

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

FENCE, GAME-PROOF
(feet)
CODE 382C

SCOPE

This document establishes the technical details, workmanship, and quality and extent of materials required to install the practice in accordance with the Conservation Practice Standard. The information shall be considered when preparing site-specific specifications for game-proof fences. Specifications for non-electric fences and electric fences are contained in separate documents.

The site-specific specifications for installing, operating, and maintaining the practice on a specific field or treatment unit shall be documented via the NRCS Hawaii Jobsheet for Game-proof Fence and given to the client. Other documents such as practice worksheets, maps, drawings, and narrative statements in the conservation plan may be used to plan or design the practice and to prepare the site-specific specifications.

TYPES OF GAME-PROOF FENCES

There are many types of fences suitable for controlling wildlife. The fence listed below is considered one of the more common types; however, this is not all inclusive. The described game-proof fence is designed to provide a deterrent enclosure for a combination of big game to include Mouflon sheep, axis deer, feral goats, and feral pigs.

- Woven wire topped with 2 strands of barbed or smooth wire, minimum height 8 feet (8'). (Figure 1.)

If a fence is being planned that is not listed above, contact the Hawaii State Range Management Specialist for approval at the beginning of the planning process and prior to construction.

MATERIAL SPECIFICATIONS

All materials used in the construction of game-proof fences shall have a minimum life expectancy of ten (10) years.

Game-proof fences will be constructed that equal or exceed the strength and durability of one built in accordance with the materials specifications in the following tables:

- Table 1 Material Specifications for Corner Braces and Gate Posts;
- Table 2 Material Specifications for Line Posts
- Table 3 Material Specifications for Wire; and
- Table 4 Material Specifications for Fasteners and Stays.

Table 1
Material Specifications for Corner Braces and Gate Posts

Wood	
Specifications for Acceptable Wood Material	<ul style="list-style-type: none"> • Untreated posts of kiawe, koa, ohia, or eucalyptus (insultimber). (NOTE: In wet conditions, ohia posts may not hold up for the entire lifespan of the fence.) • Redwood, cedar, or pine posts treated with a creosote coal-tar solution or pentachlorophenol, with not less than six pounds retention of the preservative per cubic foot in accordance with Federal Specification TT-W-571c or TT-W-571i. Federal Specifications are correlated to the American Wood-Preservers' Association Standards P2, P8, P9, C1, & C5.
Rot Treatment	<ul style="list-style-type: none"> • Wood posts set in concrete will be treated to prevent rot. (Note: When cutting treated wood posts, be sure to paint the cut end with approved preservative to prevent rot from entering the post at the cut.)
Corner Braces and Gate Posts	<ul style="list-style-type: none"> • Minimum length: 11 feet, including minimum 3 feet set in ground. • Minimum diameter: 5 inches at top or smaller end. • Compression Member (horizontal or diagonal brace) of corner brace or gate assembly : <ul style="list-style-type: none"> • Minimum length: 6 feet • Minimum diameter: 4 inches.
In-Line Braces (pull post or strainers)	<ul style="list-style-type: none"> • Can be either horizontal or diagonal in design. • Minimum length: 11 feet • Minimum diameter: 4 inches at the smaller end. • Compression Member (horizontal or diagonal brace) of in-line brace assembly: <ul style="list-style-type: none"> • Minimum length: 6 feet • Minimum diameter: 4 inches.
Steel	
Corner Braces and Gate Posts	<ul style="list-style-type: none"> • Steel Pipe: <ul style="list-style-type: none"> • Minimum length: 11 feet, including minimum 3 feet set in ground. • Minimum diameter: 3 inches. • Or equivalent weight of 7.58 pounds per linear foot. • Angle iron with the brace member welded or bolted to the in-ground posts, may also be used. Minimum size: 2" X 2" X 1/4". (Figure 5) • Compression Member (horizontal or diagonal brace) or corner brace or gate assembly: <ul style="list-style-type: none"> • Minimum diameter steel pipe: 2½ inches. • Minimum size angel iron: 2" X 2" X 1/4". • Posts will be set in concrete.
In-Line Braces (pull post or strainers)	<ul style="list-style-type: none"> • Can be either horizontal or diagonal in design. • Steel pipe: <ul style="list-style-type: none"> • Minimum length: 11 feet, including minimum 3 feet set in ground. • Minimum diameter: 3 inches. • Compression Member (horizontal or diagonal brace) of in-line brace assembly: <ul style="list-style-type: none"> • Minimum length: 6 feet • Minimum inside diameter: 3 inches. • Posts will be set in concrete.

Table 2
Material Specifications for Line Posts

Wood	
Specifications for Acceptable Wood Material	<ul style="list-style-type: none"> • Untreated posts of kiawe, koa, ohia, or eucalyptus (insultimber). (NOTE: In wet conditions, ohia posts may not hold up for the entire lifespan of the fence.) • Redwood, cedar, or pine posts treated with a creosote coal-tar solution or pentachlorophenol, with not less than six pounds retention of the preservative per cubic foot in accordance with Federal Specification TT-W-571c or TT-W-571i. Federal Specifications are correlated to the American Wood-Preservers' Association Standards P2, P8, P9, C1, and C5.
Rot Treatment	<ul style="list-style-type: none"> • Wood posts set in concrete will be treated to prevent rot. (Note: When cutting treated wood posts, be sure to paint the cut end with approved preservative to prevent rot from entering the post at the cut.)
Minimum Length and Diameter	<ul style="list-style-type: none"> • Minimum length: 10 feet, including minimum 2 feet set in ground and 6" above top wire. • Minimum diameter: 3 inches at top or smaller end.
Steel	
Specifications	<ul style="list-style-type: none"> • Steel line posts must conform to ASTM Standard A702-89. • Standard "T," "U", or "Y" section steel posts weighing not less than 1.33 pounds per foot of length, exclusive of anchor plate, may be used in lieu of wood line posts. Post length must be at least 10 feet. • Steel line posts shall be rolled from high carbon steel and shall have a protective coating. The coating may be either galvanized by the hot dip process or painted in accordance with Commercial Standard 184 with one or more coats of high-grade, weather-resistant steel paint or enamel applied and baked. • Steel posts shall be studded, embossed or punched for the attachment of wire to the posts.

Table 3
Material Specifications for Wire

Parameter	Specifications
Acceptable Materials	Barbed, smooth, or woven wire are acceptable for Game-proof fences.
Barbed Wire	
Federal Specification	<ul style="list-style-type: none"> The wire must conform to Federal Specification RR-F-221 for the specified types and styles of fencing.
ASTM Standards	<ul style="list-style-type: none"> The wire must also conform to the following ASTM Standards to which the Federal Specification is correlated to: A475-98 & A474-98. High Tensile Wire must conform to ASTM Standards: A854/A854M-98 and A679/A679M-00.
Galvinization (See Figure 8)	<ul style="list-style-type: none"> All wire shall be of new galvanized material. In non-coastal areas (with dry to humid climatic conditions): the wire shall have a Class 2 galvanization (zinc coating of at least 0.50 oz/sq.-ft. or 153 g/m² of wire surface). In coastal areas: The wire will have a Class 3 galvanization (zinc coating of 0.80 oz/sq.-ft. or 244 g/m² of wire surface). (NOTE: Aluminum coating has at least 3 to 5 times the corrosion resistance than zinc coating.)
Gage, Barbs, and Breaking Strength (See Figures 9, 10A and 10B.)	<ul style="list-style-type: none"> Gage will be 12½ gage or heavier double twisted wires OR 13½ to 15½ gage high-tensile, double twisted wires. Note: The smaller the gage, the heavier the wire. For example, 10 gage wire is heavier than 12½ gage wire. Barbs will be 14 gage or heavier 2-point barbs on 4- or 5-inch centers. Minimum strand breaking strength of 950 foot pounds is required.
Smooth Wire	
Federal Specification	<ul style="list-style-type: none"> The wire must conform to Federal Specification RR-F-221 for the specified types and styles of fencing.
ASTM Standards	<ul style="list-style-type: none"> The wire must also conform to the following ASTM Standards to which the Federal Specification is correlated to: A475-98 & A474-98. High Tensile Wire must conform to ASTM Standards: A854/A854M-98 and A679/A679M-00.
Galvinization (See Figure 8)	<ul style="list-style-type: none"> All wire shall be of new galvanized material. In non-coastal areas (with dry to humid climatic conditions): All types of wire shall have a Class 2 galvanization (zinc coating of at least 0.50 oz/sq.-ft. or 153 g/m² of wire surface) In coastal areas: All types of wire will have a Class 3 galvanization (zinc coating of 0.80 oz/sq.-ft. or 244 g/m² of wire surface). (NOTE: Aluminum coating has at least 3 to 5 times the corrosion resistance than zinc coating.)
Gage	<ul style="list-style-type: none"> Gage will be 12½ gage or heavier OR 15½ gage if high-tensile. Minimum strand breaking strength of 950 foot pounds is required or tensile strength grade 135 (135,000 psi) or better (i.e., grades 180, 200, or 220).

Table 3
Material Specifications for Wire
(continued)

Parameter	Specifications
Woven Wire	
Federal Specification (Figure 11)	<ul style="list-style-type: none"> The wire must conform to Federal Specification RR-F-221 for the specified types and styles of fencing.
ASTM Standards	<ul style="list-style-type: none"> The wire must also conform to the following ASTM Standards to which the Federal Specification is correlated to: A116-00.
Galvinization (See Figure 8)	<ul style="list-style-type: none"> All wire shall be of new galvanized material. In non-coastal areas (with dry to humid climatic conditions): All types of wire shall have a Class 2 galvanization (zinc coating of at least 0.50 oz./sq.-ft. or 153 g/m² of wire surface) In coastal areas: All types of wire will have a Class 3 galvanization (zinc coating of 0.80 oz./sq.-ft. or 244 g/m² of wire surface). (NOTE: Aluminum coating has at least 3 to 5 times the corrosion resistance than zinc coating.)
Height and Spacing	<ul style="list-style-type: none"> If two (2) courses of woven wire are used in the fence construction, then the upper course of woven wire shall be a minimum of 26 inches (26") high. The lower course of woven wire shall be a minimum of 47 inches (47") high. The top and bottom wires of any woven wire course shall be eleven (11) gage or heavier, intermediate and stay wires 14 1/2 gage or heavier spaced on not more than 12-inch centers.

APPROXIMATE PROTECTION IN VARIOUS CLIMATIC CONDITIONS AND VARIOUS GALVANIZATION CLASSES (Years until rust appears)						
Wire Size	Climatic Condition					
	Dry		Humid		Coastal and Industrial	
	Class 1	Class 3	Class 1	Class 3	Class 1	Class 3
9	15	30	8	13	3	6
11	11	30	6	13	2	6
12 1/2	11	30	6	13	2	6
	7	23	5	10	1 1/2	4 1/2
APPROXIMATE LIFE AFTER FENCE STARTS TO RUST UNTIL IT REACHES ONE-HALF ORIGINAL STRENGTH (Class 1 galvanization)						
Wire Size	Dry		Humid		Coastal and Industrial	
9	50+		50+		25	
11	50+		50		16	
12 1/2	50+		35		12	
14 1/2	50		20		7	

Table 4
Material Specifications for Fasteners and Stays

Parameter	Specifications
Fasteners (for attaching wire to posts) (Figure 12 and 13)	<ul style="list-style-type: none"> • Staples may be used on wood posts: <ul style="list-style-type: none"> • Gage: Shall be nine (9) or heavier polished (bright) hard wire. • Length: The shanks shall be 1½ inches long for softwoods and 1¼ inches long for hardwood posts. • Will be driven diagonally with the wood grain to avoid splitting the post. Space should be left between the staple and the line post to permit movement of the wire. • Tire wires may be substituted for staples on wood and steel posts: <ul style="list-style-type: none"> • Gage: Shall be 16 or heavier galvanized wire. • The wire will be wrapped around the posts. • Factory clips may be used on wood and steel posts: <ul style="list-style-type: none"> • Commercially available factory clips are usually adequate.
Stays	<ul style="list-style-type: none"> • Suitable twisted wire stays (wire spacers) are commercially available; however, since their main purpose is to keep the wire strands separated, their manufacturing specifications are not as critical as the fence wire itself. • Wood lathe or battens – either pressure treated or untreated - are often used as well as small tree limbs. Both are effective but require fastening to the wires and usually need more maintenance.

INSTALLATION SPECIFICATIONS

The fence will be installed in accordance with proper safety procedures.

The completed job shall be workmanlike and present a good appearance.

If brush or rock clearing, grading or other land work is to be done in conjunction with the fence installation, appropriate grading and erosion control measures shall be undertaken or installed. In some instances, it is advisable to also install a **Firebreak** (Code 394) and an **Access Road** (Code 560). Specifications for all measures to be installed in conjunction with the fence should be attached to the Jobsheet.

Table 5
Installation Specifications for Corner Braces and Gate Posts

Parameter	Specifications
Design and Installation	<ul style="list-style-type: none"> Design and install corner braces and gate posts first. (NOTE: These are the major components of a fence; therefore, close attention to the quality of their placement, material, and construction is necessary). The installation of the fence shall conform to the figures and drawings.
Horizontal Movement	<ul style="list-style-type: none"> All in-ground posts shall be placed to the required depth and shall be firmly embedded so there is less than one inch (1") of horizontal movement at the top of the post when a horizontal force of 80 lbs. Is applied. Steel pipe, angle iron, U, T, or Y steel in-ground posts shall be set in concrete.
Soil Conditions	<ul style="list-style-type: none"> Soil conditions; e.g., low strength (sandy or wet soils), shallowness, rockiness, steepness, or high shrink-swell capacity; may dictate a change in the normal design of a fence and require larger, longer, and deeper posts, more braces, straddlejacks or rock cribs, or trees may have to be used. (Note: Refer to USFA/SLM 2400-Range.)
Bracing	<ul style="list-style-type: none"> Bracing is required at all corners and gates and at all significant changes in the direction of the fence; usually at angles equal to or greater than twenty degrees (20°).
Post Length	<ul style="list-style-type: none"> Minimum: 11', including minimum 3' set in-ground.

Table 6
Installation Specifications for In-line Horizontal (H) Braces

Parameter	Specifications
Placement	H compression posts will be installed at least 6½ feet above the ground level and at least 6 inches from the top of the in-ground posts.
Attachment	H compression members shall be secured to the in-ground posts with steel pins or dowels (rebar) or notched and spiked to the in-ground posts.
Spacing	Depending on the topography and design, in straight sections, brace units (pull posts) shall be spaced at intervals from 66' to 990'.
Anchor Post	The anchor (end) post of an H-brace will be set with a one-inch (1") lean away from the direction of pull.
Brace Wire (Figure 20)	A doubled, smooth, twisted, diagonal brace wire will be installed four inches (4") from the top of the brace post to four inches (4") from the bottom of the anchor (end) post. A twist stick will be used to tighten the brace wire assembly and will be left in place.

Table 7
Installation Specifications for In-line Diagonal Braces

Parameter	Specifications
Selection Considerations (Figure 21 and 22)	<ul style="list-style-type: none"> • Diagonal braces using doubled, twisted, smooth wire or wood or steel posts can be used in lieu of two horizontal braces. • Diagonal braces are structurally equal to the horizontal fence brace. The diagonal brace requires one less post, is 8% more resistant to overturn, 25% less expensive, and requires only about half the labor to install.
Design and Installation Principles	<ul style="list-style-type: none"> • In the design and installation of a diagonal brace or strainer, several principles should be kept in mind: <ul style="list-style-type: none"> • Make the diagonal brace as long as possible (minimum of 6' to 6½'). • Be sure that the end of the diagonal brace in contact with the ground is free to move forward and is not blocked by a stake or post. • The diagonal brace can bear against the corner post in any location from the middle of the post to the top of the post. However, the best place to have the diagonal brace contact the corner post is within six inches (6") from the top. • When installing a diagonal strainer, the corner post should be set first, then the diagonal brace installed, then the bottom holding wire brace installed, and then the fence wires attached and tensioned. If this procedure is followed, the lower wire brace will not have to be twisted to tighten. • If one diagonal strainer will not hold the fence tension, a second diagonal strainer should be installed w/ each strainer taking half of the fence tension. • When using the diagonal strainer as a line brace, care must be exercised not to over-tension the brace wires. The vertical post can be jacked out of the ground if the wires are tensioned too much.

Table 8
Installation Specifications for Line Posts

Parameter	Specifications
Minimum Depth and Setting	<ul style="list-style-type: none"> • Line posts will be set at least two feet (2') in the ground. • All fence posts shall be erect within 2 inches (2") of plumb. All fence posts shall deviate no more than 3 inches (3") of centerline.
Spacing	<ul style="list-style-type: none"> • Maximum post interval shall not exceed one rod (16.5 ') if no stays are used between posts, twenty feet (20') if one stay is used between posts, or thirty feet (30') if stays are used between posts at intervals not greater than ten feet (10').
Locations	<ul style="list-style-type: none"> • All fence posts, particularly line posts, shall be located on high points of corridor or grade breaks to prevent the woven wire course from "bellying".

Table 9
Installation Specifications for Wire

Parameter	Specifications
Splicing (Figure 23a)	<ul style="list-style-type: none"> Splicing high-tensile wire shall be done in any of three different ways: knots, nicopress sleeves, or Reliable Wirelinks.
Knots (Figure 23b & 23c)	<ul style="list-style-type: none"> When using a knot to splice, the "Western Union" splice will be used. Overlapping the ends of each wire and wrapping each wire five times around the other wire makes the splice. The use of a fence-splicing tool will facilitate this operation and result in a neat job.
Woven Wire	<ul style="list-style-type: none"> There shall be 2 courses of woven wire. There shall be no more than 2 inches (2") of space between the lower woven wire course and the ground surface, at any given point. The lower course of woven wire shall have a minimum width of 47 inches (47"). The upper course of woven wire shall follow immediately above the lower course of woven wire. The upper course of woven wire shall have a minimum width of 26 inches (26"). The woven wire courses shall be fastened to each steel post by the top and bottom wires, and at a minimum by at least 2 interior wires. There shall be no more than a 1 inch (1") gap at any point between the two courses of woven wire. The two courses of woven wire shall preferably have an overlap of the bottom wire of the upper course corresponding to the next strand of wire immediately below the upper wire of the lower course. The overlapping courses shall be fastened securely together. The bottom wire of the lower course of woven wire shall be no more than 2 inches (2") above the ground surface at any given point. Tension on the top wire, of the courses of woven wire, shall be such that ten (10) pounds of pressure applied midway between posts shall cause no more than 6 inches (6") of displacement from the straight line between posts. There shall be 1 strand of barbed wire placed between the ground surface on the lower course of woven wire. This 1 strand of barbed wire shall be fastened to each fence post preferably 1 inch (1") above the ground surface. At no point, this strand of barbed wire shall be no more than 2 inches (2") above the ground surface or more than 1 inch (1") below the bottom wire of the lower course of woven wire. Barbed wire tension midway between posts, particularly and especially line posts, shall be such that the pressure of ten (10) pounds shall allow no more than 4 inches (4") of displacement from the straight line between posts. There shall be either 2 strands of smooth wire or barbed wire located above the upper woven wire course. There shall be a minimum of 4 inches (4") between the lower strand of smooth wire or barbed wire and the upper woven wire course. There shall be a minimum of 5 inches (5") between the upper strand of smooth wire or barbed wire and the lower strand of smooth wire or barbed wire. There shall be a height distance of 7 feet and 3 inches (7' 3") from the ground surface to the upper smooth wire or barbed wire strand. This will generally leave about 9 inches (9") from the upper smooth wire or barbed wire strand to the top of the wood line posts. Barbed wire or smooth wire tension midway between posts, particularly and especially line posts, shall be such that the pressure of ten (10) pounds shall allow no more than 4 inches (4") of displacement from the straight line between posts.

Table 10
Installation Specifications for Channel Skirts

Specifications
<p>Due to uneven terrain (such as gullies, draws or ephemeral stream channels), fasten a segment of woven wire, as skirting material, to the bottom three strands of the lower course of woven wire, and extend it 2 feet beyond the vertical plane, toward the interior of the enclosure area. Skirting shall be secured with anchors imbedded into the soil or rock. A minimum of 1 anchor shall be used for every 3 feet of skirting. (Fasteners for purposes of attaching the skirting to the lower course of woven wire shall conform to the previously stated specifications.) The skirting may be additionally secured using rocks a minimum of 12 inches or greater in diameter.</p>
<p>If the soil substrate is least 2 feet or greater in depth, the following anchor specifications shall be followed:</p> <ul style="list-style-type: none">• 9 gauge wire with a Class III coating (Grade 60) shall be threaded through the hole of a 26-inch long anchor, and wrapped a minimum of three times around itself. The hole shall be ¼ inch in diameter, and shall be drilled 6 inches from the top of the anchor.• The 26-inch long anchors shall be completely embedded into the soil, and shall be at a 30 to 45 degree angle.• The anchor wire shall be attached to the barbwire strand and the lower course of woven wire. Points of attachment on the lower course of woven wire shall include the bottom wire and at a minimum at least 1 additional wire.
<p>If the soil substrate is less than 2 feet in depth, the following anchor specifications shall be followed:</p> <ul style="list-style-type: none">• The soil substrate shall be cleaned off the rock substrate at the anchor point with a shovel.
<p><u>Option 1 (Eyebolt):</u></p> <ul style="list-style-type: none">• Drill a 5/16-inch hole 6 inches deep at a 30 to 45 degree angle into the exposed rock substrate.• Fasten the 9 gauge wire with Class III coating (Grade 60) to the eyebolt and pound into the previously described hole into the rock substrate.• Secure the anchor wire to fence as was previously described for the 26-inch long anchors.• Backfill the previously dug hole through the soil substrate with soil.
<p><u>Option 2 (26-inch long Anchor):</u></p> <ul style="list-style-type: none">• Drill a 1-1/8 inch hole 8 inches deep into the rock substrate at a 30 to 45 degree angle using a posthole bit.• Fasten the 9 gauge wire with Class III coating (Grade 60) to the anchor as previously described, and pound the anchor into the previously described drilled hole to a depth of 8 inches.• Secure the anchor wire to the fence as previously described.• Back fill the previously dug hole through the soil substrate with soil.

Table 11
Installation Specifications for Staples

- The staples will be driven diagonally with the wood grain to avoid splitting the post. Space should be left between the staple and the line post to permit movement of the wire.

Table 12
Installation Specifications for Gates

Standard 6-panel, galvanized steel ranch gates can be utilized as necessary. (Figure 2.)

- 1 steel fence post shall be inserted into each end and the center of the steel ranch gate (a total of 3 steel fence posts shall be used per gate). Steel fence posts shall conform to the specifications as previously stated.
- The distance from the ground surface to the top of the 3 inserted steel fence posts shall be 7 feet and 3 inches (7' 3"). This shall conform and correspond to the height distance from the ground surface to the height of the upper strand of barbwire or smooth wire on the fence line.
- The inserted steel fence posts shall be well secured in place with wire. Wire stops, as demonstrated in the sketch, shall be fabricated from heavy gauge 4-inch by 4-inch (4"x4") welded wire inserted through the gate as a stop for the steel fence post. Placement of the stops can be noted in Figure 2.
- Courses of woven wire shall be fastened to the gate. The woven wire shall be attached to the interior side of the gate. A lower course of woven wire shall cover the entire width and length of the gate. An upper course of woven wire shall have the distance of 6 feet and 10 inches (6' 10") from its upper wire to the ground surface. This height shall conform and correspond to the height distance from the ground surface to the height of the lower strand of barbed wire or smooth wire on the fence line. There shall be no more than a 1 inch (1") gap at any point between the two courses of woven wire. The two courses of woven wire shall preferably have an overlap of the bottom wire of the upper course corresponding to the next strand of wire immediately below the upper wire of the lower course. The overlapping courses shall be fastened securely together.
- There shall be strand of woven wire attached as necessary to close the gap between the bottom of the gate and the ground surface. There shall be no more than 2 inches (2") of gap at any point from the ground surface to this strand of woven wire. Points of attachment on the lower course of woven wire shall include the bottom wire and at a minimum at least 1 additional wire.
- Fasteners shall be a galvanized 12 gage wire at a minimum.

BASIS FOR ACCEPTANCE

After the fence has been installed, a site inspection will be made to determine if the materials and the design and installation adhered to the site-specific specifications documented in the practice Jobsheet. See the General Manual 450 Part 407, Documentation, Certification, and Spot Checking for guidance on which parameters of the fence require checking.

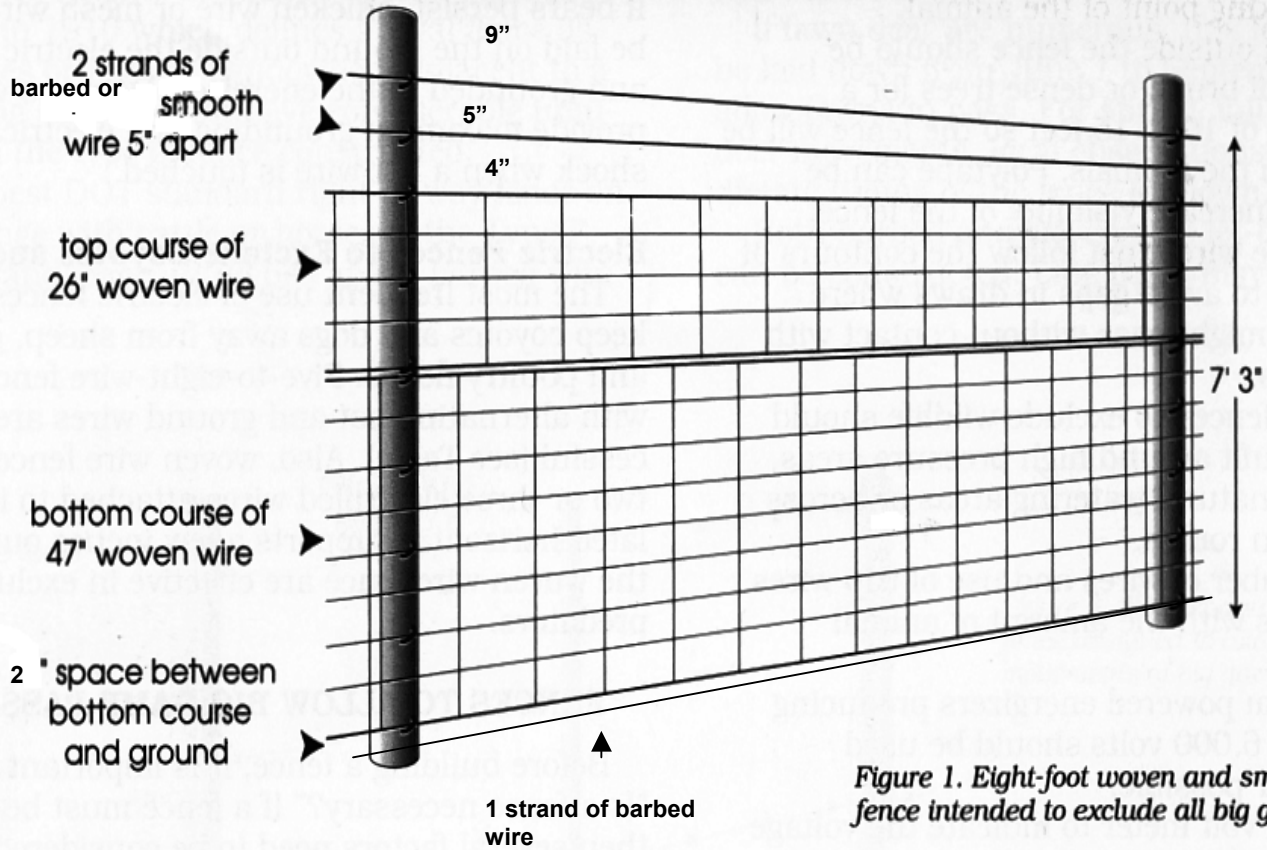
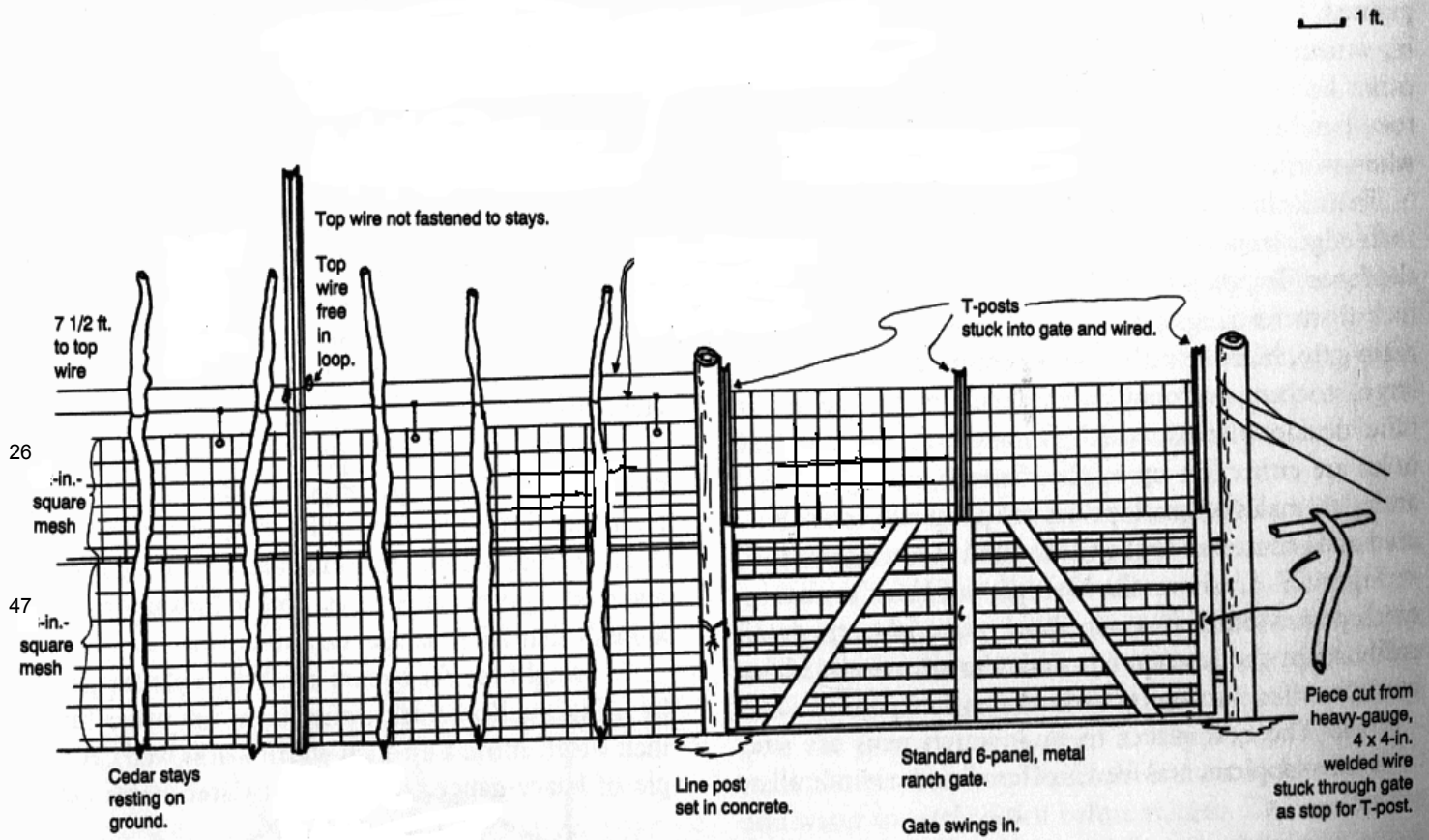


Figure 1. Eight-foot woven and smooth wire fence intended to exclude all big game animals.

Game-Proof Fence

Figure 1



Typical Gate

Figure 2