NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

382C - FENCE, ELECTRICAL

I. SCOPE

The work shall consist of furnishing materials and installation of an electrical fence at the location as shown on the drawings or as staked in the field.

II. TYPES OF ELECTRICAL FENCES

A. Permanent Fence

Permanent electric fences shall be High Tensile Wire (HTW) constructed with the intent of being in place for the life of the practice. Permanent fences will have a minimum of 1 strand of wire* (See Table 1). Electric fences provide a psychological deterrent rather than a physical barrier to live- stock and wildlife. To be effective, a shock of at least 1,000 volts must be delivered to cattle and horses, 4,000 volts to sheep, and 7,000 volts to deer, goats, dogs, and coyotes.

B. Temporary Fence

Temporary electric fence is constructed with the intent of being left in place for only a short period of time in areas where the confinement of livestock is not absolutely critical, for example, temporary paddock divisions or strip grazing. The fence is not a substitute or equivalent of permanent fence. The temporary fence requires materials, design, and construction that will accomplish the intended purpose and last for the planned time period with limited maintenance. (See Table 2)

Many companies market fence systems that use materials such as polyethylene wire, rope and tape with steel and aluminum wire woven within; aluminum wire; plastic and fiberglass posts; reels to roll up wire; and battery operated energizers that are high voltage and low impedance. A minimum of six strands of steel or aluminum should be woven into the polywire, polyrope or polytape. Temporary fences are often attached to permanent fences to subdivide pasture. Follow manufacturer's directions for construction, use, and operation of temporary electric fences.

III. MATERIALS

The materials shall be constructed to equal or exceed, in strength and durability in accordance with the following specifications:

A. Wire

Wire shall be a single strand of 12.5 gauge or larger with a minimum tensile strength of between 130,000 and 170,000 pounds per square inch (psi) galvanized (Type III) for steel wire. The wire may also be aluminum or copper and able to maintain the voltage of the equivalent galvanized high tensile wire. Wire will be attached to the posts by a method that allows wire to slip. Wires will be attached to stays in a manner that prevents stay slippage along the fence. Initially, tension wires to 200 lbs and adjust tension of each wire to maintain the wires at the appropriate height, as necessary. Wire heights and spacing are shown by intended use in Table 1.

Electric netting fence may be used when the situation requires.

Barbed wire will not be used on electric fences because it is a safety hazard.

B. Energizers

Electronic energizers of power fence controllers shall be installed according to manufacturer's recommendations. The energizers shall be high power, low impedance with appropriate peak voltage output a pulse that is less than 300 Amps in intensity, finished within 0.0003 of a second and at a rate of 35 – 65 pulses per minute. Energizers shall be provided with high impact weather resistant cases. Circuitry shall be solid state. Service modules shall be snap-in for fast field repair. A safety fuse to prevent over pulsing shall be provided. The system shall be 110 volt, 220 volt, or battery powered. In most cases battery operated energizer have a solar charger and in any case should be able to function for 3 weeks without substituting another battery. The energizer shall be capable of producing one joule for each mile of wire in the planned fence when average energy loss is expected.

C. Grounding

Proper grounding is a key to electric fencing success. The energizer ground wire should be connected to a galvanized pipe or rod ½ inch or larger in diameter. Bury 3 feet of ground rod for each joule of energy output. Ground rods should be buried where soil remains moist for best results. Ground rods should be driven into the ground at least 10 feet apart when multiple rods are necessary to provide the required length of ground rod. Normally, individual ground rods will be driven no more than 6 to 8 feet into the ground. Connect a continuous ground wire from the energizer to each ground rod with aluminum or galvanized steel clamp. 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. Copper rods with copper wire may be used if energizer terminals are stainless steel or copper. 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 to a separate ground with the same size and depth requirements. More ground rods may be needed for the system to function properly. Do not use the grounding system for other existing applications, such as power poles, breaker boxes and milk barns. At least 25 feet should separate the fence grounding system from any other grounding system.

Lightning can cause damage to the energizer. Most energizers are poorly protected from damage caused by lightning. External lightning arrestors and an induction loop (lightning choke) will be installed for added protection. Lightning arrestor grounding rods will be placed at least 65 feet from those of the energizer.

Install an additional set of ground rods and attach to a lightning arrestor. The lightning arrestor ground must be better than the energizer ground for it to function properly, because lightning will seek the path of least resistance to ground. 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.

For 120 or 240-volt energizers a voltage spike protector will be used to protect the energizer. Also, a ground rod should be installed at electric utility's transformer pole (primary ground) and another ground rod installed at the electrical circuit breaker box (secondary ground). Additionally, a surge protector should be installed between the energizer and power supply.

D. Insulation and Insulators

Insulation used for positive charged wire(s) must be high- density polyethylene with ultra-violet stabilizer or high- density polypropylene with ultra-violet stabilizer.

Insulators for conductive material posts, end, corner and angle braces shall be high-density polyethylene with ultra- violet stabilizer, high-density propylene with ultra-violet stabilizer, or porcelain. All insulators shall be capable of withstanding 10,000 volts or more of current leakage. Red insulators attract hummingbirds and should not be used.

E. Corners, Braces, and End Assemblies

Braces and end assemblies are required at all corners, gates, and angles in the fence line.

For multi-wire permanent electric HTW fences, corner, gate, end assemblies use one of the following:

- Steel "T" post that are a minimum of 1.33 pounds per foot of length, with appropriate knee, deadman, angle or H-brace.
- Wood posts with a minimum top diameter of 5.0 inches set two feet in the ground with appropriate knee, deadman, angle, or H-brace.
- Wood, steel pipe, with a minimum top diameter of 5 inches (wood) or 2 ½ inches (steel), set to a depth equal to, or greater than, the height of the post above the ground without bracing.

- Steel pipe with a minimum diameter of 2 ½ inches, set 2 feet in the ground with appropriate knee, angle, or H-brace, deadman or anchor plate.
- Steel pipe with a minimum diameter of 2 ½ inches and set in concrete to a depth of 2 feet.

For 3 or more wire power fences; corner, gate, end and brace assemblies will be either a floating angle brace or H-brace assembly. Brace assemblies will be 4 inch nominal wood, 4"x4" timber, or 2 ½ inch nominal steel pipe (capped), with appropriate appurtenances for corner and end bracing. Posts must be set a minimum of 2 feet in the ground.

All wood posts shall be at least 2 inches higher than the top wire of the fence. Posts of any other material shall be at least 1 inch higher than the top wire of the fence.

F. Line Posts and Stays

Line post and stays will be any of:

- Fiberglass, rigid plastic, composite insulated, or PVC solid round sucker rod of at least 5/8 inch diameter, or fiberglass "T" post and stays of at least 1 inch in cross-section (temporary fence only). Attach wire to the post with loose wire clips or run the wire through holes in the post. Attach the wire to stays with tight clips.
- Wood posts at least 3 inches in diameter of, pressure treated pine, red cedar, juniper, redwood or any other wood of equal life and strength may be used. At least one half of the diameter of the red cedar and redwood post shall be heartwood. Insulators shall attach wire.
- Steel "U" or "T" posts that are a minimum of 1.25 pounds per foot length. Wire shall be attached with insulators. Attaching wires on alternating sides of posts will reduce the number of insulators knocked off if a wire is knocked off the fence.

Posts for one or two wire fences shall be long enough to be set at least 18 inches in the ground, except that in soils which are sandy loam or coarser in texture, the posts shall be set at least 24 inches into the ground. Posts for 3 or more wire fences shall be set at least 24 inches into the ground. Posts in dips shall be constructed so that they do not pull out of the soil. Posts 2 inch or smaller shall be anchored. Wood posts shall be set to a depth sufficient to resist pull out.

Wood posts shall be at least 2 inches higher than the top wire on the fence. All other posts shall be at least 2 inches higher than the top wire of the fence.

Spacing of the line posts and stays depends on the terrain and the number of wires. Maximum spacing is as follows:

- One or two wire fences may have line posts spaced up to 100 feet apart with no stays. Line posts may be spaced 150 feet apart with stays every 50 feet between the posts.
- For three and four wire fences, the line posts may be spaced up to 50 feet with no stays or every 150 feet with stays at spacing of not more than every 50 feet.
- Fences with more than 4 wires shall have posts and stays spaced every 30 feet, with posts not further apart than every 90 feet.
- In undulating terrain, space posts and stays as needed to maintain the fence height.

G. Stays

Fiberglass stays of thermosetting reinforced composite consisting of marble fiberglass and high-polymer resins shall be used.

H. Gates

Electrified gates may be constructed of a single straight wire, galvanized cable, or polytape with an insulated spring loaded handle or other method and material that provides the same voltage for the gate and meets the objectives of the livestock producer. The number of wires shall be determined by the objective of the fence. The gate shall be constructed so that it is non-electrified when the gate is open.

Overhead or underground double insulated wires will be used to carry electricity past the gate to the remainder of the fence.
Use insulated galvanized wire for crossing gates and areas where electrical shocks to livestock and humans are undesirable.

All underground wires must be insulated for a minimum of 15,000 volts. Insulated underground wire should be specifically designed for high voltage electric fence. The insulation shall be high-density polyethylene with ultra-violet stabilizer or high-density polypropylene with ultra-violet stabilizer. Placing buried wire inside plastic pipe helps to decrease the likelihood of short circuiting.

Overhead transmission lines shall be at a height where the lines do not impede movement of livestock or equipment.

An electrified flood gate may be used in lieu of a non-electrified gate. The electrified floodgate should be constructed by stretching an electrified wire across the drainage above the high water level. Attach droppers of 12 ½ gauge high tensile fence wire, galvanized cable or galvanized chains to the electrified wire at a spacing of 6 inches for sheep and 12 inches for cattle. The droppers shall be extended to approximately 6 inches above normal water level. Connect gate to electric fence with a double insulated cable through a cutoff switch and flood control gate controller. If flooding is expected to last for an extended period of time, switch the floodgate off.

Panel gates, if used, shall be equivalent in quality to the fencing criteria contained in the Fence: Barbed and Woven Wire job sheet and shall be fitted with at least two hinges and a latch or galvanized chain for fastening.

IV. OTHER CONSIDERATIONS

Variations

Approve alternative fencing systems include several variations of special or non-conventional fencing systems that are acceptable when installed according to manufacturer's recommendations. Pre-approved variations from the above materials and specifications must be approved by the State Range Conservationist prior to the installation of the practice.

Alternative fencing and bracing systems must meet NRCS expected life span of the practice

V. INSTALLATION

The installation of the fence shall conform to the figures and to the drawings. All posts shall be placed to the required depth and shall be firmly embedded so that there is less than 1 inch at horizontal movement at the top of post when a horizontal force of 80 lbs is applied.

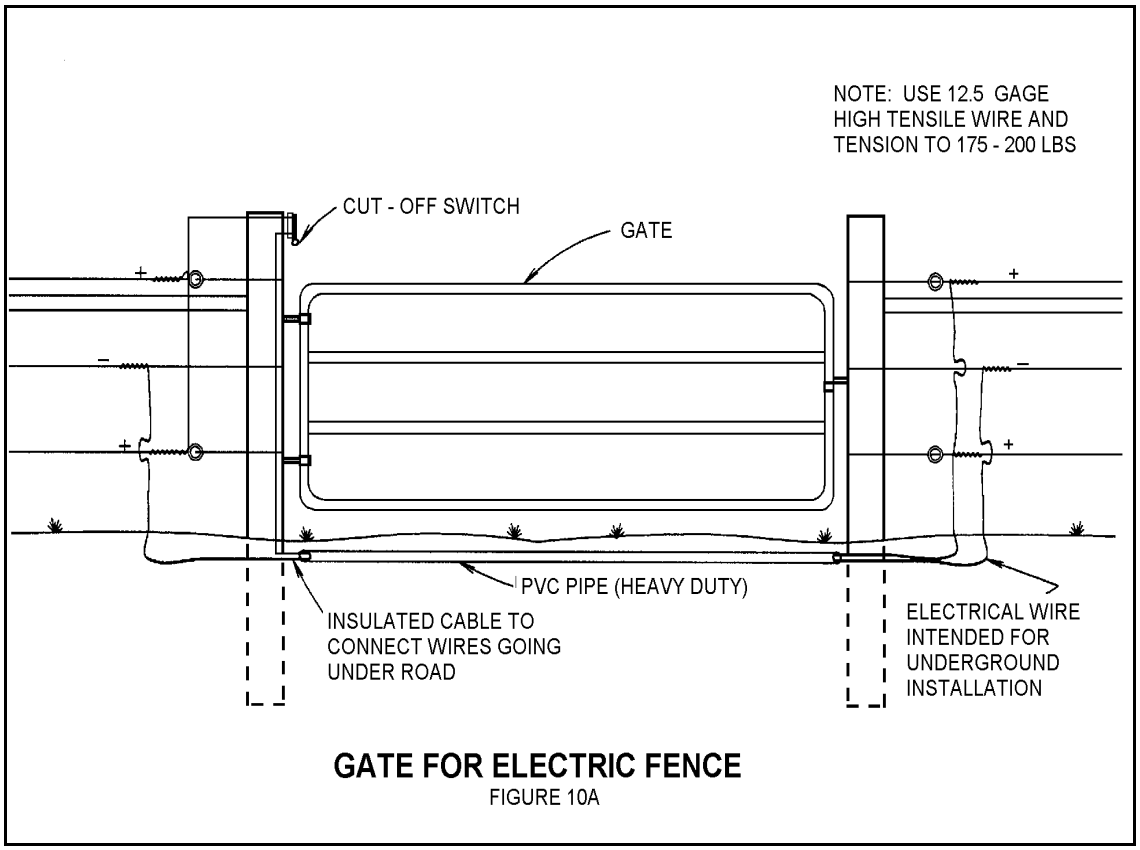
The completed job shall be workmanlike and present a good appearance. The installer and other persons will conduct all work in accordance with proper safety procedures.

VI. BASIS OF ACCEPTANCE

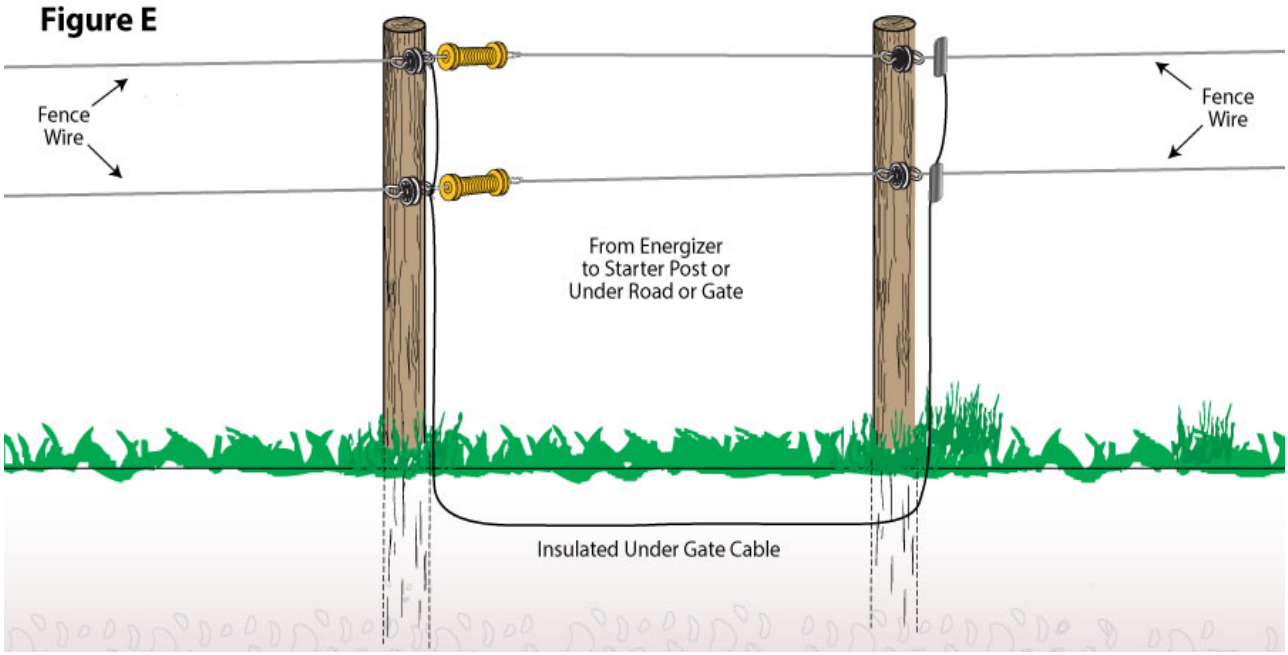
After the fence has been installed, a site inspection will be made to determine if the materials and placement adhered to the specification.

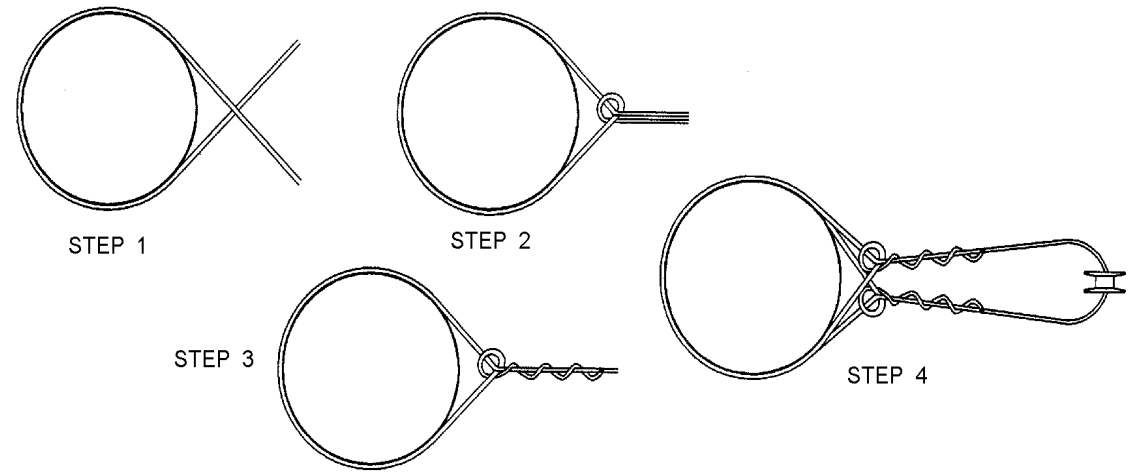
VII. OPERATION AND MAINTENANCE

A properly maintained fence is an asset to your property. This practice will require you to perform periodic maintenance. Some items to be observed and corrected are tension of wire or broken wires and post alignment and stability.

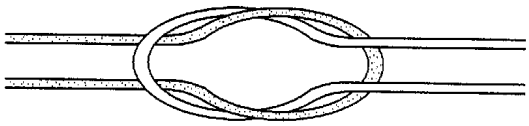


GATE FOR ELECTRIC FENCE
FIGURE 10A





WHEN TYING-OFF A GROUND WIRE AROUND A STRAINER POST WE SUGGEST YOU FOLLOW STEPS 1, 2, & 3. IF YOU ARE TYING-OFF A HOT WIRE, SIMPLY GO THROUGH STEPS 1, 2, & 3, THEN STRING AN INSULATOR ON THE TIE-WIRE, GO BACK AROUND THE STRAINER POST AND FOLLOW STEPS 1, 2, & 3 AGAIN AS ILLUSTRATED IN STEP 4. TIE-OFF FENCE WIRE AROUND THE INSULATOR BY FOLLOWING STEPS 1, 2, & 3.



SQUARE KNOT:
USED TO SPLICE WIRE TOGETHER

KNOTS
FIGURE 11.

Table 1 – Number of Wires and Wire Heights			
Fence Description	**Number of Wires**		**Wire Height (Inches)**
	Permanent	*Temporary*	
Cross Fences/Internal Fences			
Cow/Calf/Horse	1	1	30-34
Cow/Calf/Stocker/	2	1	22;32
Cow/Calf/Stocker	3	1	10;20;32
Sheep/Goats	3	2	8;20;32
Swine	1	1	12
Perimeter Fences			
Cattle/Horse/ (no predators)	5	N/A	6;12;18; 28;40
Sheep/Goats/ (predator resistant)	8	N/A	4;8;12; 18;24; 30;40;52
**** Generally, electric wire height should coincide with nose height of animals being fenced in or out. Additional wires help with grazing animals or other animals targeted such as young or predators.***			

Table 2 – Electric Netting Fence – Number of Wires and Wire Height				
Animal Type	**Horizontal Strands**	**Vertical Strings (Inches)**	**Wire Height (Inches)**	**Permanent Posts (Feet)**
Cow/Calf	10	6	48	12.5
Sheep	9	12	35	12.5
Goats	10	12	42	12.5
Swine	6	12	30	12.5
Poultry	12	3	42	12