

NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE SPECIFICATION

FENCE (FEET)

CODE 382

POWER FENCE

SCOPE: This specification provides guidance for the installation of permanent power fences. Fencing includes all components required for achieving the objectives of the practice and meeting site conditions.

High Tensile Power Fence

Power fence is an alternative to standard post-and-wire fencing. Livestock must be trained to respect a power fence if it is to be effective. Typically, power fences are designed to be more of a psychological barrier than a physical one.

MATERIALS AND CONSTRUCTION SPECIFICATIONS

Power Fence Materials

Materials used in the construction of fences will be new, except as outlined in the specifications, and will have a minimum life expectancy of 10 years. All materials must be in accordance with, and equal or exceed, in strength and durability, the requirements listed below.

Wire

All wire for power fence will be High Tensile Smooth single strand, 12-1/2 gauge, Class III galvanized per ASTM-121, with a breaking strength of 135,000 psi minimum and should not exceed 170,000 psi maximum. Wire with over 170,000 psi is extremely difficult to work with.

Barbed wire will not be used in electrified fences because of the safety hazard.

The maximum length of wire per energizer shall not exceed manufacturer's recommendation of the size of the type of wire and the energizer used.

Fence Wire Tension

An in-line wire tensioning device must be placed on each wire, between every tie off. On multi-wire fences alternate the placement on each side of a post. If devices are placed directly above or below each other, tensioners will get hooked on each other causing a dead short. Wire tension should be maintained at 175 to 200 pounds per wire.

Energizer

The capacity of the energizer must match the level of control needed. Electronic energizers need to meet the following specifications:

- Peak output limited to 10,000 volts with a pulse that is finished within 3 ten-thousands of a second or less, and has a rate of 54 to 60 times per minute. Fences constructed to deter bear and/or wolf shall deliver a minimum of 6,000-volts.
- 110-volt, 220-volt, or a 6 or 12-volt battery powered system capable of operating three weeks without recharge.
- All energizers will have a lightning arrester, high impact weather resistant case, solid state circuitry, and a safety pace fuse.

Install power to the fence energizer in accordance with state and local wiring codes.

Portable voltmeters are necessary for monitoring fence line voltage.

Specification MT382-A-2 Power Fence

Grounding

All power fences must have an adequate ground. Poor grounding is the leading cause of power fence problems. Moist soil is a good conductor of electricity, so power fences on irrigated pasture rarely require ground wires. Grounding in these situations would be for the energizer only.

Where soil conditions are dry (dryland pastures, rangeland, and frozen conditions) animals may not be adequately shocked unless ground wires are included in the system.

The number of ground rods required for an adequate ground may vary but usually three would be a minimum. A maximum reading of 0.2kv on a volt meter in dry conditions will determine if an adequate ground has been achieved.

To ground an energizer, run an insulated wire from the ground post of the energizer to a 6-foot galvanized pipe or rod, driven into the ground a minimum of five and one-half feet. If soil limitations prohibit this depth, use more rods. Galvanized pipe must be at least three-quarter (3/4) inch in diameter, and galvanized steel rods must be at least one-half (1/2) inch in diameter. If multiple rods are needed for an adequate ground, driven rods should be spaced at least ten feet apart.

Energizers should be connected to ground rods with 12-1/2-gauge insulated or heavy duty underground cable wire attached with ground rod clamps. If multiple rods are necessary connect all rods together using one continuous wire.

Ground wires in the fence must also be grounded to galvanized pipes or rods, spaced at appropriate intervals along the fence to achieve an adequate ground. Locate the ground rods anywhere along the fence that a 6-foot depth can be obtained. Attach ground wire to ground rods with bare galvanized wire unless the potential exists for short. In this situation, use insulated or heavy-duty underground galvanized wire with equal or greater diameter as fence wire.

Try to locate ground rods near permanent moisture if possible to receive a higher flow of electrons. Locate ground rods where they are not likely to interfere with cultivation or traffic, and where they will not be damaged from or cause injury to livestock.

LINE POSTS: See TABLE 1—LINE POST REQUIREMENTS FOR POWER FENCE for recommended types, sizes, setting depths and coatings. Line posts must be of sufficient length to meet fence height, setting depth requirements, plus three (3) inches.

Wood posts can provide strength, but require insulators. Fiberglass posts shall be a composite of marble, fiberglass, and polymer resins that have been treated by thermosetting (heat treatment). Fiberglass posts will not rot but are extremely susceptible to damage by fire.

Steel line posts are acceptable, but require insulators that attach to the posts. If the insulator becomes broken or fails, a dead short will result. Steel posts are not recommended for areas of high wildlife pressure, as the insulators are susceptible to breakage. Steel posts shall not be used if the fence is constructed to deter bear and/or wolf. In this case, fiberglass or wood posts are the only acceptable materials.

TABLE 1. Line Post Requirements for Power Fence

Wood posts do not need to be new materials; however, all posts shall meet the minimum quality criteria for durability and protective coating. Wood posts need to be sound and free from decay, with all limbs trimmed substantially flush with the body.			
LINE POST TYPE	MINIMUM DIAMETER/WEIGHT	MINIMUM SETTING DEPTHS	MINIMUM PROTECTIVE COATING, OTHER
Wood-juniper, cedar, black locust	4 inches inside the bark	24 inches	None
Wood-pine or similar woods	4 inches inside the bark	24 inches	Complete penetration of the sapwood with approved treatment materials.
Fiberglass round section	.66-inch	18 inches	For 3 wire fences or less.
	.75-inch	18 inches	For more than 3 wires
	1.5-inch	18 inches	Required for bear and/or wolf deterrent fences only.
Steel T Posts	1.25-inches	18 inches	Painted/Recommended only in areas that do not receive high wildlife use. Do not use on fences constructed to deter bear and/or wolf.
Australian ironwood	1—1/2 inches X 1—1/2 inches	18 inches	Recommended only for pastureland conditions. Material is brittle and does not stand up to wildlife pressure in rangeland situation. Do not use on fences constructed to deter bear and/or wolf.

SETTING POSTS: Posts shall be set to the minimum depths listed in **TABLE 1—LINE POST REQUIREMENTS**.

Wood posts shall be set in holes and back-filled with compacted earth, poured concrete, or driven to the desired depth. Fiberglass posts shall be driven or installed according to the manufacturer's directions. If soil conditions prevent firmly setting posts in the ground: rock-jacks, Figure-4's, or wire cribs may be used.

BRACE ASSEMBLY: Recommended brace types include Standard H-brace, Diagonal brace, and/or bedlog braces.

Brace Posts

See **TABLE 2—BRACE POST REQUIREMENTS FOR POWER FENCE**. Braces or Brace posts are required at all corner and gates. Fence alignment shall be reasonably straight and shall not deviate more than 12 inches between any corner, gate, or in-line brace assembly without additional brace post(s) becoming necessary.

**Specification MT382-A-4
Power Fence**

TABLE 2. Brace Post Requirements for Power Fence

BRACE POST TYPES	MINIMUM DIAMETER/WEIGHT	MINIMUM SETTING DEPTHS	MINIMUM LENGTH	MINIMUM PROTECTIVE COVERING, OTHER
Wood-juniper, Cedar, Black locust	5 inches inside the bark.	3 feet	10 feet (9 wires) 7 feet (4-5 wires) 6 feet (2-3 wires)	Post length needs to be the buried depth + height of top wire + 3 inches, minimum. The 9-wire, 10-foot brace post is for bear and/or wolf deterrent fences only.
Wood-pine or Similar woods	5 inches inside the bark.	3 feet	10 feet (9 wires) 7 feet (4-5 wires) 6 feet (2-3 wires)	Complete penetration of the sapwood with approved treatment materials. The 9-wire, 10-foot brace post is for bear and/or wolf deterrent fences only.

TABLE 3 Brace Member Requirements for Power Fence

BRACE MEMBER TYPE	MINIMUM DIAMETER/WEIGHT	MINIMUM LENGTH
Wood, horizontal	4 inches	5 feet*
Wood, diagonal	4 inches	6 feet**
Steel, round, horizontal pipe or tubular steel	1—5/8 inches OD, 2.25 lb./foot or equivalent	8 feet

*8 feet minimum brace member length for fence constructed to deter bear and/or wolf.

**9.5 feet minimum brace member length for fence constructed to deter bear and/or wolf.

BRACE ASSEMBLY: All line wires shall be dead-ended on the anchor post (pull post) of gate, corner, and in-line brace assemblies either directly for ground wires or to an insulator if hot wires. Wire ends are double wrapped around the anchor posts (pull posts), stapled, and secured with an appropriate tie-off type for high tensile wire. Hot wires are run through an insulator and tied or crimped as appropriate for high tensile wire.

Horizontal Wooden Brace Members:

Fences constructed for reasons other than to deter bear and/or wolf shall have wooden horizontal brace members shall be at least 5 feet in length and notched into the top half of the brace post and post being braced (anchor post or pull post) approximately 36 inches above ground level. Fences constructed to deter bear and/or wolf shall have wooden horizontal brace member at least 8 feet in length, and shall be notched into the top half of the brace post and post being braced (anchor post or pull post) approximately 48 inches above ground level.

Diagonal Wooden Brace Members:

The top end of wooden diagonal brace members shall be notched into the post being braced (anchor post or pull post) approximately 36 inches above ground level (or approximately 48 inches above ground level if the fence is used to deter bear and/or wolf). If using a diagonal brace, secure the brace member to the bottom brace post as well to prevent sideways movement. Steel dowels can be used, rather than notching, to attach horizontal or diagonal brace member between anchor post and brace post.

Bracing Wire

Brace wires (or guy wires) shall be formed form two complete loops of:

- No. 9 gauge smooth wire,
- No. 12-1/2 gauge double-strong smooth wire, or
- No 12-1/2 gauge high tensile smooth wire.

Brace wires shall extend from a point approximately six inches below the top of the brace post to as close to ground level as possible on the anchor post. Never have the wire on the brace post higher than the top of the anchor post or it will pull the anchor post up to that level. The brace wires shall be double-wrapped around each post, stapled, and spliced together. A stout stick, about 18 to 24 inches long, is place mid-way along the brace wires, and all four wires are twisted together so the brace wires tightly secure the compression brace and provide needed rigidity. If a diagonal brace is used, tie the wire from the bottom of the diagonal brace at the brace back to the bottom of the anchor post. Twist the wires together and secure against the brace member.

Ratchet tensioners may be used in lieu of a tightening stick. Secure the tensioning device between one strange of high tensile wire and tighten.

FENCE HEIGHT and WIRE SPACING

The following tables provide recommended wire spacings for different types of livestock and purposes. The designed height of the wire may vary up to six inches from these recommendations.

Systems may be all hot wires, or alternate hot and ground, depending on soil moisture conditions. For irrigated pasture, all hot wires are generally used where soil is moist at all times control is needed. For dryland pasture, rangeland, or frozen conditions, an alternate hot and ground wire-design are recommended.

To avoid electrocution of birds, never space wires closer than 6 inches apart.

Cattle

There are several designs of electric fence available to use for cattle control. One electrified (hot) wire can be an effective pasture subdivision control only in areas where soil is moist at all times (irrigated conditions, exclusive early spring use, etc.) Two or three wires are generally used for pasture subdivisions, and four or more for boundary fences. All hot systems can be used in irrigated situations.

The height of the bottom wire can vary depending on whether it is desired to keep calves inside the fence, or let them creep out. A minimum of 18 inches off the ground is recommended for areas where antelope reside.

Cattle: Height of wire from earth surface and charge: (+) hot and (-) ground wires					
No. of Line Wires	Top	2 nd	3 rd	4 th	Use
2	30" (+)	24" (-)			Cross-fence
3	36" (+)	26" (-)	16" (+)		Cross-fence
4	42" (+)	32" (-)	22" (+)	12" (-)	Boundary
4*	42" (+)	34" (-)	26" (+)	18" (-)	Boundary

* Recommended design for areas where antelope reside.

**Specification MT382-A-6
Power Fence**

SHEEP

Sheep are more difficult to control with power fencing than other livestock, and training is critical if sheep are to be controlled. Fence design may need to be more elaborate than with cattle, and posts are generally spaced as close as 40 to 50 feet apart. Additional wires may be desirable for predator control.

Sheep: Height of wire from earth surface and charge: (+) hot and (-) ground wires

No. of Line Wires	Top	2 nd	3 rd	4 th	5 th	Use
3	30" (+)	20" (-)	10" (+)			Cross-fence
4	32" (+)	24" (-)	16" (+)	8" (-)		Cross-fence
5	44" (+)	32" (-)	22" (+)	16" (-)	8" (-)	Boundary

BISON

Bison: Height of wire from earth surface and charge: (+) hot and (-) ground wires

No. of Line Wires	Top	2 nd	3 rd	4 th	5 th	Use
4	46" (+)	36" (-)	26" (+)	16" (-)		Cross-fence
5	52" (+)	42" (-)	32" (+)	24" (-)	16" (+)	Cross-fence

HORSES

Horses: Height of wire from earth surface and charge: (+) hot and (-) ground wires

No. of Line Wires	Top	2 nd	3 rd	4 th	5 th	Use
2	42" (+)	30" (-)				Cross-fence
3	48" (+)	38" (-)	28" (+)			Cross-fence
4	48" (+)	38" (-)	28" (+)	18" (-)		Boundary
5	48" (+)	38" (-)	30" (+)	24" (-)	18" (+)	Boundary

SPLICING: When splicing of wire is necessary, use the following:

- High-tensile wire – “Figure-8,”

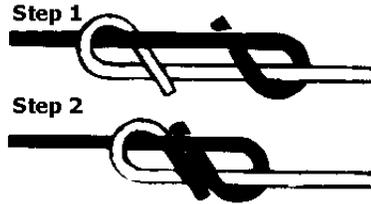


Figure-8 Splice

To crimp wires together, overlap ends of each wire about two inches then place compression fitting over both wires and firmly crimp the fittings.

INSULATORS: Insulators shall be UV-stabilized plastic, porcelain, or composite materials. For non-conductive posts with drilled holes, a wire loop fashioned from a 9-gauge galvanized wire may be used in lieu of manufactured insulators. The wire must be fastened securely to the post so that the fence wires may slide past the post with ease.

STAPLES: Staples shall be driven into the post at a 45-degree angle. Staples at gates shall be driven just deep enough to snug the line wire without bending it. In all locations where staples are used, the line wire shall be loose in the staple.

CROSSING DRAWS OR STREAMS: When the fence crosses landscape depressions, draws, or swales and the bottom line wire is more than 20 inches above the ground at the low spot, the use of a deadman may be necessary to maintain fence height. When crossing live streams or very deep draws, the fence may be dead-ended on each side of the crossing by use of line braces. The section across the stream may be removable, a breakaway type, or swinging picket type fence. The voltage and ground must be carried through to the other side or provisions made to bring that portion of the fence to similar standards.

FENCES TO CONTROL WILDLIFE: Where wildlife is needed to protect valuable crops, hay, livestock, or plantings, fences provide the most effective long-term protection. Power fences constructed properly can effectively exclude deer, elk, bear, and wolf and are generally less expensive than other fence types.

Power fences act as psychological barriers, hence whole herds can be effected by one animal being shocked. Wildlife will constantly check the fence, so the power must be on at all times of the day and night.

The most common designs for deer and elk exclusion are:

- 7 to 8 wire vertical power fence, and
- 7 wire slanted power fence.

Vertical Deer and Elk Fence Design:

Brace posts: Set 10-foot wooden posts every 100 feet, buried 4 feet in the ground

Line posts: Set 8-foot line posts along the wire at 33 feet intervals

**Specification MT382-A-8
Power Fence**

Deer and Elk: Height of wire from earth surface and charge: (+) hot and (-) ground wires

No. of Line Wires	Top	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th
7	72" (-)	60" (+)	48" (-)	36" (+)	26" (+)	16" (-)	8" (+)	
8	72" (-)	64" (+)	54" (-)	44" (+)	34" (+)	24" (-)	16" (+)	8" (+)

Slanted 7-Wire Deer Fence Design:

This fence is designed to protect high value crops. It is both a physical and psychological barrier to deer due to the three-dimension nature.

Deer: Spacing of wire from earth surface and charge: (+) hot and (-) ground wires

No. of Line Wires	Top	2 nd	3 rd	4 th	5 th	6 th	7 th
7	82" (+)	70" (-)	58" (+)	46" (-)	34" (+)	22" (-)	10" (+)

The fence design slants away from the crop side. Height of fence on deer side is 48 inches. Horizontal distance between top and bottom of line rails is 56 inches.

Line posts: 5 feet in length, buried 20 inches. Spaced 60 feet apart.

Line rails (slanted): 7 feet in length, spaced 30 feet apart.

Vertical Bear and/or Wolf Fence Design:

This type of fence is intended to protect lambing, calving, apiary (beehive) areas, and additional animal security areas from predation or harassment by bears and/or wolves. For additional construction requirements, refer to previous sections of this specification.

Energizer: Minimum 6,000 volts delivered to the fence.

H-Braces: Set minimum 10-foot long wooden posts located every 1,320 feet, buried 3 feet in the ground.

Line posts: Set minimum 8-foot long line posts along the wire at 20-foot intervals. If fiberglass line posts are used, minimum buried depth is 18 inches. If wooden line posts are used, minimum buried depth is 24 inches.

Bear and/or Wolf: Height of wire from earth surface and charge: (+) hot and (-) ground wires

No. of Line Wires	Top	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th
9	72" (+)	62" (-)	52" (+)	42" (-)	32" (+)	24" (-)	18" (+)	12" (-)	6" (+)