# NATURAL RESOURCES CONSERVATION SERVICE
# CONSERVATION PRACTICE SPECIFICATION

## PERMANENT POWER FENCE
**(FEET)**
**CODE 382(e)**

## I. SCOPE

The work shall consist of furnishing electric fence materials and installing high-tensile smooth wire at the location(s) shown on the plan map and, if needed, on the drawings or as staked in the field.

Fencing includes brace assemblies, gates, cattle guards, and other components required to meet site conditions and achieve objectives for practice application.

## II. CONSIDERATIONS

Fence design will be adequate to control the animal(s) of concern, and must be suited to the landscapes over which it will be installed and shall be adapted to the physical environment of the site.

Because of the potential hazards to humans, power fence is most appropriate for use in areas not frequented by visitors.

Livestock must be trained to respect a power fence if it is to be effective, particularly if less than three line wires are used.

## III. SPECIFICATIONS

### MATERIALS

All power fencing that is accessible to the public or visitors shall have signs securely attached to the top wire at intervals of no more than 250-feet to warn people that the fence is charged.

All fencing materials will be new unless otherwise specified.

The materials used in construction must be in accordance with, and equal or exceed, in strength and durability, the following specifications:

#### WIRE

High-tensile smooth wire is preferable for use with power fences as it is easier to handle and there is no barb damage to animals.

Fencing materials shall conform to the requirements of American Society for Testing and Materials (ASTM) ASTM A854 for high-tensile wire.

When the size of steel wire is designated, the diameter shall be defined for U.S. Steel Wire Gage.

High-tensile, single strand, smooth wire shall be at least No. 12½-gauge, Class III galvanized or aluminum coated, steel wire.

For 2-wire power fencing, a minimum strand tensile strength of 135,000-psi is required.

For 3-wire (or more) power fencing, a minimum strand tensile strength of 170,000-psi is required

The American Society for Testing and Materials has graded metallic coated (galvanized), high tensile, steel fence wire as follows:

| GRADE | MINIMUM TENSILE STRENGTH* | MINIMUM BREAKING POINT** |
|---|---|---|
| 135 | 135,000 | 1,039 |
| 180 | 180,000 | 1,386 |
| 200 | 200,000 | 1,540 |
| 220 | 220,000 | 1,694 |

**pounds per square inch* (PSI)
***pounds of direct pull for No. 12½-gauge wire*

Wire connecting ground rods to the energizer and all underground wires shall be No. 12½-gauge, or larger, high-tensile steel wire having an insulating cover. Wire insulation shall be high density, polyethylene or polypropylene plastic, with ultraviolet stabilizer and capable of withstanding a minimum of 10,000 volts.

#### LINE POSTS

All line posts shall be of sufficient length to be driven at least 18-inches into the ground (24-inches deep in low-strength, sandy soils).

Above ground post length must be sufficient to allow for the required top wire height *plus* adequate space (normally about 3-inches) to firmly install wire fasteners, insulators, etc. Pre-drilled holes in posts (constructed of non-conducting material) allow situating the top wire closer to the top of a post.

Wooden in-line posts shall have a minimum 2-inch top diameter.

Wood posts need not be new material; however, all posts should be of the most durable wood type available (*i.e.*, cedar, eucalyptus, Australian ironwood, "insultimber", etc.).

**MATERIALS** (continued)

**LINE POSTS** (continued)

In accordance with Federal Specification TT-W-571C, pine posts treated with a creosote-coal tar solution with not less than 10-pounds retention per cubic-foot or pentachlorophenol, with not less than six-pounds retention per cubic foot, are acceptable.

Steel posts shall conform to the requirements of ASTM A702. Standard T-section steel posts, weighing not less than 1-pound per foot of length, may be used when high-quality plastic or ceramic insulators are installed. Steel posts are to be studded, embossed or punched for the attachment of wire insulators and have an anchor plate near the bottom of the post. Steel line posts shall be rolled from high carbon steel and have a protective coating. The coating may be either galvanizing by the hot dip process, or painted using one or more coats of high quality, weather resistant, paint or baked enamel.

Fiberglass posts are lighter than steel posts and withstand greater side-to-side stress. Polypropylene plastic posts have adequate strength but special clips are needed to attach wire to the posts. Fiberglass and plastic posts will not rot.

Fiberglass posts shall be a composite of marble, fiberglass, and polymer resins that have been treated by thermosetting (heat treatment).

"T"-shaped fiberglass posts shall be at least 1-inch in cross section with notches.

Round plastic posts should be at least 1-inch in diameter posts with notches on a 2-inch spacing.

**BRACE POSTS**

Wooden, upright, brace posts and anchor posts (pull posts) shall have a minimum top diameter of 6-inches.

Posts for brace units shall be of sufficient length to allow for the required top wire height *plus* 3-inches and to be set in the ground a minimum of 36-inches.

Wooden horizontal braces shall be a minimum of 6-feet in length and have a minimum diameter of 4-inches.

Unless otherwise specified, wood brace posts shall be of cedar, redwood, juniper, or other wood of equal life and strength. Pine posts treated in accordance with Federal Specification TT-W-571C shall be treated with a creosote-coal tar solution with not less than 10-pounds retention per cubic-foot or pentachlorophenol, with not less 6-pounds retention per cubic foot, are acceptable.

All metal corner, gate and in-line brace unit posts shall be new pipe or angle iron at least 6½-feet in length. Steel pipe shall have a minimum diameter of 4-inches and angle iron shall have sectional dimensions of at least 2½ x 2½ x ¼-inch. Horizontal or diagonal cross braces will be new or used pipe at least 2-inches in diameter or angle iron a minimum of 2 x 2 x ¼-inch in dimension. Steel horizontal or diagonal cross braces will be a minimum of 6-feet in length. Steel brace posts and horizontal braces shall conform to the requirements of ASTM A702 for steel posts and ASTM A53 for bracing pipes. Steel posts and braces shall be permanently capped and have a protective coating; either galvanizing by the hot dip process, or painted using one or more coats of high grade, weather resistant, paint or baked enamel.

**OTHER:** Alternative types of materials and designs may be used for fence construction if: (1) they meet or exceed NRCS fence specifications; and, (2) they are approved in advance by the State Resource Conservationist.

Locally accepted fencing materials and fence configurations not addressed in Nevada NRCS fence specifications should be incorporated into the Field Office Technical Guide with prior approval of the State Resource Conservationist.

**BRACING WIRE**

Brace wires (tension members or guy wires) shall be formed from two complete loops of No. 12½-gauge, high tensile, galvenized, wire or two complete loops of No. 9-gauge smooth wire.

Tension wires shall have a tensile strength not less than 58,000-psi and shall have a minimum of Class 2 zinc coating as specified in ASTM A641.

**STAYS**

Stays and stay fasteners shall conform to the requirements of the appropriate ASTM for the fencing material specified, unless otherwise specified.

Fiberglass stays of thermosetting (heat treated) reinforced composite material consisting of marble fiberglass and high-polymer resins shall be used.

Wooden stays that are specifically manufactured for use in permanent electric fence designs are also acceptable.

**MATERIALS** (continued)

**INSULATORS**

All metal posts and wooden brace posts require insulators. Wood line posts also require insulators unless specially fabricated posts are used which carry the manufacturer's recommendation that insulators are not needed.

Fiberglass posts do not require insulators.

Insulators of porcelain ceramic or high quality, high-density, polypropylene or polyethylene plastic, with ultra-violet (UV) stabilizer, capable of withstanding a minimum of 10,000 volts must be used on steel or conventional wooden posts. See Exhibits 2, 3, and 4.

**WIRE FASTENERS**

Fence fasteners or "clips" are to be galvanized and fastened to allow fence wire to slide past fiberglass (or specialty wood) line posts and stays.

An alternative to fasteners is to drill properly spaced holes in fiberglass (or specialty wood) posts. The holes should be sized so that wires are free to move when tightened.

**ENERGIZER AND COMPONENTS**

Electronic energizers or power fence controllers are to meet the following attributes/specifications:

- Energizer must have high output and low impedance.
- Energizer must have a minimum output of at least 4000-volts (4kv) with all fencing charged under maximum anticipated load.
- Pulse rate of 35 to 65 pulses per minute.
- Each pulse is completed within 300-microseconds, or less.
- High impact, self-insulating, and weather resistant, cases.
- Solid state circuitry.
- Safety pace fuse to prevent over-pulsing.
- 110-volt/220-volt systems must be ul listed.
- Battery powered systems must be capable of operating 3 weeks without recharge.

The effective power of an energizer is determined by the "joule" rating of the unit. Joules measure the total amount of stored energy released by the energizer during each pulse. The higher the joule rating of the energizer the greater the shock, and the better the fence performance.

In general, an energizer should supply 1-joule for every 6-miles of wire to be electrified.

For example, if 12-miles of electrified fence wires are installed (*i.e.*, 4-miles of fence running 3 "live", or "charged", wires), the energizer should have a rating of at least 2-joules.

Recommended joule ratings for energizers based on fence design:

| MINIMUM JOULE RATING | MILES OF ELECTRIFIED FENCE WIRE |
|---|---|
| 1 | 6 |
| 2 | 12 |
| 3 | 18 |
| 4 | 24 |

**FENCE GROUND SYSTEM**

Poor grounding is the most common cause of electric fence problems.

For an animal to receive a shock it must complete a circuit between the energizer by touching a "live" wire and simultaneously touching a fence ground wire leading back to the energizer; or, by touching a "live" wire while standing on mineral soil that can pass electrical current back to the energizer (through soil grounding rods).

Moist soil is a relatively good conductor of electricity and an electrical circuit can be established by installing a grounding system at the energizer location and running only "live" or "charged" line wires. Irrigated pastures usually do not require ground wires.

Dry soils are very poor conductors of electricity and have high resistance to electrical current. Electric fencing on dry, upland soils will not provide an effective shock to animals unless ground wires are included on the fence.

All grounding rods shall be galvanized steel rods ½-inch in diameter and a minimum of 6-feet in length.

If energizer terminals accept copper wire, then copper grounding rods, copper clamps and copper wire may be used in the energizer grounding system. Avoid mixing dissimilar metals to prevent electrolysis.

A lightning arrestor or lightning choke is recommended. The energizer manufacturer's requirements for lightening protection must be met or exceeded.

## CONSTRUCTION SPECIFICATIONS

### ALIGNMENT

Fences shall be reasonably straight and not deviate more than 12-inches from a straight line between corner and brace assemblies.

### FENCE HEIGHT AND WIRE SPACING

The number of line wires, fence height and wire spacing are determined by the kind and class of livestock to be controlled. The top line wire should be set no lower than two-thirds the shoulder height of the animals to be controlled.

*Permanent power fences will consist of at least two "*live*" or "*charged*' wires.*

The interval between line wires shall be set so that grazing animals will receive a facial shock if they attempt to extend their head through the constructed fencing.

Examples of fence heights and wire spacing (from the ground upward) for electric fencing to control different kinds of livestock under both wet and dry soil conditions are listed below. A charged or live wire is designated as **+** and a ground-return wire as **–**.

| WET SOIL/IRRIGATED PASTURE OR MEADOW | |
|---|---|
| **MATURE CATTLE WITH/WITHOUT CALVES - NO SHEEP** | |
| 2-wire Fence: | 18" (+) - 32" (+) |
| **SHEEP WITH/WITHOUT MATURE CATTLE AND CALVES** | |
| 4-wire Fence: | 8" (+) - 16" (+) - 24" (+) - 34" (+) |

| DRY SOILS/RANGELAND | |
|---|---|
| **MATURE CATTLE WITH CALVES - NO SHEEP** | |
| 3-wire Fence: | 12" (+) - 20" (–) - 32" (+) |
| 4-wire Fence: | 16" (–) - 22" (+) - 30" (–) - 36" (+) |
| **MATURE CATTLE WITH CALVES - SHEEP** | |
| 4-wire Fence: | 6" (–) - 13" (+) - 23" (–) - 36" (+) |
| **SHEEP** | |
| 5-wire Fence: | 6" (–) - 13" (+) - 21" (+) - 30" (–) - 40"" (+) |
| **DEER AND ELK** | |
| 9-wire Fence: | 8" (+) 16" (–) 24" (+) 32" (–) 40" (+) 50" (–) 60" (+) 72" (–) 84" (+) |

Where calf (or antelope, elk calf or deer fawn) movement is to be allowed for, the bottom line wire should be a ground wire with subsequent wires alternately charged. A 20-inch ground clearance is recommended for the bottom line wire when it is charged and free antelope or calf movement is desired. To accommodate passage of mature elk and deer, maximum fence height is 42-inches (40-inches is preferable) and the top line wire should be a ground wire. A "live" or charged top line wire can be encased within small diameter plastic pipe encouraging continued passage over a fence section having high deer or elk traffic while the remaining fence line is left with an exposed "live" top wire.

### LINE POST

Line posts serve simply to maintain the spacing between wires and to set fence height.

Wooden line posts shall be set solidly in the ground a minimum depth of 30-inches.

Wooden line posts can be driven.

Where post holes are dug for installing fence posts, the holes shall be at least 6-inches larger than the diameter or side dimension of the posts.

Post holes shall be back-filled with soil unless otherwise specified. Earth backfill around posts shall be thoroughly tamped in layers not thicker than 4-inches and shall completely fill the post hole up to the ground surface.

Steel or fiberglass line posts shall be driven solidly into the ground a minimum depth of 18-inches. For very loose, sandy soils, set posts 24-inches deep

**LINE POST SPACING** is the same for all line post materials (fiberglass, metal, wood, etc.): Line post intervals shall be as follows:

- Spacing of line posts for a 2-wire cross fence will not exceed 100-feet with or without stays.
- Spacing of line posts for a 3-wire (or more) fence will not exceed 100-feet without stays.
- Spacing of line posts for a three (or more) wire fence may be to 150-feet where two or more stays are evenly spaced between posts.

### LINE WIRE INSTALLATION

Fence line wires shall be stretched and attached to posts as follows:

- The fencing wire shall be placed on the side of the post expected to receive the greatest pressure.
- Where fencing is installed to protect a specific area, wire shall be placed opposite the area being protected.
- Each strand of wire shall be attached to each post.
- The top line wire shall be set so that fence posts extend a minimum of 3-inches above the wire unless specially fabricated posts that allow a more narrow spacing are installed.
- The fencing wire shall be fastened to line posts by means of wire insulators manufactured for this purpose. See Exhibits 2, 3, and 4.
- Line wires must be free to move back and forth through wire fasteners.
- All live wires and all ground wires shall be joined to themselves with a continuous jumper wire. These connections shall be made near the start and end of each line wire, and at gate posts. Jumper wires are to be insulated from each other. See Exhibit 4.
- All line wires shall be dead-ended at the anchor post (pull post) of gate, corner, and in-line brace assemblies. See Exhibits 3 and 4.

**CONSTRUCTION SPECIFICATIONS** (continued)

**FENCE WIRE TENSION**

As with non-electric fence, fence wires should be tensioned working from the top wire down.

Each line wire strand is stretched taut to over 200-pounds of tension per strand of wire depending on wire grade.

A tension indicator spring can be installed on one line wire and remaining wires tightened, according to feel, to same tension as the wire strand with the indicator spring.

In-line or end-post ratchet strainer devices shall be installed on each line wire to maintain correct tension between all brace assemblies. See Exhibit 5.

- On short fence runs (less than 600-feet), in-line wire strainers (ratchet wire tighteners) shall be attached to one end of each line wire where it terminates at the brace post location.
- On long, straight, fence runs over 600-feet in length, wire tighteners should be located at the center point (friction center) between fence line ends.

**GROUND SYSTEM**

All electric fences must be grounded. See Exhibit 1.

The energizer shall be grounded to a minimum of four galvanized steel or copper rods, ½-inch in diameter and a minimum of 6-feet in length, driven 5½-feet into the ground near the energizer and spaced at 10-foot intervals. The energizer shall be connected to each of the grounding rods with one continuous line of No. 12½-gauge insulated wire attached with ground rod clamps.

The energizer grounding system must be set at least 35-feet away from ground rods of any other electrical circuit.

When possible, locate energizer ground rods in areas of water accumulation where the soil is always moist.

Ground wires in the fence must also be connected to a ground rod. The ground wire attached to the fence may be located anywhere along the fence that a 6-foot depth can be obtained for driving the grounding rod.

Ground wires along the fence line should be connected to ground posts;

- every 3000-feet in wet soil conditions, and
- every 1500-feet in dry soil conditions.

Additional grounding is required for large energizer systems (14-joules or more).

An additional set of four ground rods (6-foot in length and ½-inch in diameter) for arresting lightening are required to be installed not closer than 65-feet from the ground rods set at the energizer.

A lightning choke (lightning diverter) should also be installed.

**STAYS**

When required, stays shall be evenly spaced between line posts to ensure that the proper interval between line wire strands is maintained.

**SPLICING**

Proper wire splicing is critical to insure both adequate contact and minimum damage to wire coating.

When splicing line wires, the "Figure-8" knot or suitable splice sleeves applied with a tool designed for that purpose shall be used.

The "Figure-8" knot shall have no less than four (4) wraps of each end about the other. All wraps shall be tightly wound and closely spaced. See Exhibit 4.

Splices made with splice sleeves shall have a tensile strength no less than 80 percent of the strength of the wire being spliced.

**CORNER, BRACE AND GATE POSTS**

Braces are required at all corners, gates, and at all definite slope breaks and changes in alignment to the line fence.

- In straight sections on moderate terrain, in-line brace units are required at intervals not to exceed 4000 feet (250 rods).
- Corner brace assemblies shall be installed at all points where the fence alignment changes 15-degrees or more. Brace units are required at the beginning and end of each curved fence section.
- Brace units are required at any point where the vertical angle described by two adjacent reaches of wire is upward and exceeds 10-degrees.

All wooden corner, gate, and in-line brace unit posts shall be set a minimum of 4-feet in the ground - the deeper a post is set, the stronger it will be.

Anchor posts (pull-posts) shall be set with a I to 2-inch lean away from the direction of fence pull.

Wooden brace posts can be driven.

If post holes are dug for installing fence posts, the holes shall be at least 6-inches larger than the diameter or side dimension of the posts. Post holes are to be back-filled with soil or concrete. Earth backfill around posts shall be thoroughly tamped in layers not thicker than 4-inches and shall completely fill the post hole up to the ground surface. Concrete backfill around posts shall be rodded into place in layers not thicker than 12-inches and shall completely fill the post hole to the surface of the ground. Backfill, either soil or concrete, shall be crowned-up around posts at the ground surface. No stress shall be applied to posts set in concrete for a period of not less than 24-hours following the development of a firm set of the concrete.

**CONSTRUCTION SPECIFICATIONS** (continued)

**CORNER, BRACE AND GATE POSTS** (continued)

Wooden, horizontal, brace members (compression braces) shall be notched into the top part of the brace post and post being braced, at a location between the top two line wires. Steel dowels can be used, rather than notching, to attach a horizontal brace between the anchor post and brace post.

The elevated end of diagonal brace members shall be notched into post being braced at a location sited between the top two line wires.

**BRACING WIRE**

Brace wiring (tension member) shall consist of two (2) wire strands that extend from a point approximately 6-inches below the top of the brace post to about 4-inches above the ground level of the post being braced (anchor post or pull post). The brace wires should be double wrapped around each post, stapled, and spliced together.

**GATES AND OTHER FENCE COMPONENTS**

Live or charged line wires are best routed under a gateway using insulated wire, rather than overhead. Grounded line wires should also be directed under the gateway. Line wires strung over a gateway are susceptible to wind and vehicle damage. See Exhibits 6, 7, and 8.

Materials used in gate construction shall conform to the kinds, grades, and sizes specified for a new fence, and shall include the necessary fittings.

Panel gate fittings shall not be of a lesser quality than the gate manufacturer's standard.

Also see practice specifications for Let-Down Fencing, Water Gaps, Cattle Guards, and Other Fence Components, Practice Code 382(h).

## IV. INSTALLATION

Installation of the fence shall conform to the specifications and exhibits or other drawings, as provided.

All posts shall be placed to the required depth and shall be firmly embedded so that there is less than 1-inch of horizontal movement at the top of post when a horizontal force of 80-pounds 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.

## V. BASIS OF ACCEPTANCE

After the fence has been installed, a site inspection will be made to determine if fence construction, and the materials used, meet practice specification requirements.

## VI. MAINTENANCE

This practice will require the performance of periodic maintenance.

Volt meters, used to determine voltage on line wires, are desirable for monitoring electrical systems.

Fence maintenance items to be alert to and corrected include:

- disconnected ground wires
- short across wires
- broken insulators
- deteriorated ground rods
- wire tension
- broken wires
- wire corrosion
- ground rod clamps loose
- electrical terminals corroded
- shorting due to vegetation
- pulled clips
- bent steel posts
- bent or broken stays
- post alignment
- post stability
- sagging gates

## REFERENCES

The following references provide excellent guidance for fence construction, selection of fencing materials, and the installation of fence components:

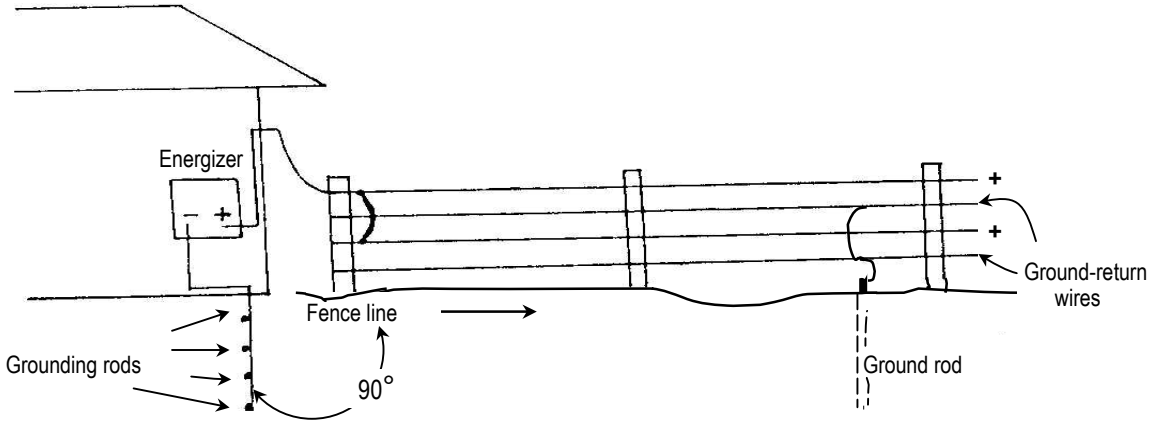
Gallager Power Fence Systems. Gallagher Power Fence Manual. San Antonio, Texas.

Selders, A. W. et al. High Tensile Wire Fencing. Northeast Regional Agricultural Engineering Service, Ithaca, NY. September 1987.

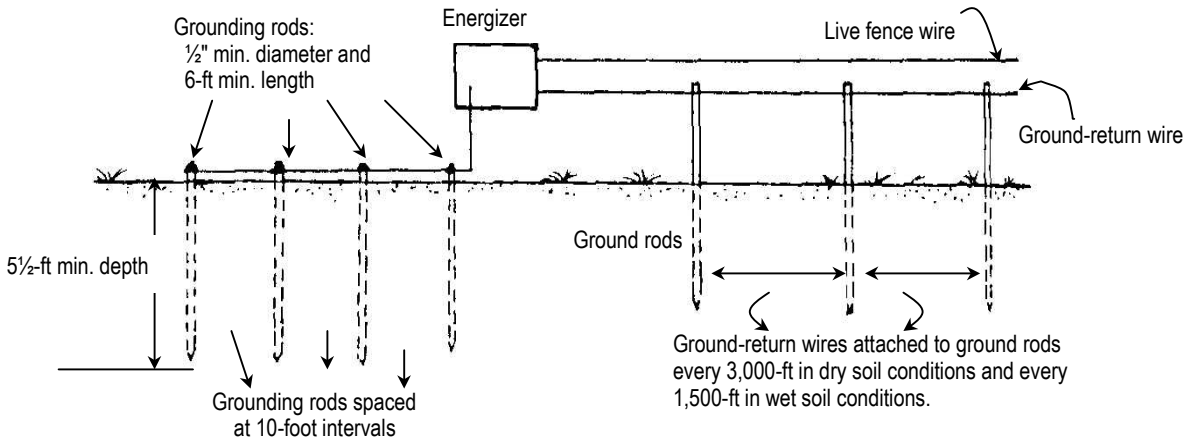
Turner, H.J. ed Planning Fences. American Association for Vocational Instructional Materials. Winterville, GA. June 1997.

USDI Bureau of Land Management and USDA Forest Service. Fencing. 2400-Range 8824 2803. July 1988.

# EXHIBIT 1

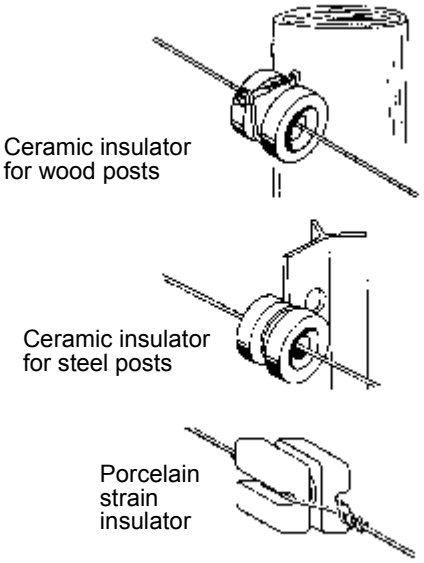



## GROUNDING AN ELECTRIC FENCE




**USDI/USFS 2400-Range 8824 2803 (1988)**

# EXHIBIT 2




**Porcelain Insulators**

**INSULATORS**

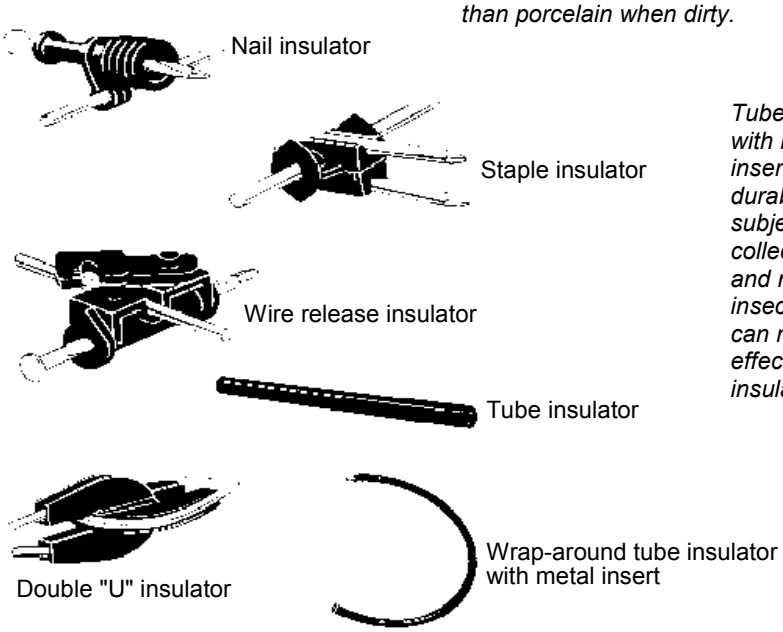
Insulators are constructed of either porcelain or plastic and may be attached to posts by wire clips, nails, staples, or wrap-around tubes. Both porcelain and plastic will deteriorate under extreme climatic conditions.

Insulators should be designed to withstand ultraviolet light and support up to 2,200-pounds of strain.

*Porcelain insulators are strong, durable, and resist damage by fire. Porcelain insulators are also very reliable in high strain positions at wire ends and corners. Porcelain insulators are susceptible to frost damage and may develop fine cracks in the glaze.*

*Black plastic insulators resist breakdown under ultraviolet light but are less efficient insulators than porcelain when dirty.*

**Plastic Insulators**

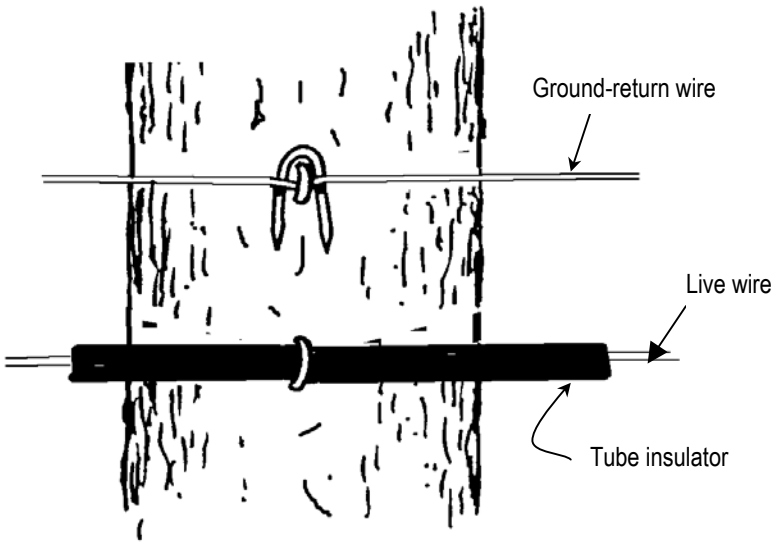



*Tube insulators with metal inserts are durable although subject to the collection of dirt and nesting insects which can reduce effectiveness of insulation.*

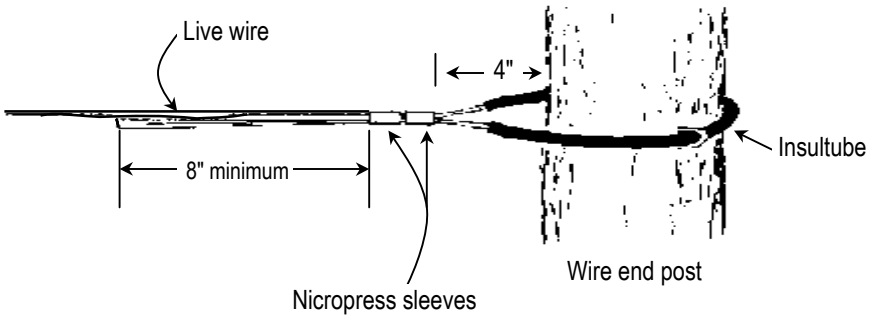
## ELECTRIC FENCE INSULATORS

**USDI/USFS 2400-Range 8824 2803 (1988)**

# EXHIBIT 3




**INSULTUBE WIRE INSULATION**



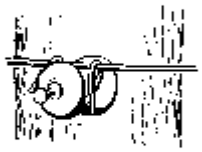

**WIRE END TIE-OFF**

**USDI/USFS 2400-Range 8824 2803 (1988)**

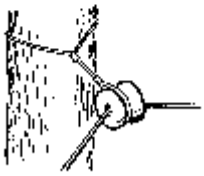
## ELECTRIC FENCE INSULATORS

# EXHIBIT 4

Typical plastic insulator for wood post



Porcelain insulator on wood line post



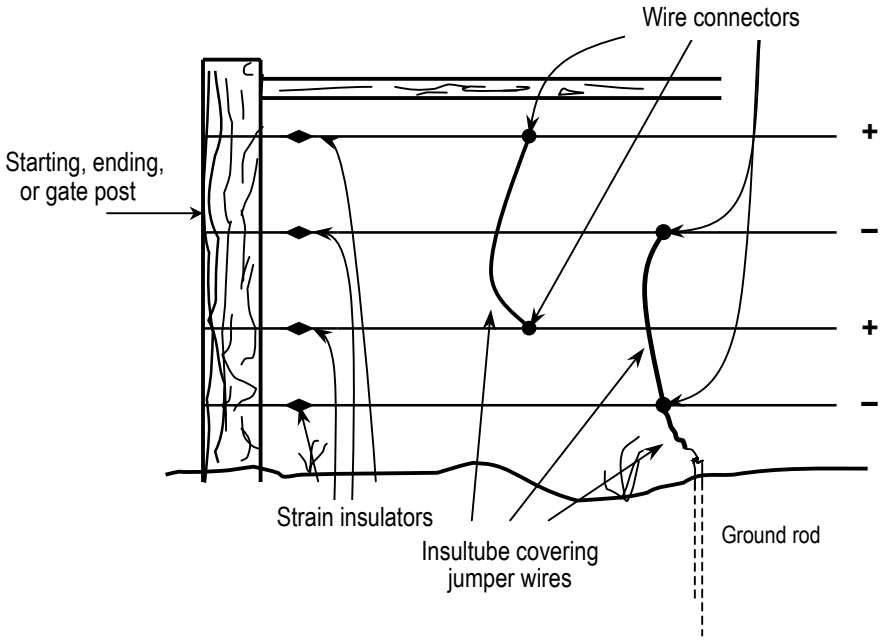
Porcelain insulator installed on wood corner post




**LINE WIRE SPLICING**

High-tensile wires on electric fence can be spliced as shown above. Knots give only about 75 percent of the wire strength. Once a wire is spiced, it is impossible to slide insulators or sleeves past the splice.

**USDI/USFS 2400-Range 8824 2803 (1988)**




**LINE WIRE ELECTRICAL CONNECTIONS**

All live wires and ground wires on electric fences are joined to themselves with a continuous jumper wire. These connections are made near each starting, ending, or gate post. Insultube may be used to insulate the wires from each other.

On long fence lines, live and ground-return wires are joined to themselves with insulated jumper wies at intervals not exceeding 1 mile.

If the fence consists of all live wires, one continuous jumper wire is installed at intervals not exceeding one mile.

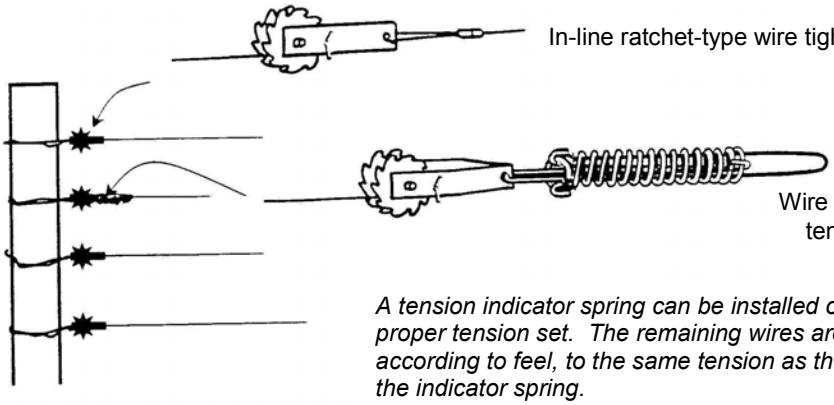
Jumper wires are connected to the line wires with a nicropress sleeve or other suitable type of wire connector.

## ELECTRIC FENCE

# EXHIBIT 5

### Measuring Wire Tension

Several wire tensioning tools are available, including tension indicator springs that measure wire tension or that allow tensioning line wires to a preset number of pounds.



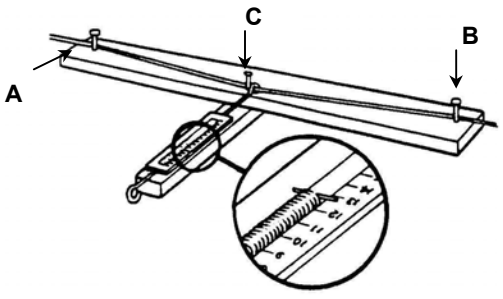

*A tension indicator spring can be installed on one line wire and proper tension set. The remaining wires are then tightened, according to feel, to the same tension as the wire strand with the indicator spring.*

A simple device can also be fabricated that adequately measures wire tension. On a straight piece of 1-inch x 4-inch board that is 44-inches long, drive two cup hooks (or nails) 40-inches apart and one-inch down from the top of the board (points A and B in the drawing below). Drive a nail ½-inch below the center point of the straight line from point A to B (this is point C in the figure below). Place a fence line wire on the cup hooks (or nails) at points A and B. Attach a spring scale to the center of the line wire and pull the scale until the wire touches the nail at point C. Read the number of pounds needed to pull the wire to point C and multiply by 20 to determine pounds of line tension.

For example, a pull of 12½-pounds times 20 equals a tension of 250 pounds on the line wire.

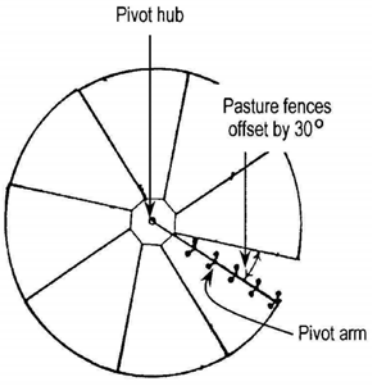
Construction of this simple tension meter is based on the general formula for static wire tension:

$$\text{Tension (pounds)} = \frac{\text{Length (inches)} \times \text{Balance Scale Reading (pounds)}}{4 \times \text{Vertical Displacement (inches}}$$

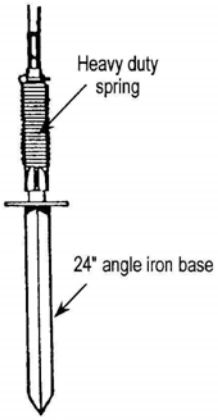



**after Sanderson et al (1990) and USDI/USFS 2400-Range 8824 2803 (1988)**

# EXHIBIT 6




**Pasture design for center pivot irrigation system**

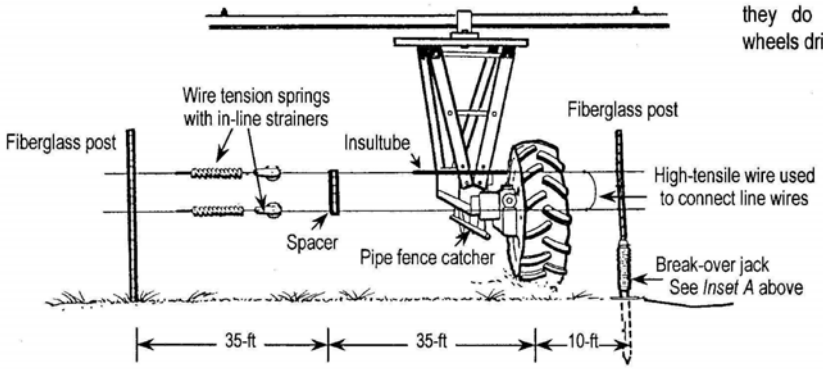


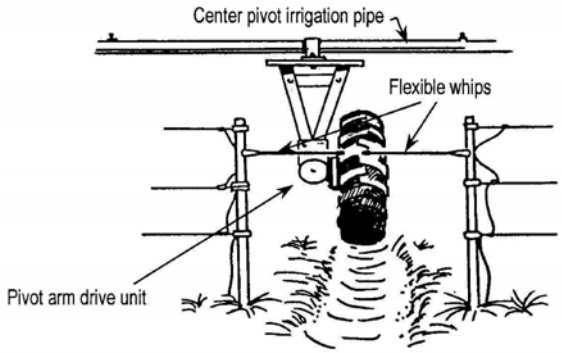

***Inset A***
***Break-over jack***

**BREAK-OVER FENCE FOR CENTER PIVOT IRRIGATION**

The break-over fence allows the pivot arm to drive over pasture fencing rather than travel through openings in the fence line. The fence line must be offset 30-degrees (or more) so that no more than two drive units of the pivot arm are on the fence line at one time. Break-over jacks are placed 10 to 20-feet away from cross-over points of the pivot drive units. Pivot towers that are space more than 130-feet apart require a 48-inch fiberglass line post in the middle of the fence span. Tension springs are needed on each line wire to provide the necessary stretch as the fence is forced down by the pivot arm dive units. At each cross-ver point, a short piece of high-tensile wire is needed to connect the wire strands so they do not become separated by wheels driving over them.

**PIVOT IRRIGATION BREAK-OVER FENCE**




**Gate for pivot irrigation system**

**USDI/USFS 2400-Range 8824 2803 (1988)**

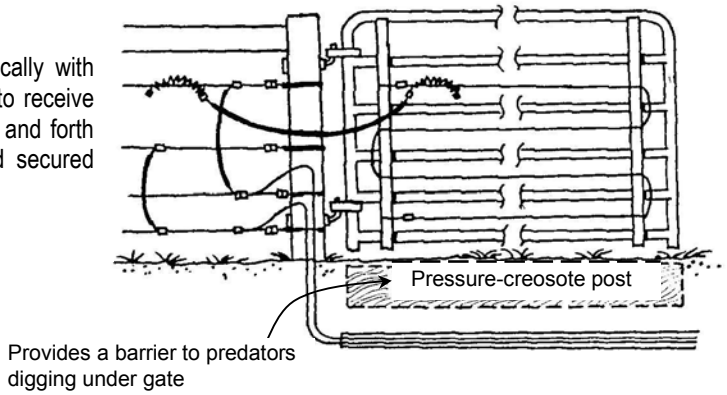
**CENTER PIVOT BREAK-THROUGH GATE**

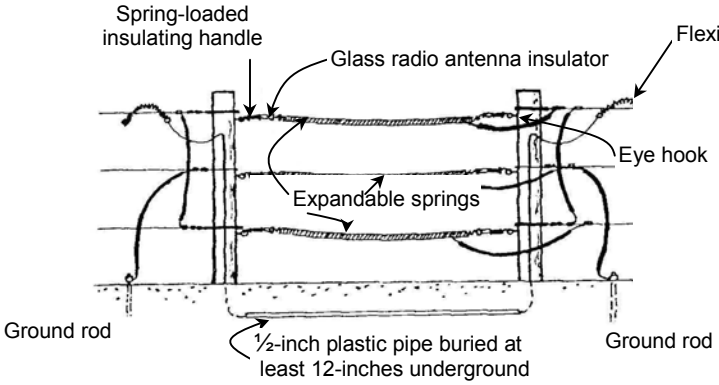
This type of gate provides an opening for the pivot arm drive units to pass through pasture division fences. The break-through gate has flexible whips attached to posts on either side of the gate area that extend into the middle of the gate opening.

**ELECTRIC FENCE CROSSINGS FOR CENTER PIVOT IRRIGATION SYSTEMS**

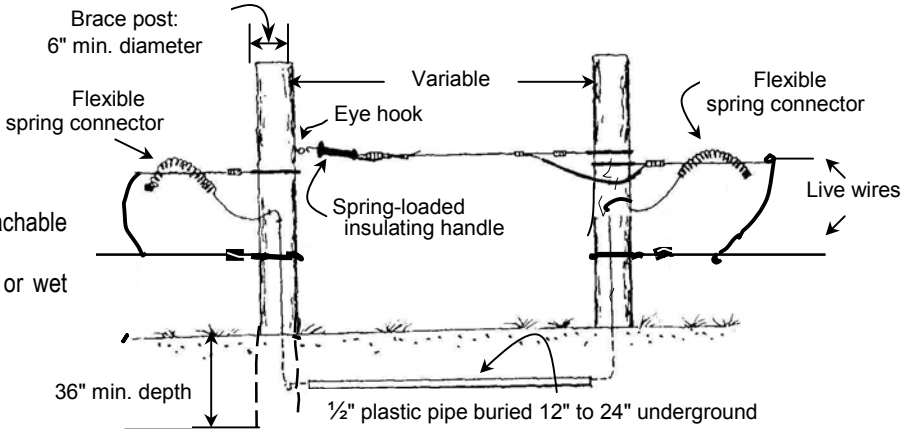
# EXHIBIT 7

**ELECTRIFIED CONVENTIONAL GATE**
Nonconductive stays are attached vertically with galvanized U-bolts on the side of gate to receive pressure. High tensile wire is run back and forth between stays from top to bottom and secured with wire stays.




**EXPANDABLE SPRING GATE**
This is a highly visible electric gate. One or more springs are used, depending on type of livestock being fenced.

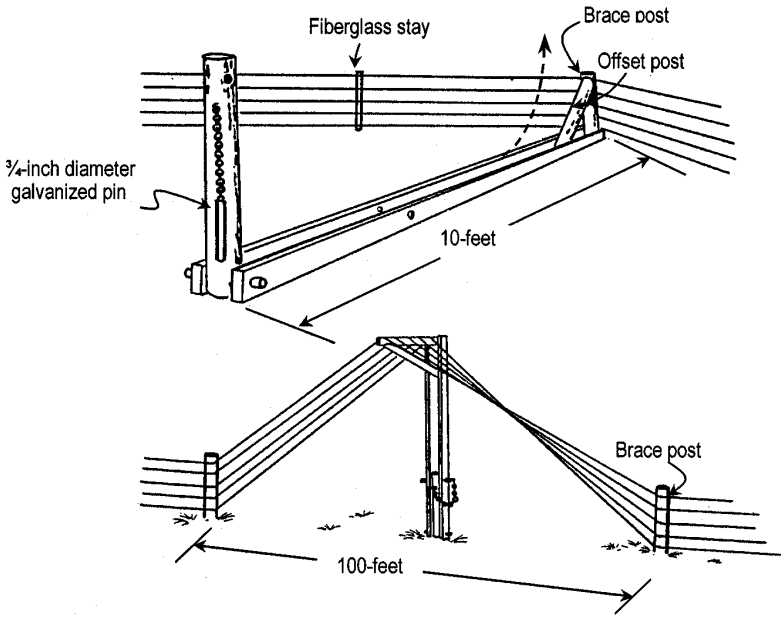



**ONE WIRE GATE** with detachable electrified wire.
Suitable only for irrigated or wet soils.

**USDI/USFS 2400-Range 8824 2803 (1988)**

## ELECTRIC FENCING GATES

# EXHIBIT 8




**"LIFT" or "AUSTRALIAN" GATE**

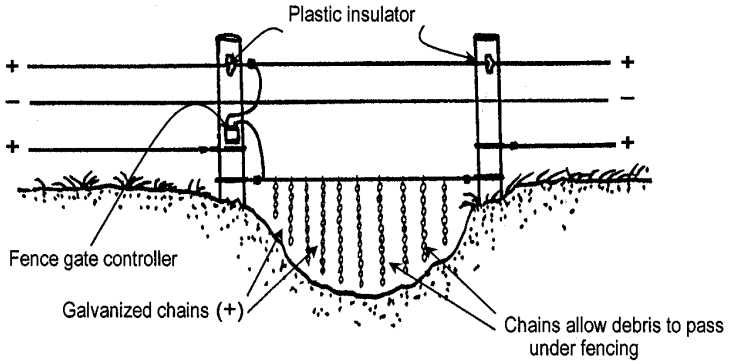
An offset lift mechanism consisting of: 2-each pressure-creosote planks 10-feet long x 4-inch wide x 1½-inch thick; 1-each 8-foot x 4-inch post set 48-inches in earth; and, 2-each 4-foot x 4-inch posts that comprise the offset post and brace. All gate members are fastened with ¾-inch galvanized bolts and a removable ¾-inch galvanized pin to hold the unit upright.

Gate should be considered practical only for fence with 6 wires or less and with only occasional use when moving from one pasture to an adjacent field.

**USDI/USFS 2400-Range 8824 2803 (1988)**

**ELECTRIC FLOOD GATE**

Example of electric high-tensile wire fencing to cross small streams or "swales".




**ELECTRIC FENCE SPECIALTY GATES**