

**NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI CONSTRUCTION SPECIFICATION**

FENCE

(Electric Fence)

CODE 382

PERMANENT ELECTRIC FENCES

Permanent electric fences are constructed with the intent of being left in place for years. It is the equivalent of any standard non-electric permanent fence. Therefore, the criteria for permanent electric fence require materials, design, and construction that will last for many years with minimal maintenance.

A. Wire

Wire shall be a minimum of 12.5 gauge high tensile single strand or 16 gauge multi-strand braided cable, with a tensile strength of 110,000 PSI minimum breaking strength, with Type III galvanizing or be aluminum or copper clad or vinyl coated.

Barbed wire will not be used on electric fences because of safety hazard. Wires will be attached to line post by a method that allows them to slip. Wires will be attached to stays in a manner that prevents stay slippage along the fence. Splicing of high tensile wire will be accomplished by crimping sleeves, "figure eight knots", or "square knots" or "union splice". (See Attachment B).

Fastening of high tensile wire to end post will be accomplished using "thread through method" or crimping sleeves. (See Attachment B).

Tension of wires will be designed to maintain the proper average height of the fence wires and tightness to provide wire contact with animals. In-line wire tighteners (strainers) will be used to maintain tension on wires. In-line strainers will be used on each wire to obtain the correct tension. Strainers with tension springs are optional, but are helpful in maintaining proper tension and absorbing sudden shocks to the wire.

B. Number of wires and spacing.

The number of wires and spacing shall be designed to accomplish the desired result of the fence. Farm border fences must conform to Missouri State Fence Laws (See MU Extension Guide G810 – Missouri Fencing and Boundary Laws). Cross fences can be constructed of one or more wires, with the fence height being 2/3 of the shoulder height of the grazing animal.

Specifications for number of wires and wire spacing can be found on Table 1. When multiple wire systems are used, spacing of wires should be designed to insure facial shock when animal attempts to place head between wires.

Conservation practice specifications are reviewed and revised periodically. To obtain the current version of this specification, contact the Natural Resources Conservation Service or download the standard and specification from the electronic Field Office Technical Guide for Missouri.

**NRCS MOFOTG
September, 2008**

In instances where ground moisture is high an all positive charged fence will normally suffice. If experience shows that the soil on site will dry to the point of not causing a shock to the animal, then a combination of positive (+) and negative (-) wires should be used.

Specifications for containment fences should be used for perimeter fences, land use boundaries, livestock exclusion, and livestock containment and isolation areas (bull/stud/ram/buck pastures, weaning pastures, lanes, livestock quarantine pastures/lots). Specifications for deterrent fences should be used for most internal cross fences to facilitate grazing management.

C. Line Post and Offset Brackets.

1. Line post and stays:

See Table 3 for line post size, spacing and depth specifications.

Attach wire to fiberglass, composite, UV protected plastic or PVC posts with loose wire clips or by running wire through holes in post. Attach to stays (3/8" fiberglass, composite, or steel posts) with clips or appropriate insulators to hold wire in place.

All steel pipe used for posts (either corner or line) must be capped.

All wooden posts (except red cedar, Osage Orange/hedge, or black locust) shall be treated by a method to ensure that complete penetration of the sapwood is obtained. Quality of treated wood shall provide sufficient strength and last for the expected life of the fence. Pressure treatment shall conform to NEH 20 Materials Specifications 585. At least one half of the diameter of red cedar post shall be heartwood.

Charged wire shall be attached to wood posts by insulators. (See III. F Insulation) Steel posts may be used. They may be "T" or "U" post that are a minimum of 1.25 pounds per one foot of length. Charged wire must be attached with insulators. (See F. Insulation)

All wood posts will be at least 2 inches higher than the top wire of the fence to prevent splitting when attaching insulators. All posts of other materials shall be at least 1 inch higher than the top wire of the fence.

Spacing of line post and stays depends on terrain and number of wires. **See Table 3 for line post spacing specifications.** In undulating terrain, space posts and stays so that fence height is maintained. Posts in dips shall be constructed so that they will not pull out of the soil. Two inch or smaller posts will be anchored. Wooden posts (3 inch) set to sufficient depth to resist pull out. Stays shall be at least 3/8 inch in diameter steel, fiberglass, composite, or UV protected rigid plastic.

2. Offset Brackets:

Offset brackets made of galvanized high tensile spring wire with insulator of high density polyethylene with ultraviolet stabilizer or porcelain can be attached to standard barbed wire fence or woven wire fence to provide transmission line and/or to protect a standard fence.

Place Offset Brackets no further than 60 feet apart and attach to wires of standard fence next to post. If control of animals is desired, place Offset Brackets at 2/3 the height of the animals to be controlled. Insure that no wires of the old fence come in contact with the electric fence wire, as a short will occur.

3. Live trees as line, bracing and corner posts:

Live trees used for corner, bracing and line posts shall have a diameter breast height (DBH) equal to or greater than those prescribed for normal wooden posts. Some alignment variation shall be allowed, but caution should be taken to minimize offsets and prevent excess fencing needs. Wire or insulators will not be fastened directly to trees.

When using live trees, protection will be provided between the tree and wire or insulator. (CCA treated wood, red cedar, osage-orange, black locust, fiberglass or UV protected rigid plastic strip. Strips should be at least 3.5 inches wide and 6 inches in length placed 3" above top and 3" below bottom of wire to prevent splitting or cracking). A 3/8" x 8" eye or J screw may be fastened directly to the tree to the depth of the threads and then an end or corner insulator assembly attached to the eye or J screw.

D. Corners and Braces

Braces and end assemblies are required at all corners, gates and angles in the fence line. (See Attachment A for criteria on corners, angles, or brace assemblies.) **See Table 2 for corner gate and end post size, depth and bracing specifications.** All wood posts will be at least 2 inches higher than the top wire of the fence to prevent splitting when attaching insulators. All posts of other materials shall be at least 1-inch higher than the top wire of the fence. When posts are set in concrete, concrete should extend 6 inches from the outside of the post.

All steel pipe used for posts (either corner or line) must be capped.

E. Energizers

Electronic energizers or power fence controllers shall be installed according to the manufacturer's recommendations and will meet the following minimum specifications:

- High voltage, low impedance that can produce at least 5,000 volt peak output and a short pulse that is less than 300 mAmps in intensity, finished within 0.0003 of a second and a rate of 35 - 65 pulses per minute.
- High impact, weather resistant case.
- Solid state circuitry. Snap in service modules provide for fast field repair.
- Safety pace fuse, to prevent over-pulsing.
- 110-volt, 220-volt, or battery powered system capable of working 3 weeks. If the length of the fence requires an energizer of more than 4 joules, a solar charger will be needed on the battery systems.
- The accepted figures for minimum voltage on the fence for livestock control are: cattle - 1600v; sheep and hair goats - 2000v; hogs, horses and meat goats - 1200v. Vegetation loads and shorts will reduce the voltage on the fence, therefore the need for a higher voltage energizer.

Size - Rule of thumb, 1 output joule will power 1 – 4 miles of wire depending on the vegetation load on the fence with 3 miles per output joule being about average under normal loads. (Joules are units of electrical energy, one joule does about 0.74 ft.lb. of work. watts x seconds = joules.)

Consideration should be given to the area where the energizer is to be installed. Install in an area away from flammable materials.

1. Ground

All electric fences must be properly grounded. Follow manufacturer's written recommendations for grounding. In lieu of manufacturer's recommendations, bury 3 feet of ground rod for each joule of energy output with a minimum of 8 feet of ground rod buried.

Ground rods should be galvanized pipe or rod ½" diameter or larger. Drive ground rods where soil remains moist for best results. Drive sufficient 6 to 8 feet rods into the ground at least 10 feet apart to provide the required amount of ground rod. With adequate moisture and proper installation, four 8 foot ground rods are usually the maximum necessary.

Connect a continuous ground wire from the energizer to each rod or pipe with a galvanized steel, stainless steel or aluminum clamp. When running grounding wire through buildings use insulated wire to reduce fire hazard.

Copper rods with copper wire may be used if the energizer terminals are stainless steel or copper. If energizer terminals are not stainless steel or copper, do not use copper ground rods due to corrosion at the connection and subsequent loss of electrical continuity. Use copper clamps with copper wire and copper rods.

The ground wire(s) of the fence may be connected to the same ground as the energizer or a separate ground with the same size and depth requirement.

More ground rods may be needed for system to function properly. To test for adequate grounding, ground out the fence to 2000 volts or less by laying 3 to 6 steel posts on the fence 300 feet away from the charger. Attach one lead of a digital volt meter to the ground rod and push the other lead into the ground (soil) at least 2 feet away from the ground rod. If you get a reading above 300 volts then the existing grounding system is not adequate.

Do not use the grounding system for other existing applications, such as power poles, breaker boxes and milk barns.

At least 65 feet should separate the fence grounding system from any other grounding system. For safety precautions, the grounding system should be greater than 25 feet from well casings.

2. Lightning Protection

Lightning can cause damage to the energizer. Most energizers are poorly protected from lightning strike. External lightning arrestors and an induction loop (lightning choke) should be installed for added protection. If available, follow manufacturer's written recommendations for installing lightning protection. If not available use the following guidance.

Lightning arrestor grounding rods should be placed at least 65 feet from those of the energizer. (See Attachment B).

Use at least 1 more ground rod on the arrestor than was used on the energizer. Attach the lightning arrestor to the wires of the fence.

Install a lightning choke in the fence line immediately between the lightning arrestor and the energizer.

The lightning arrestor ground must be better than the energizer ground for it to function properly, because lightning will seek the least resistance route to ground.

3. Surge Protector

For protection of 120 or 240 volt energizers, a voltage surge protector will be installed between the energizer and power supply. Also, a ground rod should be installed at electric company's transformer pole (primary ground) and another ground rod installed at the electrical circuit breaker box (secondary ground), if they do not exist.

F. Insulation

Insulation used for positive charged wire(s) must be high density polyethylene with ultraviolet stabilizer or high density polypropylene with ultra-violet stabilizer. All underground wire(s) installations must be double insulated or equivalent thickness single wall, molded, aluminum, or high tensile strength steel 14 gauge or larger wire. The insulation must be high density polyethylene with ultraviolet stabilizer or high density polypropylene with ultra-violet stabilizer.

Insulators for steel and other conductive material posts must be high density polyethylene with ultra-violet stabilizer, high density polypropylene with ultra-violet stabilizer, or porcelain; that withstands 10,000 volts or more or current leakage.

Insulators for end, corner, and angle braces must be high density polyethylene with ultra-violet stabilizer, high density polypropylene with ultra-violet stabilizer, or porcelain; that withstands 10,000 volts or more or current leakage. Red insulators should not be used due to their attracting hummingbirds.

G. Insulated Cable

To cross gates and areas where electrical shocks to humans and livestock should be prevented (e.g. working facilities), use insulated galvanized wire.

For underground burial, use wire designed for burial. Placing buried cable inside plastic pipe helps to decrease the incidence of short-circuiting.

When overhead transmission is used height should be sufficient so as not to impede the movement of livestock or equipment.

Do not use insulated copper wire due to corrosion at the splice and lack of tensile strength.

H. Gates

Electrified gates may be constructed of a single straight wire, galvanized cable, polywire, polytape, or polyrope with a spring loaded insulated handle, or an expandable, coiled, high tensile, 12 1/2 gauge wire or bungie rope attached to an insulated handle.

The number of wires shall be determined by the fence objective.

The gate should be constructed so that it is non-electrified when the gate is open.

Over head or underground transmission lines will be used to carry electricity past the gate to the remainder of the fence.

I. Flood Gates

An electrified flood gate may be used in lieu of a non-electrified gate if desired. The electrified flood gate is constructed by stretching an electrified wire across the drainage above high water flow level. Attach droppers of 12 1/2 gauge high tensile fence wire, galvanized cable or galvanized chains to the electrified wire at a spacing of no more than 12" apart and 6-inches above average normal water level. Connect gate to electric fence with insulated cable through a cut-off switch

and flood gate controller. If flooding is expected to last some time, switch the flood gate off. (See Flood Gate drawing, Attachment C).

J. Other materials of equivalent strength, durability and appropriate design may also be used. Variance requests for materials and workmanship not included in this standard will be submitted to the NRCS State Office through proper channels.

TEMPORARY ELECTRIC FENCE

Temporary electric fence is constructed with the intent of being left in place for only a short time period. The fence is not constructed as an equivalent of a permanent fence. Therefore, the criteria for temporary fence requires materials, design, and construction that will accomplish the intended purpose and last for the time period planned with no more maintenance than desired.

The number of wires and spacing will be designed to accomplish the desired result of the fence. See Table 1 for number of wires and spacing. See Tables 2 and 3 for post specifications.

Temporary net fence is available for animals such as sheep, goats, hogs, and crowding areas.

A minimum of six strands of steel, copper, or aluminum wire should be woven into the poly-wire or poly-rope and a minimum of 5 conductive strands woven into poly-tape.

Temporary fences may be attached to permanent fences to further subdivide pastures.

Follow manufacturer's directions for construction, use, and operation.

OPERATION AND MAINTENANCE

Routine inspection of fences should be part of an on-going management program. Inspection of fences after storm events is needed to facilitate the function of the intended use of the fence.

Maintenance and repairs will be performed as needed to facilitate the intended operation of the installed fence.

Electric fences will be regularly checked to determine the voltage on the fence. If voltage is not sufficient, determine the cause and correct.

During dry weather, ground rods may need water applied to soil around them.

Maintain proper tension on the fence wires. Clear brush and other vegetation from fence lines to reduce voltage loss. Remove fallen limbs. Overhanging trees and limbs should be trimmed or removed as needed to prevent their falling onto the fence. During extended flooding periods, switch the flood gates off. Electrified flood gates must be maintained. Keep flood gates and fences clear of debris.

Table 1
Wire Height & Spacing

| Fence type | Livestock type | Purpose* | Min Number of Wires | Height of Top Wire | Suggested Wire Spacing** |
|--|----------------|-------------|--------------------------------|--------------------|----------------------------|
| Barbed Wire (12.5 gauge standard; 12.5 gauge, 2 strand, twisted, barbless; or 15.5 gauge high tensile) | Cattle | Containment | 4 | 48" | 12,12,12,12 |
| | | Deterrent | 4 | 48" | 12,12,12,12 |
| | Sheep/Goats | Containment | 6 | 48" | 6,6,6,8,10,12 |
| | | Deterrent | 5 | 36" | 6,6,6,8,10, |
| | Horses | Containment | 4 | 48" | 12,12,12,12 |
| | | Deterrent | 4 | 48" | 12,12,12,12 |
| | Hogs | Containment | 7 | 48" | 0,6,6,6,8,10,12 |
| | | Deterrent | 6 | 36" | 0,6,6,6,8,10 |
| Deer/Predator | Deterrent | 8 | 60" | 0,6,6,6,8,10,12,12 | |
| Woven wire (Conventional – top & bottom strands 12.5 gauge with 14.5 wire for intermediate strands with verticals every 4 – 12") (High tensile – all 12.5 gauge high tensile wire with verticals every 6 – 24") | Cattle | Containment | 39" woven + 1 barb or HTE** | 48" | 4(woven), 5 |
| | | | 32" woven + 2 barbs or HTE**** | 48" | 4(woven) 6,6 |
| | Sheep/Goats | Containment | 39" woven + 1 barb or HTE**** | 48" | 2(woven) 7 |
| | | | 36" woven + 2 barbs or HTE**** | 48" | 2(woven)2,8 |
| | | | 32" woven + 2 barbs or HTE**** | 48" | 2(woven)6,8 |
| | | Deterrent | 36" woven | 36" | 0-2 " |
| | | | 32" woven + 1 barb or HTE**** | 36" | 0 – 2"(woven) 4 |
| | Horses | Containment | 39" woven + 1 barb or HTE**** | 48" | 4(woven) 5 |
| | | Deterrent | 32" woven + 1 barb or HTE**** | 42" | 4(woven) 6 |
| | Hogs | Containment | 39" woven + 2 Barbs | 48" | 0,2(woven) 7 |
| | | Deterrent | 36" woven + 1 barb | 36" | 1 barb on ground + (woven) |
| | | | 32" woven + 2 barbs | 36" | 0,(woven),4 |
| | Deer/Predator | Deterrent | Woven + 4 barbs or HTE**** | 60" | 0,4 (39" woven) 2,7,8 |

**Table 1 - continued
Wire Height & Spacing**

| Fence type | Livestock type | Purpose* | Min Number of Wires | Height of Top Wire | Suggested Wire Spacing ** |
|--|--|-------------|---------------------|--------------------|---------------------------|
| Suspension (Barbed wire or High tensile smooth wire non-electrified or 16 gauge multi-strand braided cable) | Cattle | Containment | 5 barbed | 48" | 10,10,10,10,8 |
| | | | 6 HT*** smooth | 48" | 8,8,8,8,8,8 |
| | | Deterrent | 4 barbed | 42" | 10,10,10,12 |
| | | | 5 HT*** smooth | 42" | 8,8,8,8,10 |
| | Sheep/Goats | Containment | 7 barbed | 48" | 4,6,6,6,8,8,10 |
| | | Deterrent | 6 barbed | 36" | 4,6,6,6,6,8 |
| | Horses | Containment | 5 barbed | 48" | 10,10,10,10,8 |
| | | | 6 HT*** smooth | 48" | 8,8,8,8,8,8 |
| | | Deterrent | 4 barbed | 42" | 10,10,10,12 |
| | | | 5 HT*** smooth | 42" | 8,8,8,8,10 |
| Permanent Electric (12.5 gauge high tensile, 12.5 gauge vinyl coated, or 16 gauge multi-strand braided cable) | Cattle | Containment | 2 | 36 – 48" | 18 – 24", 18 – 24" |
| | | Deterrent | 1 | 26 – 36" | 26 – 36" |
| | Sheep/Goats | Containment | 5 | 38 - 40" | 6-8,6-8,8,8,8,8-10 |
| | | Deterrent | 3 | 30 - 32" | 8-10, 10, 10-12 |
| | Horses | Containment | 3 | 48" | 24,12,12 |
| | | Deterrent | 2 | 40 – 44" | 24, 16-18 |
| | Hogs | Containment | 3 | 18" | 6,6,6 |
| | | Deterrent | 1 | 12" | 12 |
| | Deer/Predator | Deterrent | 7 | 60" | 6,6,8,8,10,10,12 |
| | Temporary Electric (polywire, polyrope, polytape) | Cattle | Deterrent | 1 | 26 – 36" |
| Sheep/Goats | | Deterrent | 3 | 30 – 32" | 10,10,10-12 |
| Horses | | Deterrent | 2 | 40" | 24,16 |
| Hogs | | Deterrent | 2 | 12" | 6,12 |

*Containment fences should be used for perimeter fences, land use boundaries, livestock exclusion, and livestock containment and isolation areas (bull/stud/ram/buck pastures, weaning pastures, lanes, livestock quarantine pastures/lots) Deterrent fences should be used for most internal cross fences to facilitate grazing management.

**Inches between strands of wires; the first number represents distance from the ground to the first wire or bottom of the woven wire.

***HT – high tensile smooth wire, \geq 110,000 PSI tensile strength with Class 3 galvanizing

****HTE – high tensile smooth wire energized

**Table 2
Corner, Gate & End Post Size, Depth and Bracing**

| | Minimum Top Diameter | Depth/anchoring | Bracing |
|---|---|---|---|
| Standard Fences Barbed Wire Woven Wire | Wood – 5 “ | 30 - 36” or 24” set in concrete | H Brace, Angle brace, Floating angle brace |
| | Wood – 5” | 36” | Single post with deadman or scew-in anchor |
| | Wood – 6” | 36” set in concrete or driven 48” | None |
| | Steel Pipe – 2.5” | 30 – 36” or 24” set in concrete | H brace, Angle Brace, Floating angle brace |
| | Steel Pipe – 2 7/8” | 36” set in concrete | None |
| Suspension Fences | Same as for Standard Fences | Same as for Standard Fences | Same as for Standard Fences |
| Permanent Electric Fences 1 – 2 wire | Wood – 5” | Set to a depth \geq height of top wire or set in concrete 2’ deep | None |
| | Wood – 3.5” | Set 2’ in ground | H brace, angle, floating angle, knee, deadman |
| | 2 7/8” Steel pipe, 2.5” fiberglass, 2” composite | Set to a depth \geq height of top wire or | None |
| | Steel pipe, fiberglass, composite – 2” | Set in concrete 2’ deep | None |
| | Steel pipe, fiberglass, composite – 2” | Set 2’ in ground | H brace, angle brace, floating angle brace, knee brace, or anchor plate/deadman |
| | Steel pipe, fiberglass, composite – 1” | screw –in or driven ground anchoring | Angle brace |
| | Steel T or U posts | Set 2’ in ground | H brace, angle brace, floating angle brace, knee brace, deadman |
| 3 or more wires | Wood – 5” | 3’ Set in ground | H brace or floating angle brace |
| | Steel pipe, fiberglass, composite – 2” | Same as above | Same as above |
| | 6” wood or 2.5” steel pipe or 2” composite | Set in concrete 3’ deep or driven 4’ in soil | None |
| | Steel T or U posts | Same as above | H brace, angle brace, floating angle brace, |
| Temporary Electric Fences | 3/8” Fiberglass, composite, plastic, or steel rod | 6” | Angle brace as needed |

**Table 3
Line Post Size & Spacing**

| Fence Type | Type | Size | Depth | Maximum Spacing |
|---|--|--------------------------------|--------------------------------|--|
| Standard Fences Barbed Wire Woven Wire | Treated wood, cedar, black locust | 3" | 20" | 20' or 30' with 1 stay at 15' |
| | Bois D'arc/hedge | 2.5" | 20" | Same as above |
| | Steel T or U posts | 1.25 lbs. per foot | 16" | Same as above |
| | Steel pipe, fiberglass, composite | 1.25" | 16" | Same as above |
| Suspension | Same as for Standard Fences | Same as for Standard Fences | Same as for Standard Fences | 100' with stays spaced at 15' apart |
| Permanent Electric Fences 1 – 2 wire | Wood | 3" | 16" | 150' with stays at 50' intervals or 100' with no stays |
| | Australian iron wood | 2" | 16" | Same as above |
| | Fiberglass | 5/8" | 16" | Same as above |
| | Fiberglass T posts, PVC | 1" | 16" | Same as above |
| | Composite, Plastic | 1 1/8" | 12" | Same as above |
| | Steel T or U posts | 1.25 lbs./ft | 16" | Same as above |
| 3 or more wires | Same as for 1 – 2 wire | Same as for 1 – 2 wire | Same as for 1 -2 wire | 150' with stays at 50 ' intervals or 50' with no stays |
| Temporary Electric Fences | Fiberglass, composite, plastic, steel rod | 3/8" | 4" | 40 - 60' |