

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

**FENCE
(feet)
Code 382**

DEFINITION

A constructed barrier to livestock, wildlife, or people.

PURPOSES

This practice may be applied as part of a conservation management system to facilitate the application of conservation practices that treat the soil, water, air, plant, animal, and human resource concerns, to include:

- Exclude livestock from areas that should be protected from grazing.
- Confine livestock or big game to an area.
- Subdivide grazing land to permit use of managed grazing systems.

CONDITIONS WHERE PRACTICE APPLIES

This practice may be applied on any area where livestock and/or wildlife control is needed, or where access to people is to be regulated. Fences are not needed where natural barriers will serve the purpose.

This standard applies to permanent fences and does not apply to temporary fences.

CRITERIA

General Criteria Applicable for all the Purposes Stated Above.

1. STANDARD FENCE

A. Barbed Wire

Barbed wire fences shall have a minimum of four wires (three wires for the portion of the fence within a floodplain of a major watercourse).

- The top wire shall be not more than 48 inches above the ground, and shall be at least 4 inches from the top of the post.
- The second wire shall be from 10-12 inches from the top wire.

- The third wire shall be from 10-12 inches from the second wire.
- The bottom wire shall be from 12-16 inches above the ground surface, but not more than 12 inches from the third wire.

All material used shall be new and have a minimum life expectancy of 20 years.

Refer to Table 382-1 for minimum wire gauge and coatings.

Barbed wire shall be two twisted strands of 12 1/2 gauge wire or high tensile 15 1/2 gauge. Barbs shall be spaced no more than 5 inches apart and shall be of 14 gauge or heavier wire with at least two points.

B. Woven Wire

Fences constructed with woven wire 32 inches or less in height shall have at least two barbed wires or high tensile wires above the woven wire. The first wire shall not be more than 4 inches above the woven wire, and the second wire shall not be more than 8 inches above the first wire, and must be at least 4 inches below the top of the post.

Fences constructed with woven wire greater than 32 inches in height must have at least one barbed wire or high tensile wire, not more than 4 inches above the woven wire, and must be at least 4 inches below the top of the post.

The base of the woven wire shall be placed near the ground surface.

All material used shall have a minimum life expectancy of 20 years. Refer to Table 382-1 for minimum wire gauge and coatings.

The top and bottom of standard strength woven wire shall be 11 gauge, or heavier, and the line and stay wires shall be 14 1/2 gauge or heavier. High tensile woven wire shall be 12 1/2 gauge

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Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

C. Staples and Wire Fasteners

Fence wires will be stretched to sufficient tension prior to being fastened to the posts. Staples shall be 9 gauge steel wire with a minimum length of 1 1/2 inches for soft woods, and a minimum length of 1 inch for close grained hardwoods. Drive staples diagonally to the wood grain at a slight downward angle (upward if the pull is up) to avoid splitting the post.

Space shall be left between the post and the staple to permit free movement of the wire and to avoid damage to the zinc coating of the wire.

Wires may be attached to steel posts by use of clips supplied by the manufacturer of the posts. When special clips are not used, galvanized wire of a minimum of 12 gauge shall be used to fasten the wire to the posts.

D. Posts

Wood posts shall be red cedar, black locust, redwood, pressure treated pine, or other wood of equal life or strength. All wood posts except red cedar, black locust, redwood, white oak, and burr oak shall be treated with creosote, pentachlorophenol, or copper chromate arsenate (CCA) by a method such that complete saturation of the sapwood is obtained. At least half of the diameter or diagonal dimension of red cedar or redwood posts shall be heartwood. Wood posts shall be sound, new, and free from decay with all limbs trimmed substantially flush with body. They shall be substantially straight throughout their length.

Used railroad ties may be used if they are sound and do not exhibit appreciable cracking, splintering, or decay.

Wood posts will be driven into the ground, or placed into a dug hole with fill placed around the post in lifts of not more than 4 inches, with each lift being thoroughly tamped.

Steel line posts shall be "Tee" type with suitable corrugations, knobs, studs, or grooves for fastening line wires. Each post will have an anchor plate attached. The posts will be either galvanized or painted.

Post spacing shall not exceed one rod (16 1/2 feet) for barbed wire fences and standard woven wire fences. Post spacing shall not exceed 25 feet for high tensile woven wire fences.

Line Posts: Wood posts shall have a minimum diameter of 4 inches, be 94% free of bark, a minimum length of 7 1/2 feet, and will be set to a minimum depth of 3 feet into the ground. Steel posts will have a minimum weight of 1.33 lbs per foot (exclusive of the anchor plate), be a minimum length of 6 1/2 feet, and will be set into the ground a minimum depth of 2 feet.

Corner, Gate, End, and Pull Assemblies: Wood posts will have a minimum top diameter of 6 inches inside of the bark, a minimum length of 8 feet, and be set a minimum of 3 feet 6 inches into the ground.

E. Bracing Materials and Construction

Bracing is required at all corner, gate, end, or pull assemblies in the fence.

- Corners are required at all points where the fence alignment changes 15 degrees or more.
- End bracing is required where the fence ends, and on both sides of gate openings.
- Pull assemblies are required in straight sections of the fence so that the maximum distance between brace posts does not exceed 660 feet for barbed wire fences, and 330 feet for woven wire fences.

Bracing will consist of vertical wooden posts meeting the criteria outlined in section D, above, a horizontal or diagonal brace, with a diagonal tension member of wire.

The brace shall be the equivalent of:

- A 4 inch diameter wood post, minimum of 8 feet long, or
- Standard weight galvanized steel pipe of 1 1/2 inch diameter, minimum of 8 feet long.
- Galvanized steel pins, 3/8 inch in diameter, will be used to prevent dislocation of the brace member. The pin will penetrate the upright post to 1/2 the post diameter, and will penetrate the brace member at least 4 inches.

The wire tension member shall be:

- Two complete loops of 9 gauge smooth wire, or
- A single loop of 12 gauge double twisted strand smooth wire, or
- A single loop of 12 1/2 gauge high tensile smooth wire.

All corner and pull assemblies shall be braced in both directions of the fence, which requires three vertical posts. End assemblies require two vertical posts. All standard brace structures shall maintain a minimum two to one ratio of brace length to height of the top wire. The brace member shall be installed at least 3 feet above the ground and at least 4 inches below the tops of the posts. The tension member shall extend from a point approximately equal to the height of the brace member, to a point near the ground level of the post being braced. The tension member shall be twisted or strained to provide the necessary rigidity.

F. Gates (Barbed or Woven; non-powered HTW)

Wire gates shall be made of materials of the same kind, grade, and size specified for the field fence. Stays on wire gates will be no more than 4 feet apart.

Panel gates and tube gates shall be of equivalent quality to the adjacent fence and shall be fitted with at least two hinges and a latch or galvanized chain for fastening. Steel gates will be galvanized or painted to protect from rust. Wood gates will be painted. Fiberglass gates will be treated with ultraviolet inhibitors to achieve a guaranteed lifespan of 20 years. Aluminum gates do not require protection from the elements.

Hinges and latches will be galvanized or painted.

All fittings shall be equivalent to the gate manufacturers standards.

G. Crossing Draws and Watercourses

Crossing draws and watercourses will require weights and anchors to be fastened to the fence wires to keep them parallel to the ground and maintain wire spacing. Another option is to use taller posts through these areas and add additional wires below the bottom wire for the main portion of the fence.

2. NON-POWERED HIGH TENSILE WIRE (HTW) FENCE

This section pertains to high tensile fences that are not powered (not electrified). HTW fences that are powered must meet the criteria in section 3. Of this standard, Permanent Power Fences.

A. Wire

Non-powered HTW fences will have a minimum of eight strands of smooth high tensile wire with the minimum criteria for rust protection, and diameter as

stated in Table 382-1. The wire must have a tensile strength of 200,000 psi.

Each wire will be tensioned to a minimum of 200 pounds after being installed on the posts. To maintain the proper tension, ratcheting type in-line strainers will be used on each wire. Compression springs are used to gage tension on the wire and one will be installed in each strain of fence.

Wire will be connected on a direct line splice with three nicopress sleeves. End wraps will be fastened with two nicopress sleeves or with a twist link.

The top wire shall be from 48 to 50 inches from the ground. The bottom wire shall be not more than 8 inches from the ground.

B. Posts

The posts shall be wood. Red cedar, redwood, black locust, pressure treated pine, white oak, burr oak or other wood of equal life and strength may be used. All wood posts except red cedar, black locust, redwood, white oak, and burr oak shall be treated with creosote, pentachlorophenol, or CCA by a method such that complete saturation of the sapwood is obtained. At least half of the diameter or diagonal dimension of red cedar or redwood Posts shall be heartwood. Wood posts shall be new, sound, and free from decay with all limbs trimmed substantially flush with the body. They shall be substantially straight throughout their length.

Corner and Brace Posts: These will be double assemblies consisting of three posts 8 feet long, driven 3 feet 6 inches into the ground with the end post not less than 6 inches in diameter, the second and third posts not less than 5 inches in diameter. Horizontal brace posts 8 feet long and not less than 4 inches in diameter shall be installed 4 inches below the top of the posts. A tension member consisting of single loop of 12 1/2 gauge high tensile wire shall extend from a point approximately equal to the height of the brace member, to a point near the ground level of the post being braced. The tension member shall be twisted or strained to provide the necessary rigidity.

Galvanized steel pins, 3/8 inch in diameter, will be used to prevent dislocation of the brace member. The pin will penetrate the upright post to 1/2 the post diameter, and will penetrate the brace member at least 4 inches.

Line Posts: Line posts shall be of the same quality as corner and brace posts, except the minimum diameter shall be 4 inches. The length shall be 8 feet,

and they will be driven to a depth of 3 feet 6 inches. Spacing of the line posts shall be not more than 30 feet, with a wire spacer made of either wood or fiberglass spaced not more than 15 feet from either posts.

C. Fasteners

Wire shall be fastened to the posts with Class III barbed galvanized staples 1.75 inches long.

Drive staples diagonally to the wood grain at a slight downward angle (upward if the pull is up) to avoid splitting the post. Space shall be left between the post and staple to permit free movement of the wire and to avoid damage to the protective coating on the wire.

D. Gates

See standard fence.

E. Crossing Draws and Watercourses

See standard fence.

3. PERMANENT POWER FENCES

The information in this section applies to fences for the containment of domestic livestock. For control of wildlife such as deer and coyote, refer to Minnesota Department of Natural Resources, Division of Wildlife, specifications for energized and woven wire fence.

A. Energizers

Electronic energizers are available in 220 volt, 110 volt, or 12 volt battery powered systems. Solar chargers are available for the battery powered units.

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

- High power, low impedance with a 5,000 volt peak output and a pulse that is less than 300 milliamps in intensity, finished within 0.0003 of a second, and at a rate of 35-65 pulses per minute.
- Solid state circuitry.
- Safety pace fuse, to prevent overpulsing.
- High impact, weather resistant case.
- Joule rating high enough to provide a minimum shock of 2000 volts for cattle, 3000 volts for sheep at the point farthest for the energizer.

- Battery powered units of 3 joules or more shall have a solar panel attached to charge the battery.

B. Lightning Protection

Lightning can damage the energizer. To reduce the risk damage, an induction coil must be installed between the energizer and the fence. This induction coil is often referred to as a lightning choke. Additional lightning protection is provided by attaching lightning diverters/arrestors to the fence and to a 6 foot long galvanized rod driven into the ground. This ground rod must be located at least 65 feet away from the ground rods for the energizer and fence.

C. Earth Return

All power fence energizers must be properly connected to an earth return system (commonly called ground rods). The energizer ground wire must be connected to a galvanized rod 1/2 inch or larger in diameter, driven into the ground a minimum of 6 feet for each joule of energy output. Multiple earth return rods connected in series may be used, but they must be spaced at least 10 feet from each other. A minimum of 3 earth return rods are required for all permanent power fences. For best results earth return rods should be installed in an area where the soil remains moist. Do not use copper ground rods due to corrosion at the connection and the subsequent loss of electrical continuity.

To prevent stray voltage, earth return rods must be at least 65 feet from electric utility ground rods, buried water pipes and buried telephone lines.

Do not connect the neutral wire(s) for the fence to the energizer earth return rods. They should be connected to the same ground rods used for lightning protection for the fence.

D. Wire

Perimeter fences: Perimeter fences are those that surround a pasture or grazing cell. They are intended to keep livestock from being in an area not devoted to grazing. Perimeter fences must be constructed with a minimum of 4 wires, and may have up to eight strands of wire. Three strands of wires are allowed for the portion of a perimeter fence within a floodplain of a major watercourse. The height to the top wire must be at least 40 inches. The top wire must be at least 3 inches from the top of the post. The fence should be constructed so that all of the wires may be electrified. At least one of the wires must be electrified. Wire must be new, smooth, and meet the minimum criteria as stated in Table 382-1 for high tensile wire.

Interior fences: Interior fences are used to subdivide a pasture or grazing cell into paddocks. They may also be used to define lanes within the pasture or grazing cell. Permanent interior fences must use wire and posts as described in this section, Permanent Power Fences. They may have a single strand of wire or as many as 8 strands of wire, dependent upon the kind and class of livestock being managed.

Wire must be tightened to a tension of 175 to 200 pounds. To maintain the proper tension, ratcheting type in-line strainers will be used on each wire. The following wire spacing and height are suggested for fences with one to five strands of wire. The kind, class, and size of livestock, as well as the operator's needs will determine the best option. (+) refers to hot wire; (-) refers to neutral wire:

One wire:	2/3 shoulder height (+)
Two wire:	22"(+) 28"(+); or 22"(-) 28"(+)
Three wire:	16"(+) 26"(+) 38"(+); or 16"(-) 26"(-) 38"(+)
Four wire:	12"(+) 20"(+) 30"(+) 40"(+); or 12"(-) 20"(+) 30"(-) 40"(+)
Five wire:	6"(+) 12"(+) 20"(+) 30"(+) 40"(+); or 6"(-) 12"(-) 20"(+) 30"(-) 40"(+)

Neutral wires will be used on sites where soil conditions become very dry and electricity may not be conducted very well back to the energizer to complete the circuit.

Insulated galvanized wire is used to carry power over or underneath gateways and for connecting hot and neutral wires in multi-wire fences. It may also be used in areas where the risk of electrical shock to humans is high. If buried in the ground, use wire designed for burial. For added protection of buried wire, place it inside plastic pipe. Be sure that the ends of the pipe are turned downward to prevent water from accumulating in the pipe. When overhead transmission is used, the height should be sufficient so that the movement of livestock and equipment is not impeded. Do not use insulated copper wire due to corrosion at the connections.

E. Fasteners and Insulators

Porcelain, ceramic, high quality polyethylene, or equivalent insulators will be used to fix wire to wood

and steel posts. Wire clips may be used to fasten wires to fiberglass and polycarbonate posts. All wires shall be insulated to permit switching of hot wires to ground wires and vice versa by switching the power connection and grounding rod connections. Insulators must be strong and durable at points where tension from the wire is transferred to corner, gate, end, pull, and brace posts.

F. Line Posts

All line posts must be of sufficient length so that when driven or set to the required depth, sufficient height remains above the ground to allow for the desired top wire height of the fence plus an additional 3 inches.

Line posts shall be placed at all high and low points in the fence line with enough additional posts and/or stays added to maintain wire at the desired height. Spacing will not exceed 50 feet. Use light posts or stays as wire spacers when spacing between the posts exceeds 30 feet. These will be of a nonconductive material, such as wood, fiberglass, or polycarbonate.

Posts can be wood, fiberglass, polycarbonate, or standard steel "Tee" posts.

- Fiberglass and polycarbonate posts will be at least 7/8 inch in diameter with ultraviolet protective coating, guaranteed to last for 20 years without splintering or deteriorating from sunlight or weather. They will be set to a minimum depth of 18 inches.
- Wood posts will be at least 3 inches in diameter, and must be treated or of rot resistant wood. They will be set into the ground a minimum of 36 inches.
- Steel posts will have a minimum weight of 1.33 lbs per foot (exclusive of the anchor plate), be a minimum length of 6 1/2 feet, and will be set into the ground a minimum depth of 2 feet.

All posts will be driven into the ground through sections of the fence where there is upward pull on the wires.

The alignment of the fence will be a straight as possible.

G. Bracing Materials and Construction

Bracing is required at all corner, end and pull assemblies in the fence.

- Corners are required at all points where the fence alignment changes 15 degrees or more. Three vertical posts are required.

- End bracing is required where the fence ends and on both sides of gate openings. Two vertical posts are required.
- Pull assemblies are required in straight sections of fence so that the maximum distance between brace and pull assemblies does not exceed 2,640 feet. Three vertical posts are required.

Brace assemblies will use wood posts with a minimum top diameter of 6 inches, and a minimum length of 8 feet, and set a minimum of 46 inches into the ground as upright members.

All brace assembly posts will be driven into the ground or set in concrete to avoid displacement when tension is applied to the wires.

The bracing (horizontal) member will be a wooden post with a minimum top diameter of 4 inches and a minimum of 8 feet long. The tension member will be a single loop of 12 1/2 gauge high tensile wire, or equivalent.

Manufactured brace assemblies that are screwed into the ground are acceptable if installed according to the manufacturers recommendations, and the fiberglass component is guaranteed to last for 20 years without splintering or deteriorating from sunlight and weather.

Over uneven terrain, additional bracing may be needed between corner, end, and brace assemblies. Wood posts with a minimum top diameters of 4 inches shall be set at least 42 inches into the ground at all points where excessive upward or downward pull is encountered. These posts will be set into concrete or driven to avoid displacement.

H. Gates

Refer to standard fence.

CONSIDERATIONS

The following should be considered when selecting the type of fence to use and the location of the fence:

- Kinds and habits of livestock and wildlife.
- Location and adequacy of water facilities.
- Topographic features.
- Soil-site characteristics.
- Locating fence in relation to livestock handling facilities.
- Equalize forage production between grazing units.
- Development of potential grazing systems.

- Federal, state, and local fencing codes.
- Landscape resources.
- Expected life of fence.

PLANS AND SPECIFICATIONS

Specifications for fencing shall be prepared based on the specific objectives for each site or planning unit according to the criteria and considerations described in this standard.

OPERATION AND MAINTENANCE

Fences will be inspected in the spring after snowmelt to determine if any damage occurred during the winter. Inspection will be done at intervals throughout the grazing season as deemed necessary to maintain the condition of the fence so that it performs its intended function. Repairs will be made as required.

Power fences will be inspected at regular intervals during the season of use to determine that continuity exists, and that the proper output is realized.

Warning signs will be posted on power fences at 300 foot intervals in areas where people have easy access to the fence, such as along roads, developed areas, and in farmsteads.

REFERENCES

Standard drawings:

- MN-ENG-801 Barbed Wire Fence Details
- MN-ENG-802 Permanent Power Fence Details
- MN-ENG-803 Non-Powered High Tensile Fence Details
- MN-ENG-804 Woven Wire Fence Details

TABLE 382-1 MINIMUM WIRE GAUGE AND COATING REQUIREMENTS

Fence Type	Gauge	Zinc Coating (oz/sq.ft)	Alum. Coating (oz/sq.ft)	Federal Spec. RR-F-221 Considerations
Barbed Wire Double Strand Strand Barb	12.5 14.0	0.30 0.25	0.30 0.25	1. Zinc coated wire classified as Type 1.
High Tensile Barb Wire (two strand)	15.5	0.15	0.11	2. Aluminum coated barb wire classified as Type 2. 3. Minimum coating for barb wire equates to Class 1 coating for both zinc and aluminum coatings.
High Tensile Wire	12.5	0.80		Minimum coating for high tensile fencing and Permanent Electric equates to a Class 3 □ coating. □
Woven Wire Top and Bottom Wire Intermediate and Stay Wire	11.0 14.5	0.30 0.20	0.19 0.15	1. Farm field fences classified as Style 1. Minimum zinc coating equates to Class 1 coating. □