it does crumble with repeated bending and over time. Most successful electric fences, and the fences pictured in this guide, 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.

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 grounds rods 10' long to maximum 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 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. 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.

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 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 tied into the red terminal on the energizer.

The hot/ground system overcomes poor soil or grounding conditions 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.

The photo below shows a five-wire electric fence that was constructed near Ovando, Montana to deter grizzly bears.



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 the fencing can quickly and easily be taken down 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 provide a temporary electric fence enclosure. Both install quickly and don't require significant digging or bracing, and both can be easily removed and stored for future use. Temporary fencing is usually cheaper to install but doesn't hold up long term 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, or in warmer climates, for a year or more.

The fence to the right shows how cattle panels can be secured to t-posts and the electric "Turbowire" is 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."

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 Fencing (cont.)



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 a train wreck resulted in a large-scale grain spill. 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 at 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





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 their effectiveness for deterring bears from game carcasses and other attractants.

Photo Courtesy of Montana Fish, Wildlife & Parks

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 or 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 for 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 on 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



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 several 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.

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."



Photos courtesy of Patti Sowka

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 presented in this section of the guide show many 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.

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 would also work well for wolf exclusion.

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 or other areas.



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

Photo above and photos at right courtesy of Margo supplies.



This photo shows another 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.

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, 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 and 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, preferable 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 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.

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 bears 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 Montana Fish, Wildlife & Parks.

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.

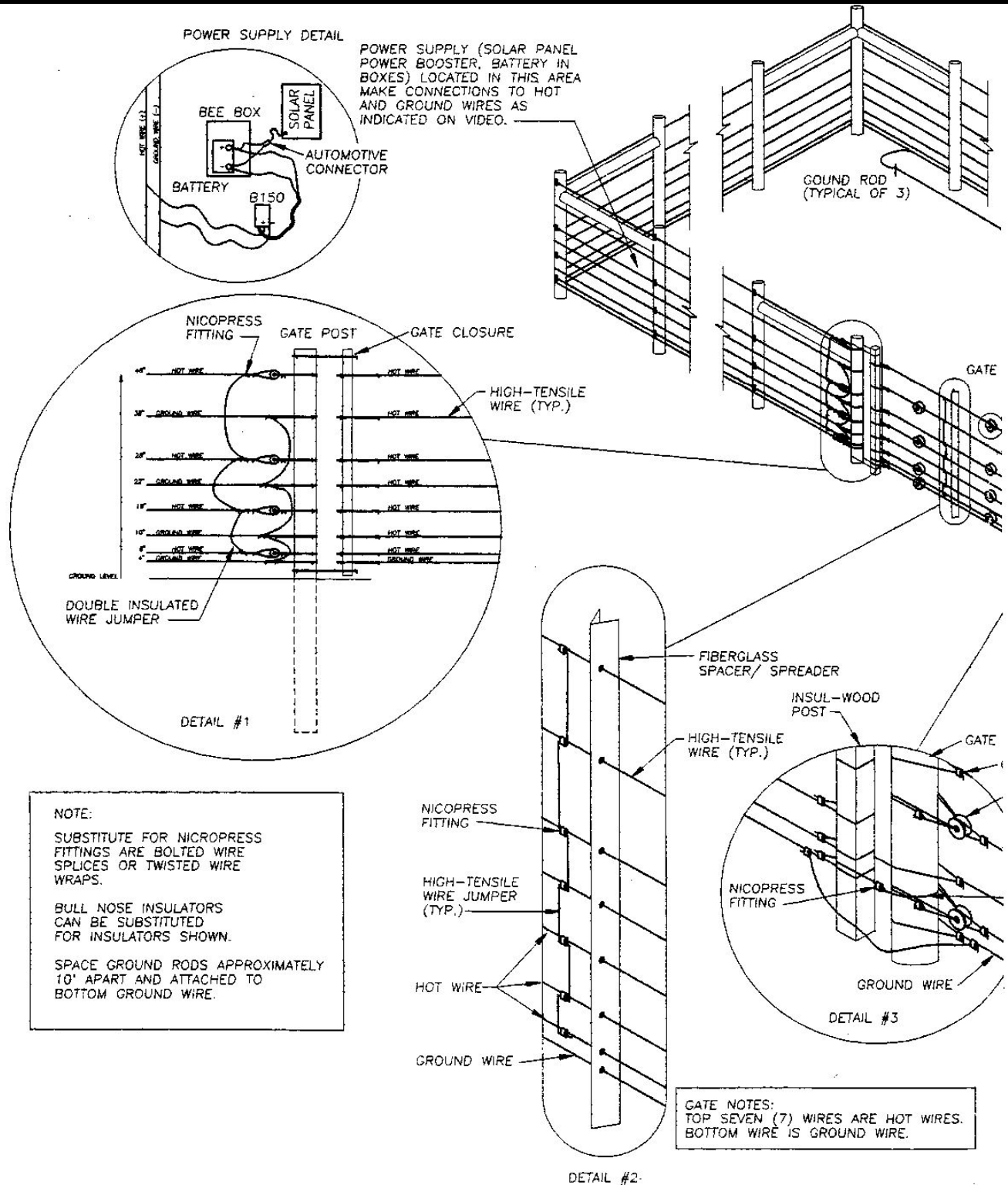
*Photo courtesy of
the Living with
Wildlife Founda-
tion.*



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.

Deterring Bears From Bee Yards

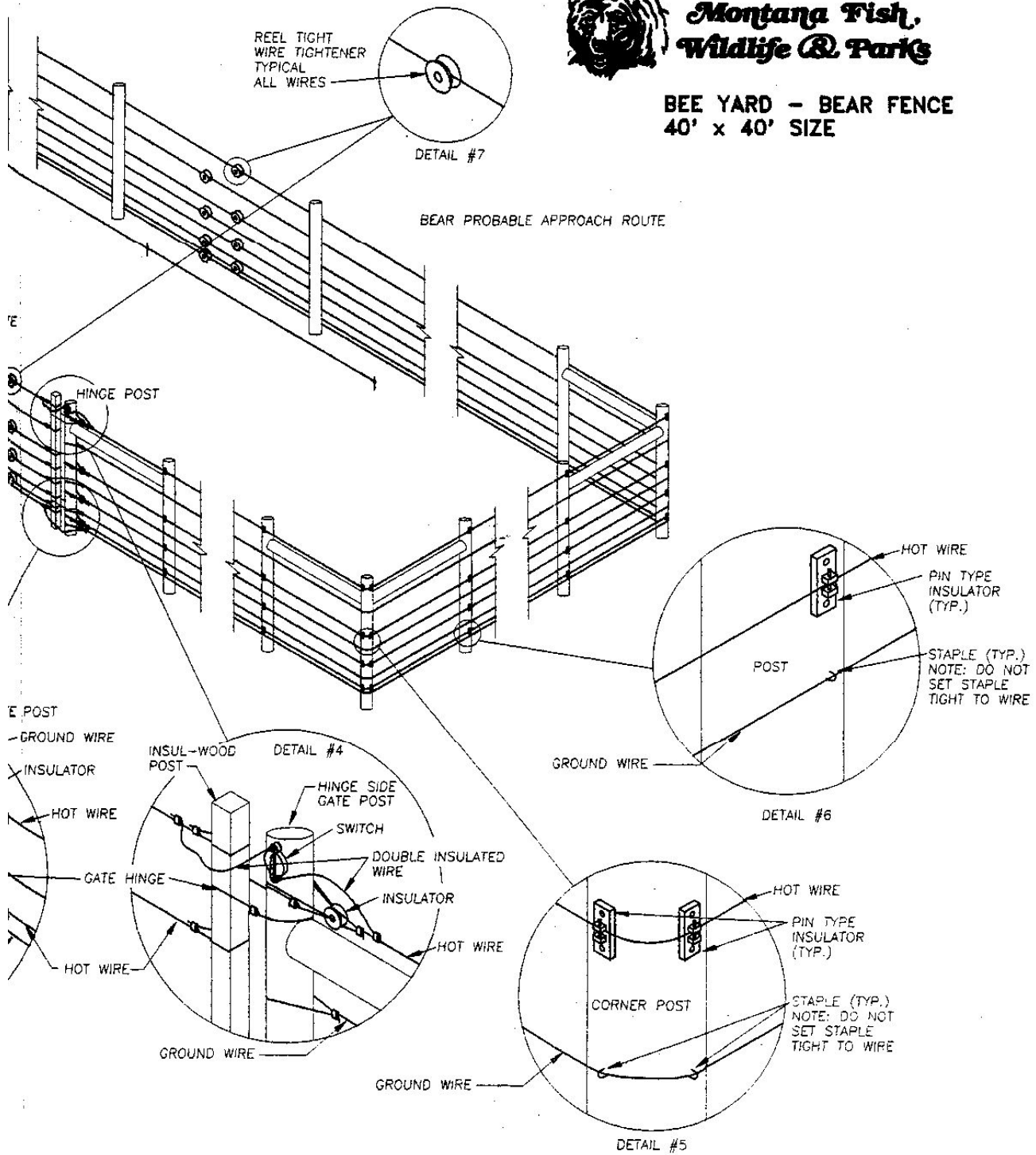
Information Courtesy of Montana Fish, Wildlife & Parks

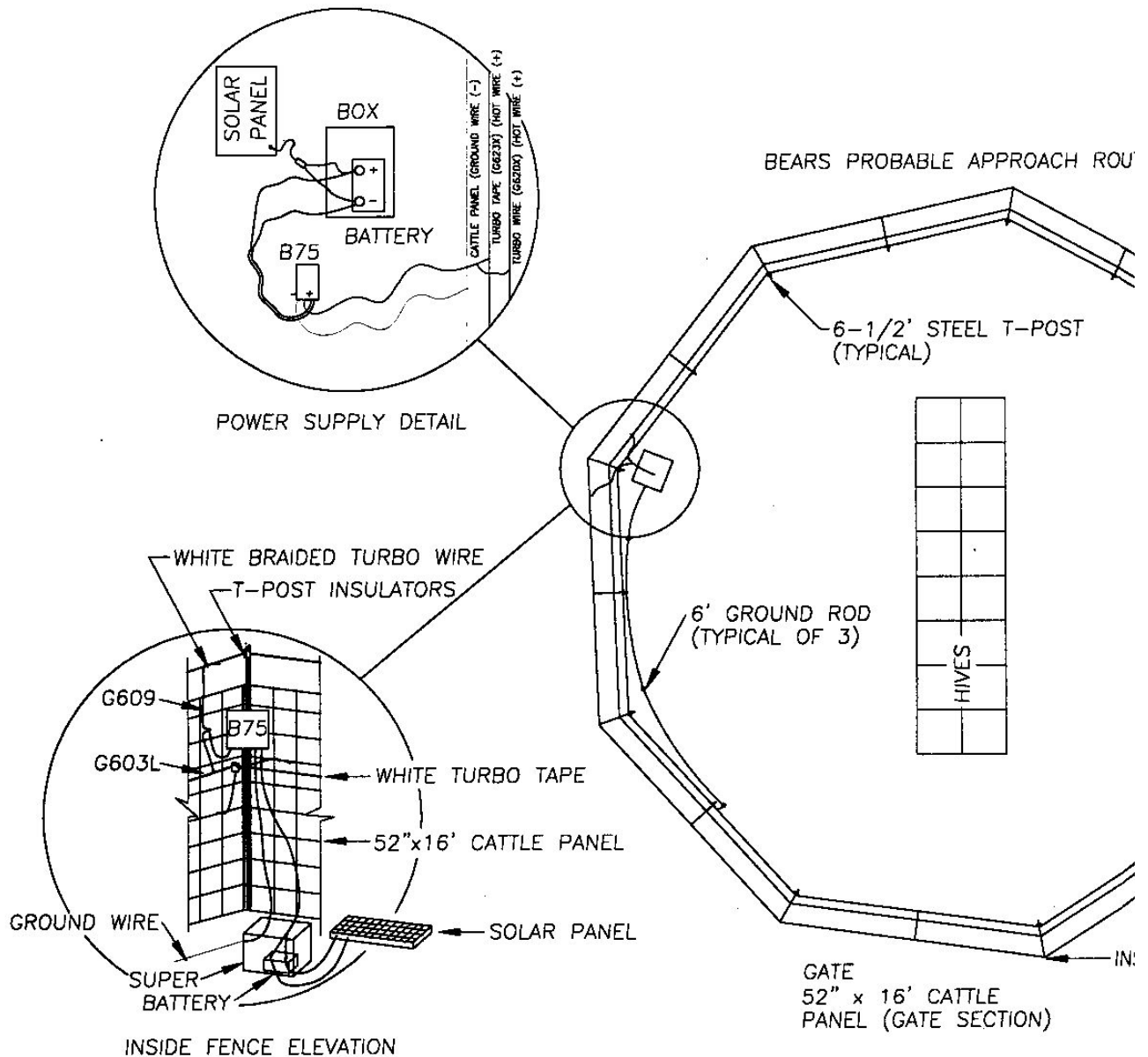




**Montana Fish,
Wildlife & Parks**

**BEE YARD - BEAR FENCE
40' x 40' SIZE**

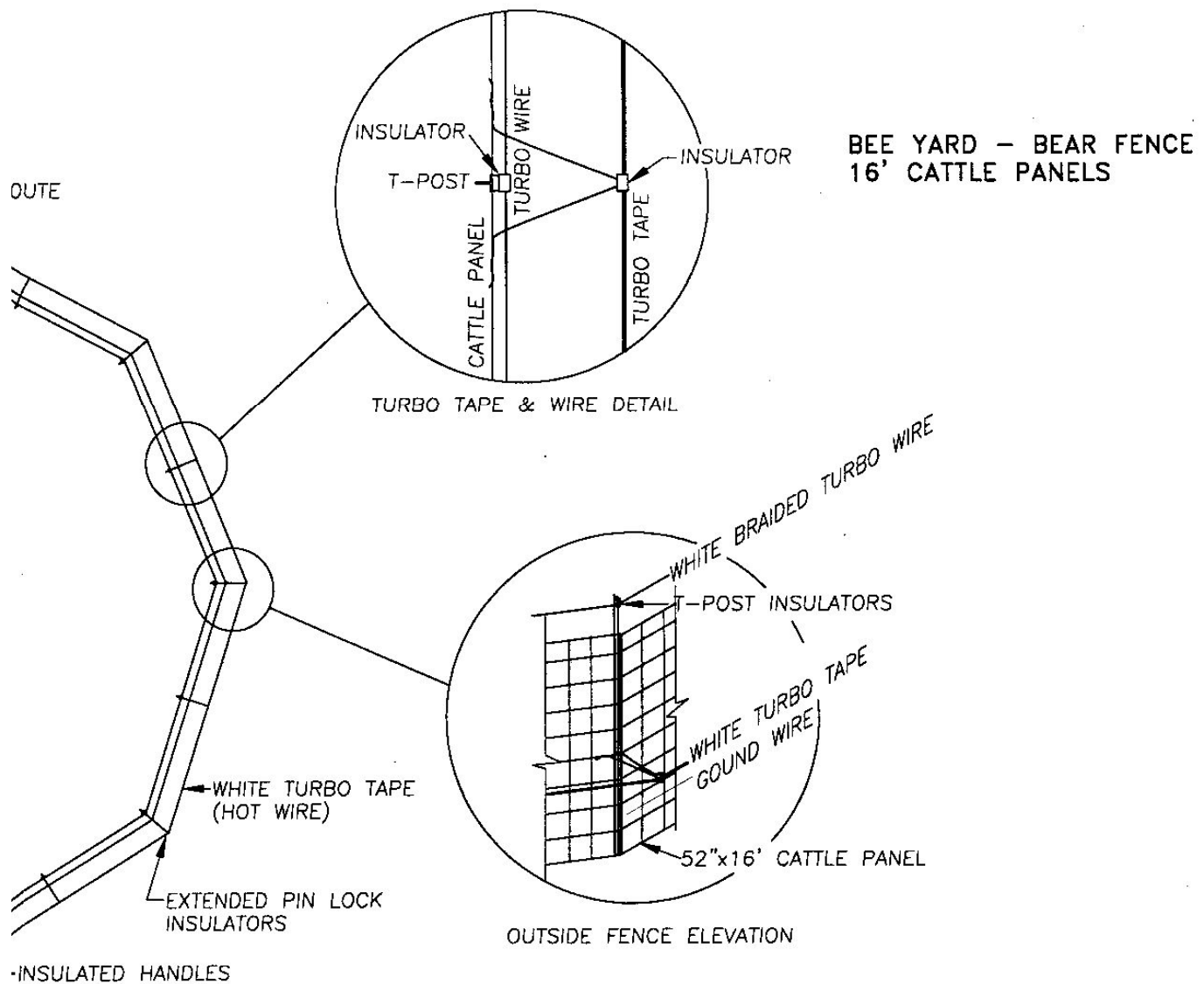




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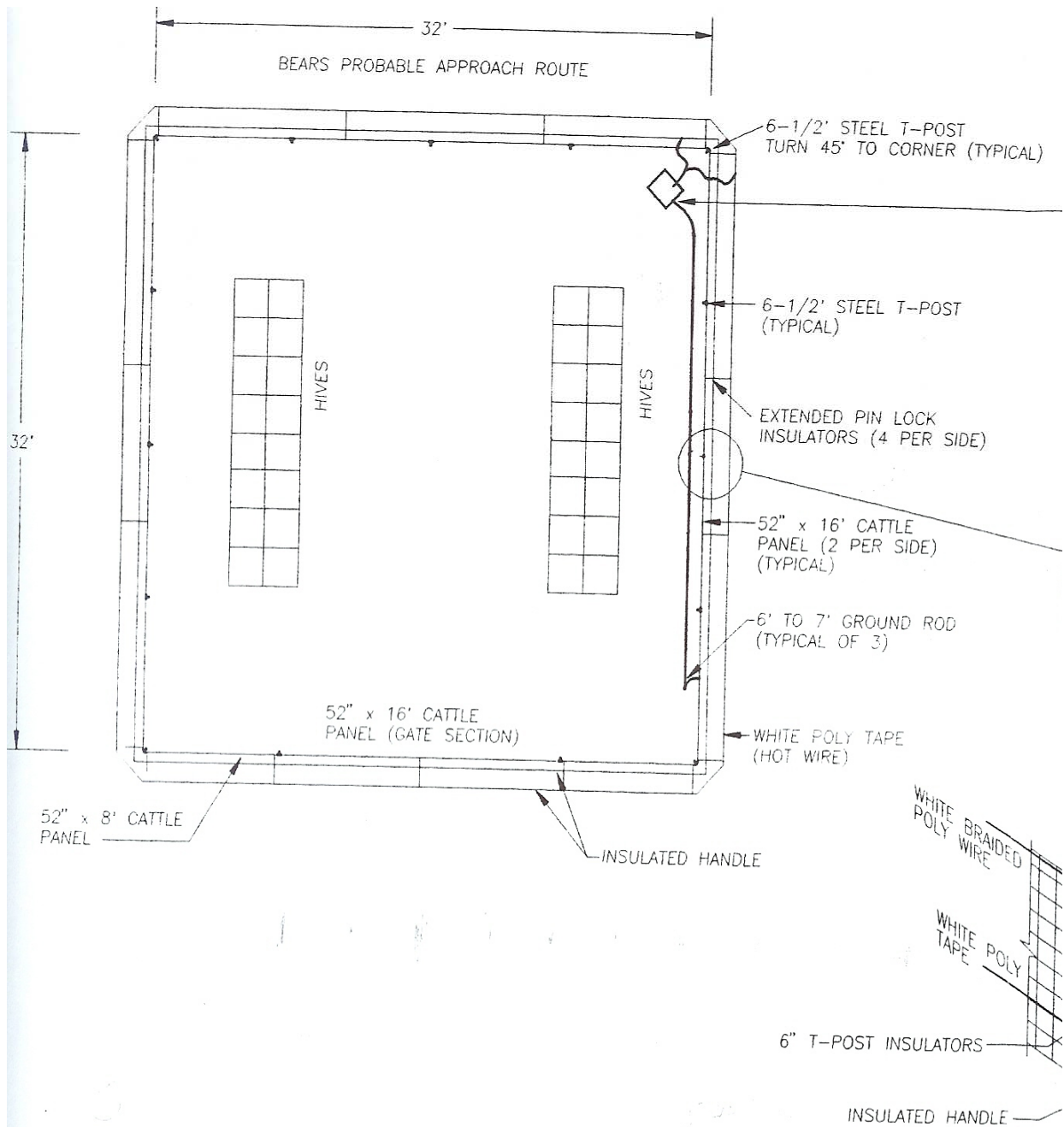
PRODUCTS REFERED TO ARE GALLAGER.

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



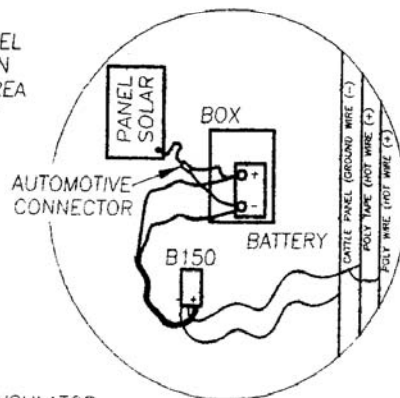
Bee Yard—Bear Fence 32' x 32' size (continued)



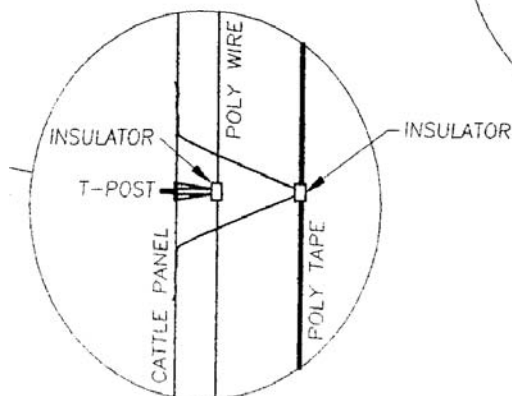
**Montana Fish,
Wildlife & Parks**

BEE YARD - BEAR FENCE 32' x 32' SIZE

POWER SUPPLY DETAIL



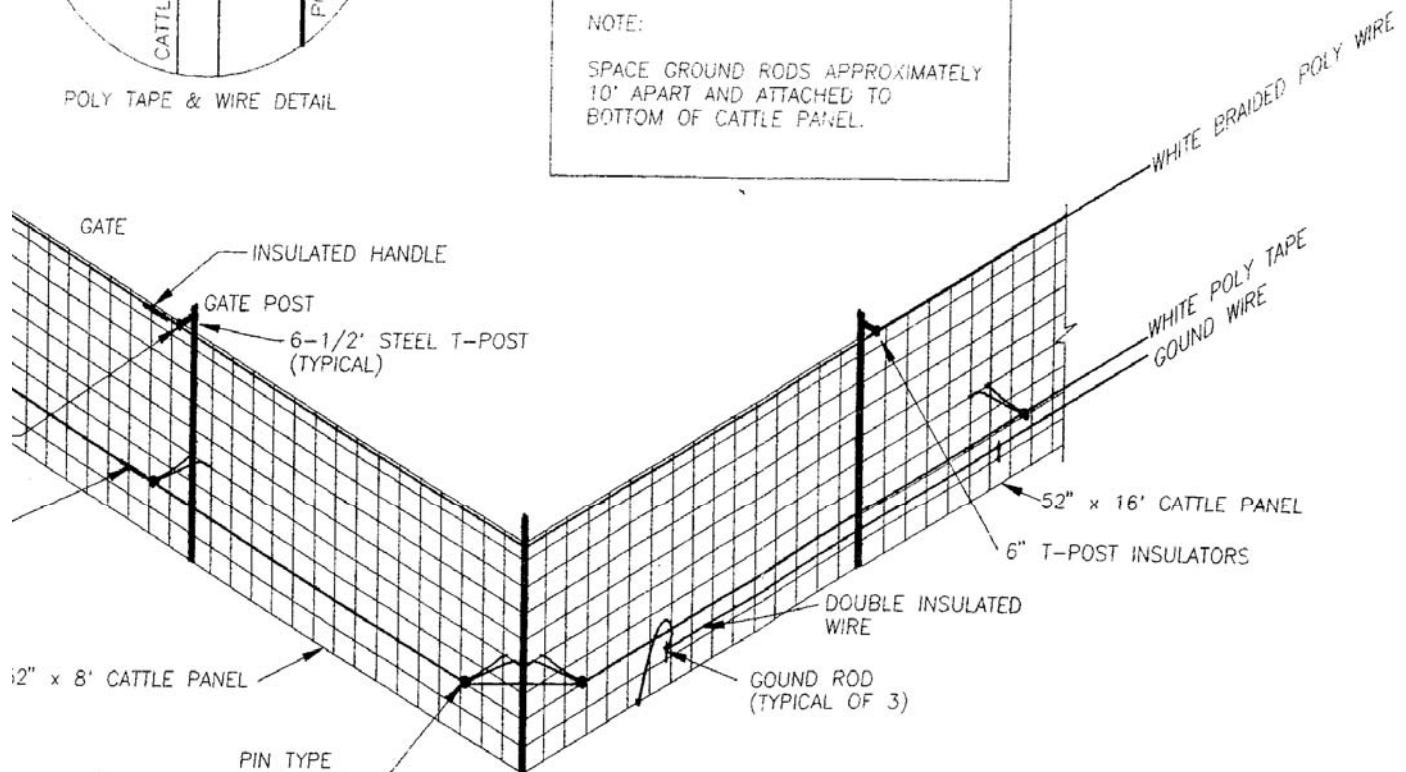
POWER SUPPLY (SOLAR PANEL POWER BOOSTER, BATTERY IN BOXES) LOCATED IN THIS AREA MAKE CONNECTIONS TO HOT AND GROUND WIRES AS INDICATED ON VIDEO.

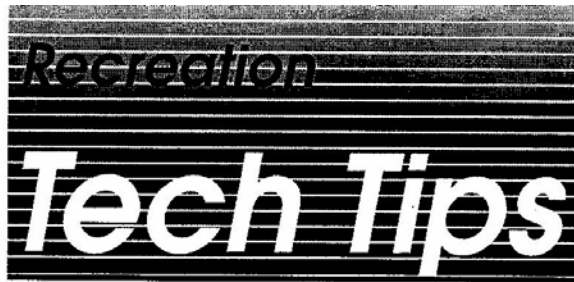


POLY TAPE & WIRE DETAIL

NOTE:

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





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.

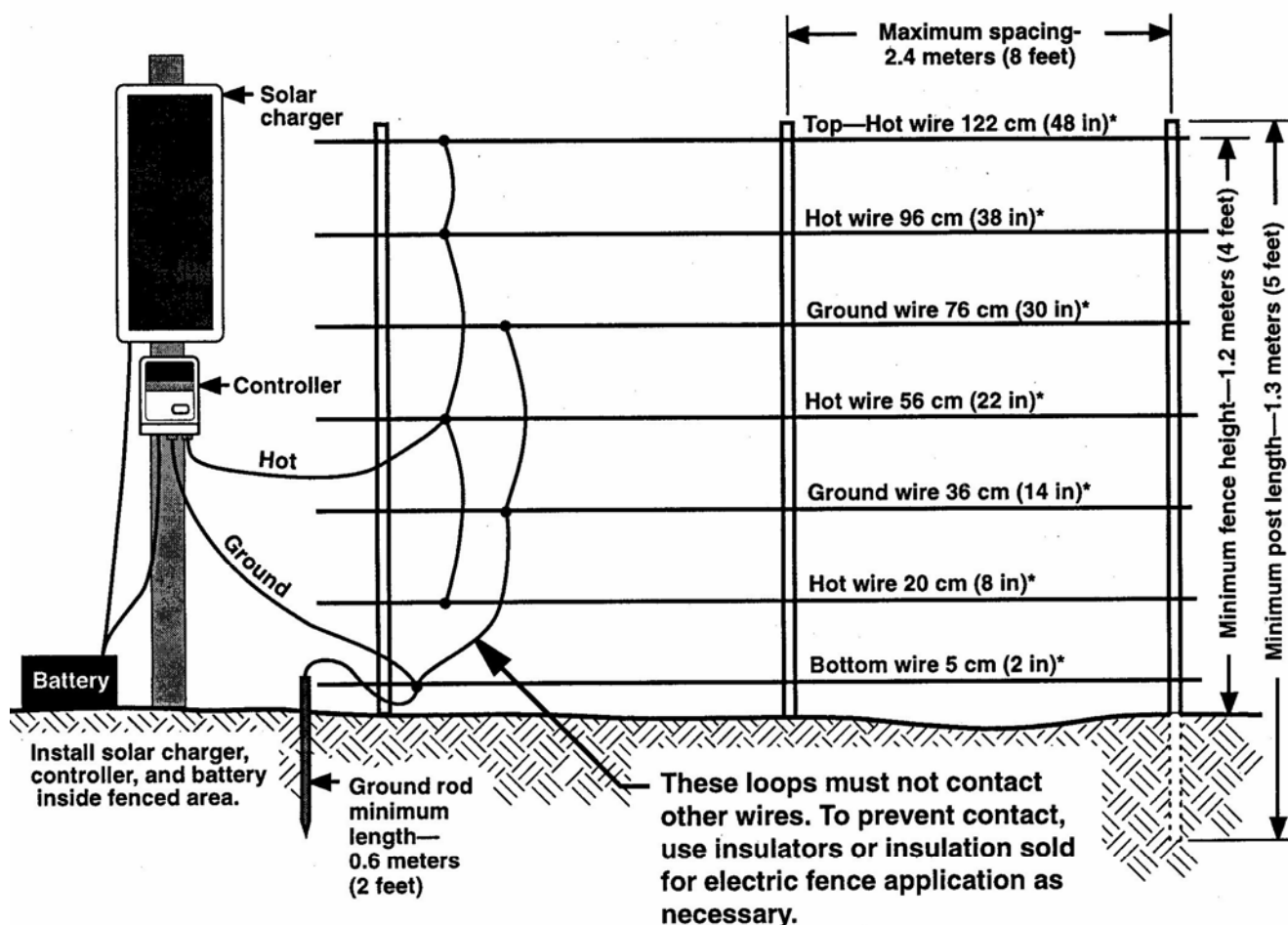
Fence System Requirements

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

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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

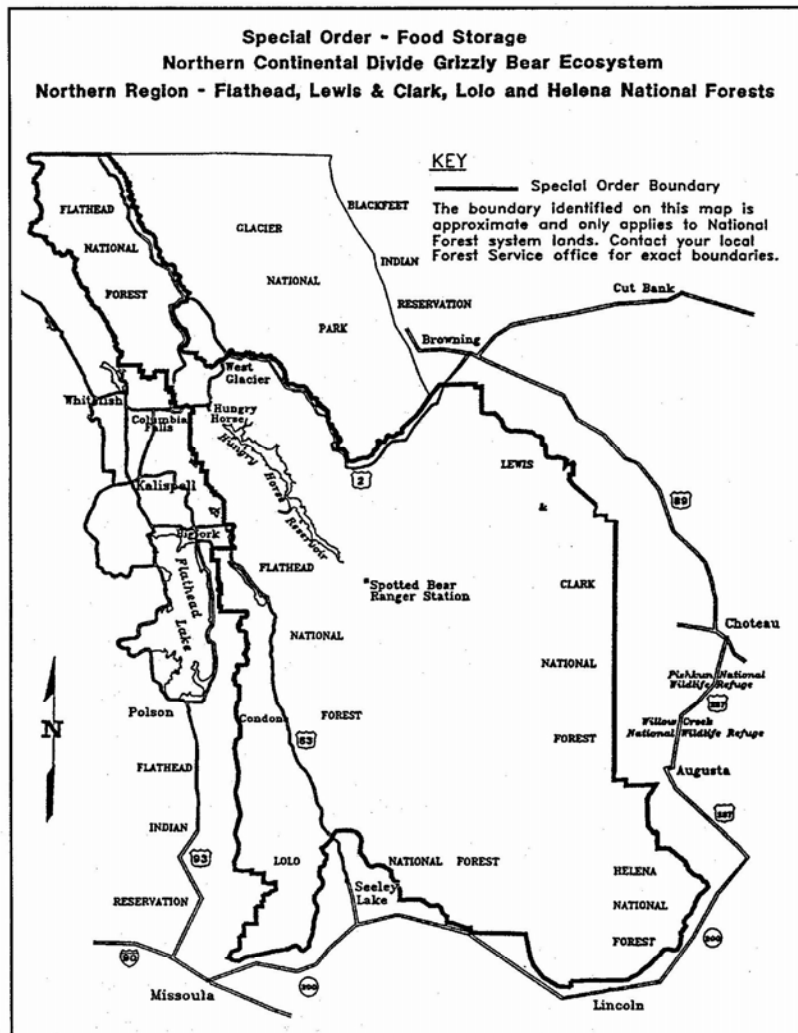
Minimum stored energy of
the fence controller _____ 0.7 joules

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

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



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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. Small or temporary paddocks or holding pens have been enclosed by electric fencing with 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 with using electric fencing to deter wolves, and "Turbo" fladdry shows promise.

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



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 courtesy of Patti Sowka



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

Photo courtesy of Wyoming Game and Fish

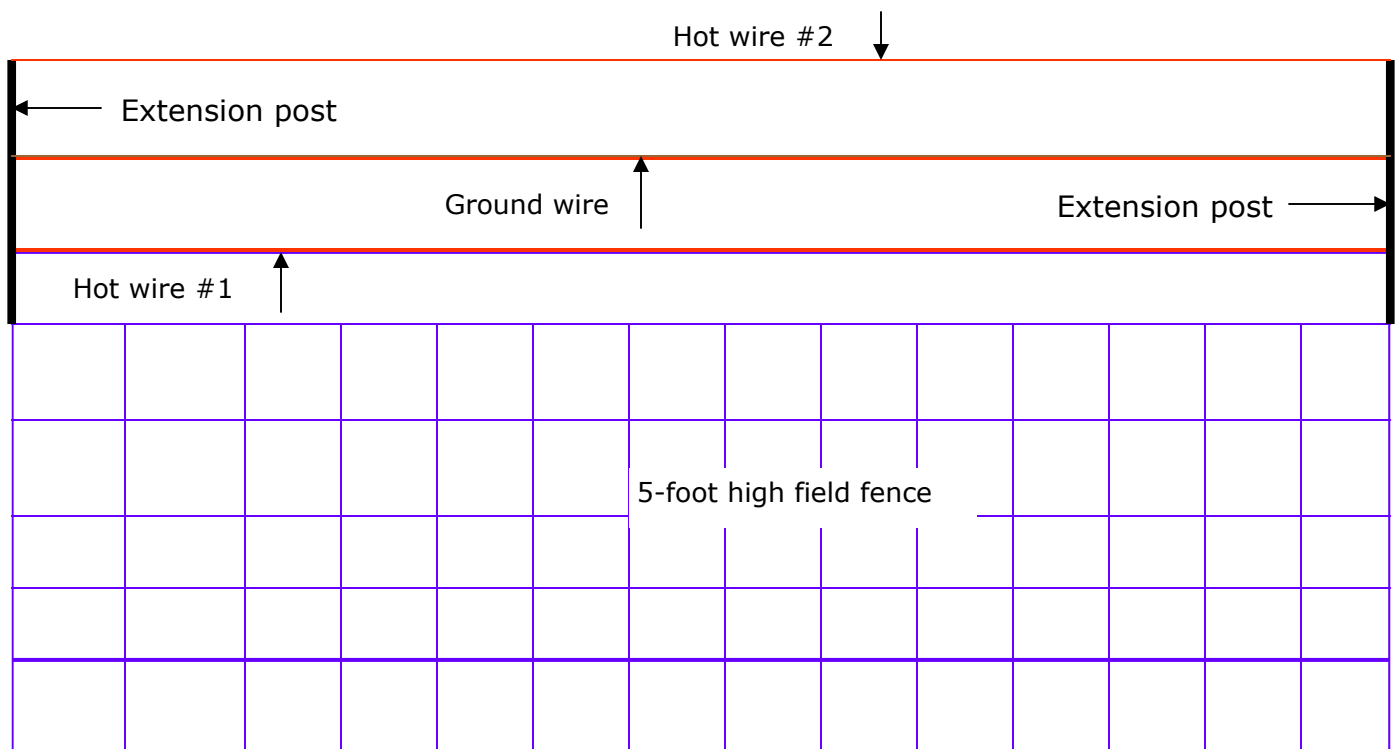
As other wolf exclusion designs are constructed and tested, designs that prove to be effective will be added to this manual.

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 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 cougar 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 cat 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

CML Backcountry Equipment

P.O. Box 325
Huson, MT 59846
CMLbackcountry@montana.com
(406)240-2722

Fi-Shock Inc.

5360 N. National Drive
Knoxville, TN 37914-6695
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

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

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

City of Juneau, Alaska

www.juneau.org

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

The Tahoe Donner Association

www.tahoedonner.com

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](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 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