

**NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC ISLANDS AREA**

CONSERVATION PRACTICE SPECIFICATION

FENCE (382)

PURPOSE OF SPECIFICATION

This document establishes the technical details, workmanship, quality and materials required to construct a fence. For guidance on small mammal deterrent fences, refer to Appendix 1; and for game-proof fences, refer to Appendix 2. Guidance may include information about applying different methods listed in the Conservation Practice Standard, details of site preparation and protection, instructions for use of materials described in the Standard, and other information not directly addressed in the Standard.

Specifications for the installation, operation and maintenance of the practice shall be prepared for each treatment unit in accordance with the requirements in the Conservation Practice Standard and the guidance in this Specification. The site specifications shall be recorded in the Conservation Practice Jobsheet and given to the client.

TYPES OF FENCE

There are many types of fence. For planning and design purposes, they've been broken into four types: High Tensile, Non-High Tensile (standard), Small Mammal Deterrent, and Game-Proof.

A high tensile fencing system uses smooth 12-1/2 gauge wire with a yield strength of 200,000 pounds per square inch, or a strength of 1,600 pounds for each wire. Conventional fencing wire (non-high tensile) normally has a yield strength of less than 60,000 pounds per square inch. A conventional 12-1/2 gauge wire will yield at tensile force of less than 500 pounds and break at less than 550 pounds.

High tensile wire is flexible enough to bend, wrap, tie in knots, or to be clamped with crimping sleeves. Tension in the wire is maintained by permanent in-line stretchers or tension springs. The use of high tension in the wire reduces sag in the wire. The higher tension in the wire requires the use of strong end- and corner-brace assemblies.

The main disadvantage of high tensile fencing is that cattle may slip through the smooth wire easier if the wire is not electrified. Also, animals tend to rub on non-electrified smooth wire fences.

There are many types of fences suitable for controlling feral animals and wildlife. The fence type described for small mammal deterrent has been successfully used on the Big Island of Hawaii to exclude feral cats from Nene habitat at the Ainahou property of Hawaii Volcanoes National Park. A similar construction has been used in Australia by the Arid Recovery staff, and in other places to exclude rabbits, cats and foxes. Each of these fences have provided for wildlife protection and/or vegetation recovery by excluding predators.

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. It is considered one of the more common types; however, this is not all inclusive.

DESIGN CRITERIA AND GUIDANCE

The following tables, figures and charts are provided to give planners and landowners options when designing a fence to meet specific needs. Use the information provided to design a fence that meets NRCS specifications. Take careful note of the footnotes throughout the tables when designing each fence. Any of the following tables, figures or charts may be copied into a specific Fence jobsheet for greater understanding between the NRCS and client.

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Table 1. Fence-Type, Wire, Line Post Spacing, Wire Height -- Fence construction must meet or exceed these minimum specifications:

Kind of Grazing Animal	Kind of Fence		Galvanized Wire (New Only)		Minimum Number of Wires	Maximum Line Post Spacing With or Without Stays (feet) ^{7/}	Maximum Line Post Spacing With 2 or More Stays (feet)	Minimum Height of Top Wire (inches)	Special Considerations ^{15/}
	Non-Electric ^{10/}	Electric	Gage ^{1/}	Type					
Axis Deer (Game-proof Fence)	Woven		19/	Malleable	18/	16.5	30	≥72	17/, 20/, 21/, 23/
	Woven		19/	High Tensile	18/	16.5	30	≥72	17/, 20/, 21/, 23/
Cattle, Carabao or Horse	Barbed		12.5	Malleable	4	20	30	42	Refer to Figure 2 for details
	Barbed		15.5	High Tensile	4	20	30	42	Refer to Figure 2 for details
	Smooth		12.5	Double-strand malleable	4	20	30	42	Refer to Figure 2 for details
	Smooth		12.5	High Tensile	4	20	30	42	Refer to Figure 2 for details
	Woven		2/	Malleable ^{2/}		16.5	16.5	39	17/
	Woven		2/	High Tensile ^{2/}		20	N/A	39	17/
		Smooth	14	High Tensile ^{3/}	1 ^{5/}	75	150	36	
		Smooth	14	High Tensile ^{3/}	2 ^{5/}	100	150	36	
		Smooth	14	High Tensile ^{3/}	1 ^{5/ 9/}	100	150	32	
		Barbed (suspension)		12.5	Malleable or High Tensile	4	N/A	100 ^{4/}	42
	Smooth (suspension)		12.5	Double-strand malleable	4	N/A	100 ^{4/}	42	Refer to Figure 4 for details
Goat; Feral Goat	Barbed		12.5	Malleable	7 ^{8/}	15	20	36	
	Barbed		15.5	High-tensile	7 ^{8/}	20	30	36	
	Woven		2/	Malleable ^{2/}	8/	20	30	39	17/
	Woven		2/	High Tensile ^{2/}		20	N/A	39	17/
		Smooth	14	High Tensile ^{3/}	2 ^{5/ 12/}	75	150	39	Only for use as offsets with Woven Wire to control feral goats. ^{12/}
		Smooth	14	High Tensile ^{3/}	5	50	150	36	

Table 1. Fence-Type, Wire, Line Post Spacing, Wire Height – Continued

Kind of Grazing Animal	Kind of Fence		Galvanized Wire (New Only)		Minimum Number of Wires	Maximum Line Post Spacing With or Without Stays (feet) ^{7/}	Maximum Line Post Spacing With 2 or More Stays (feet)	Minimum Height of Top Wire (inches)	Special Considerations ^{15/}
	Non-Electric ^{10/}	Electric ^{16/}	Gage ^{1/}	Type					
Pig; Feral Pig	Woven		2/ ^{2/}	Malleable ^{2/}		20	30	39	17/
	Woven		2/ ^{2/}	High Tensile ^{2/}		20	N/A	39	17/
	Barbed		12.5	Malleable ^{6/}	1	N/A	N/A	42	Optional - to be used only in conjunction with Woven Wire. Barbed or smooth wire above woven wire; Barbed wire between woven wire and ground (no more than 1-inch above ground surface).
		Smooth	14	High Tensile	2 ^{12/}	N/A	N/A	42	Optional - to be used only in conjunction with Woven Wire and located as offsets on the outside of the fence. ^{12/}
Sheep or Philippine Deer	Barbed		12.5	Malleable	7 ^{8/}	20	30	36	
	Barbed		15.5	High-tensile	7 ^{8/}	20	30	36	
	Woven			Malleable ^{2/}	8/ ^{8/}	20	30	39	17/
	Woven			High Tensile ^{2/}		20	N/A	39	17/
		Smooth	14	High Tensile ^{3/}	2 ^{5/}	75	150	24	
		Smooth	14	High Tensile ^{3/}	5	50	150	36	
Small Mammal Deterrent (cat; dog; mongoose) ^{11/}	Woven		13/ ^{13/}	Malleable	11/ ^{11/}	10	N/A	≥72	17/, 22/
	Woven		13/ ^{13/}	High Tensile ^{13/}	11/ ^{11/}	10	N/A	≥72	17/, 22/
	Poultry			PVC-fuse Coated	11/ ^{11/}	N/A	N/A	≥72	All poultry wire must be PVC-fuse coated. Minimum mesh opening = 1-inch. At least one-foot of poultry wire will be placed outside the fence, along the ground surface, to deter digging. ^{14/}
		Smooth	9	High Tensile	11/ ^{11/}	N/A	N/A	N/A	Used to support the floppy top created with the poultry wire. ^{14/}

- 1/ All wire must equal or exceed 950 pounds-force (lbs.) break strength. Barbed wire, woven wire and wire netting fencing shall conform to the requirements of Federal Specification RR-F-221 for the specified types and styles of fencing. All wire will be of new-galvanized material and shall have zinc coating of at least 0.80 ounce per square foot of wire surface (Class III galvanization) or a Bezial / Galfan coating (95% Zinc/5% Aluminum + Mischmetal). If lab tests are needed, three wire samples of the lot under consideration will be tested. The average strength of the samples shall be the basis for acceptance. Any single sample of the three tested having less than 900 (lbs.) shall disqualify the lot.
- 2/ Woven wire must be at least 32" in height (unless otherwise specified) with stay wires spacing 12" or less. Malleable woven wire must have at least 11 gauge top and bottom strands with 14.5 gauge intermediate and stay wires. High tensile woven wire must have at least 12.5 gauge top and bottom strands with 14.5 gauge intermediate and stay wires, and will be fixed-knot. Woven wire fences shall be topped by at least one double strand 12.5 gauge or larger malleable/15/5 gauge high tensile wire with first strand 2-4 inches above top of woven wire.
- 3/ Electric fences will consist of at least two-wires. Unless otherwise indicated, one or more wires will be hot, one grounded. Wire will be new, smooth 14 gage or heavier, high-tensile 135,000 to 165,000 psi (recommend 160,000 psi), and minimum of Class III galvanization, which has .80 ounces of zinc per square inch of wire surface.
- 4/ Twisted wire stays must be installed at not more than 15' intervals between line posts.
- 5/ For multi-pasture fast move rotations only. Introducing animals to electric fencing in a designated training facility is recommended. Not to be used for exterior fences.
- 6/ Bottom section of at least 48" woven wire, 11-gage or larger top and bottom strands, 12.5 gage or larger intermediate and stay wires, and stay wires spaced no more than 6 inches. Top section of at least 35" woven wire and made of 11-gage or larger top and bottom strands, 14.5 gage or larger intermediate and stay wires with stay wires spaced no more than 12 inches.
- 7/ Line posts must be set at significant high and low points along fence to maintain proper wire height.
- 8/ When cattle are grazed in addition to sheep and/or goats, the top wire will be barbed or smooth, with an approximately 10-inch spacing between top two wires.
- 9/ A minimum 2 wire (grounded to energizer) system must be used in 25-inch or less rainfall area if the ground rods cannot be located where soil moisture is high year-round (e.g., locate ground rods near seeps, ponds, springs, or troughs where an overflow can moisten the soil during hot/dry months).
- 10/ When splicing of non-woven wire is necessary, the "Western Union" splice is recommended. This splice is made by overlapping the ends of each wire and wrapping each wire five times around the other wire (Figure 21). The use of a fence-splicing tool will facilitate this operation and result in a neat job. If sleeve is used, a crimping tool is required. When splicing woven wire, refer to Figure 20.
- 11/ The small mammal deterrent fence uses all of the listed wire types in the construction of the fence. The woven wire is the "base" or "foundation" wire that is affixed to the line and brace/corner posts. The PVC-fuse coated poultry wire is attached to the woven wire and also serves as the "floppy top" and ground wire to prevent digging. The smooth wire is used to create the arched supports for the floppy top. Refer to appendix 1 for additional requirements for this type of fence.
- 12/ When fencing out feral goats or feral pigs, the optional use of electric wire offsets is recommended. In this case, 2 or 3 electric wires that are offset to the outside of the woven fence and spaced at these intervals is recommended. GOATS: For 2-wire electric offset, spacing should be 14" and 24" above ground surface. For 3-wire offset, spacing should be 14", 24" and 34" above ground surface. PIGS: For 2 wire electric offset, spacing should be 4" and 6" above ground surface. For 3-wire electric offset, spacing should be 4", 6" and 9" above ground surface. All the electric wires will be hot. Do not alternate hot with grounded wires.

- 13/ Malleable woven wire must have at least 11 gauge top and bottom strands with 14.5 gauge intermediate and stay wires. High tensile woven wire must have at least 12.5 gauge top and bottom strands with 14.5 gauge intermediate and stay wires, and will use a fixed-knot. Select the preferred wire material and gauge and use that throughout the entire project -- do not vary the material or gauge of the woven foundation wire. Use of graduated wire mesh openings is acceptable, provided that the mesh openings do not exceed 6" x 6", and the smallest mesh openings are installed closest to the ground surface. Commonly available materials will meet the specs of 1775-6-12.5 Bekaert solidlock woven wire.
- 14/ All clips and fasteners will be stainless steel to protect against corrosion. Fasten both wire meshes (woven and poultry) to all line, brace, corner and gate posts with stainless steel wires, clips or hog-rings.
- 15/ Wire Tension for Barbed or Smooth Wire Fences: The wire tension midway between the posts shall be such that the pressure of 10 pounds will allow no more than 4 inches of displacement for the straight line between posts. Wire Tension for Woven Wire: The tension on the top wire of the woven wire course will be such that the pressure of 10 pounds will allow no more than 6 inches of displacement from the straight line between posts.
- 16/ Refer to Table 4 for additional requirements for this type of fence.
- 17/ To prevent "bellying" of the wire, additional posts will be located on high points or grade breaks. This may result in closer post-spacing than shown here.
- 18/ There shall be no more than 2 courses of woven wire. When 2 courses are used, the lower course of woven wire shall have a minimum height of 47 inches, while the upper course shall have a minimum height of 26 inches. The upper course of woven wire shall overlap the lower course of woven wire so that the bottom wire of the upper course corresponds to the next strand of wire immediately below the top strand of the bottom course of woven wire. The overlapping courses fastened securely together. There shall be no more than 2 inches of space between the lower woven wire course and the ground surface at any given point.
- 19/ Malleable woven wire must have at least 11 gauge top and bottom strands with 14.5 gauge intermediate and stay wires. High tensile woven wire must have at least 12.5 gauge top and bottom strands with 14.5 gauge intermediate and stay wires. Select the preferred wire material and gauge and use that throughout the entire project -- do not vary the material or gauge of the woven wire. Use of graduated wire mesh openings is acceptable, provided that the mesh openings do not exceed 12" x 12", and the smallest mesh openings are installed closest to the ground surface.
- 20/ There shall be 1 strand of barbed wire placed between the ground surface and the lower course of woven wire. This strand of barbed wire shall be fastened to each fence post preferably 1 inch above the ground surface. At no point will this wire be more than 2 inches above the ground surface or greater than 1 inch below the bottom course of the woven wire. This strand of barbed wire shall meet the minimum specifications described previously in this specification for barbed wire.
- 21/ There shall be either 2 strands of barbed or smooth wire located above the upper course of woven wire. There shall be a minimum of 4 inches between the upper woven wire course and the first strand of barbed or smooth wire, and a minimum of 5 inches between the upper and lower strands of barbed or smooth wire. There shall be a height of at least 7 feet 3 inches from the ground surface to the upper strand of barbed or smooth wire
- 22/ See 382-Appendix 1 for more details about planning small mammal deterrent fences.
- 23/ See 382-Appendix 2 for more details about planning game-proof fences

Table 2. Fence Posts and Fasteners -- Construction must meet or exceed these minimum specifications:

Kind of Post	Post Use and Treatment ^{1/}	Minimum Post Length (feet)	Minimum Post Diameter at Smallest End (inches)	Minimum Buried Depth (feet) ^{2/}	Minimum Staple Gage ^{3/}	Minimum Wire Fastener Gage ^{3/}	Maximum Angle Change Without Use of Brace Posts ^{4/}	Maximum In-Line Brace Spacing (feet) ^{5/}	Special Considerations
Wood	Line Post	6 ^{6/}	3	2	9	16	20°	N/A	
	Brace/Corner Post	7	5	3	9	16	20°	N/A	5 ^{5/}
	In-Line Brace Post	6	4	2	9	16	20°	1320	5 ^{5/}
	Gate Post	7	5	3	9	16	N/A	N/A	5 ^{5/}
Steel	Line Post	6 ^{6/}	7 ^{7/}	Wood=2. Steel T- post=1.5	N/A	16	20°	N/A	7 ^{7/}
	Brace/Corner Post	7	2-7/8	3	N/A	16	20°	N/A	8 ^{8/}
	In-Line Brace Post	6	2-7/8	2	N/A	16	20°	1320	8 ^{8/}
	Gate Post	7	2-7/8	3	N/A	16	N/A	N/A	8 ^{8/}

^{1/} Post Use is specified for Line, Brace or Gate posts. Brace post requirements apply to corner post arrangements also. Post Treatment required: 1) Cut surfaces of Koa, Ohia or Eucalyptus posts will be hand-painted with approved wood preservative to prevent rot. All bark will be removed and all surfaces and cuts will be treated. Kiawe does not need to be treated with preservative. Ohia is not recommended for use in wet soil or climate conditions; 2) Redwood, Cedar or Pine posts will be treated with a creosote coal-tar solution, or pentachlorophenol, or chromated copper arsenate (CCA). In accordance with Federal Specification TT-W-571c or TT-W-571i, there will not be less than six pounds retention of the preservative per cubic foot of wood.

^{2/} Posts may be driven into soil if depth is sufficient to meet buried depth requirements. Posts may also be drilled into rock and then stabilized with concrete. Posts placed in dug-holes will be stabilized with a minimum of 12" x 12" concrete that fills the entire depth of the hole. If posts cannot be driven, drilled or dug into the ground, circular rock cribs can be used to stabilize the posts. Each rock crib will be constructed with woven wire (mesh openings no greater than 6" x 6"), and filled with rocks at least 6-inch diameter in size on the longest surface. The rock crib will equal the height of the line or brace posts, and will be ≥24 inches in diameter when finished.

^{3/} When staples are used, they must be driven diagonally with the wood grain to avoid splitting the post. Space will be left between the staple and the post to permit wire movement. Staple length will be ≥1.5 inches for softwoods and ≥1.25 inches for hardwoods. If tie wires are substituted for staples, the tie wires will be 16-gage or heavier, Class III galvanized, and wrapped around the posts. Factory clips may also be used on wood and steel posts. For fences close to the coast or located in brackish water conditions, and for all Small Mammal Deterrent fences, all fasteners and clips will be stainless steel.

^{4/} When fence angle changes more than 20°, brace posts must be installed.

^{5/} Horizontal or diagonal compression member will be ≥6 feet long and ≥3 inch diameter. It will be located 6-12 inches from the top of the vertical brace posts. The compression member will be secured to the vertical in-ground post(s) with steel pins or dowels (rebar), or notched and spiked to the in-ground post(s). If diagonal, the post end will rest on a large, flat surface (rock, disk blade, concrete surface, etc.). A tension wire will extend from the farthest brace post to the bottom of the diagonal post (≤6 inches above the ground surface), and will be tightened to prevent slippage of the diagonal post. Both posts supporting the tension wire will be notched no more than 1-inch deep for the wire to rest within.

^{6/} Line post length will be long enough to allow for at least 1.5-feet of buried depth, plus 3-6 inches above the top wire. For example, if the top wire height is 42 inches, the line post length can be 6-feet (42" wire height + 18" buried depth + 6" post height above top wire = 66").

- 7/ Line post anchor plates will be fully buried. All fence posts will be erect within 2-inches of plumb. All fence posts will deviate no more than 3-inches of centerline. All steel line posts ("T", "U", and "Y" posts) will be at least 1.33 pounds per linear foot. Steel line posts will be rolled from high carbon steel and have a protective coating (galvanized or hot-dip process, or painted in accordance with Commercial Standard 184 (one or more coats of high-grade, weather-resistant steel paint or enamel applied and baked)). Steel line posts will also be studded, embossed or punched to allow attachment of wire. For the PIA-West offices (Guam, CNMI), if forged-steel line posts cannot be obtained in a reasonable time frame for installation, it is acceptable to use minimum 1-inch diameter rebar posts as line posts. No exceptions or variations will be made to corner, brace, or gate posts requirements.
- 8/ Steel posts for corner and gate posts will weigh at least 7.58 pounds per linear foot and will be free from excessive pitting and/or corrosion. Angle iron with the horizontal compression member welded or bolted to the in-ground posts is acceptable (minimum angle iron dimensions for brace member are 2" x 2" x 1/4"). Horizontal or diagonal compression member will be ≥6 feet long and ≥3.0 inch diameter. It will be located 6-12 inches from the top of the vertical brace posts. The compression member will be secured to the vertical in-ground post(s) with steel pins or dowels (rebar), or notched and spiked to the in-ground post(s). If diagonal, the post end will rest on a large, flat surface (rock, disk blade, concrete surface, etc.). A tension wire will extend from the farthest brace post to the bottom of the diagonal post (≤6 inches above the ground surface), and will be tightened to prevent slippage of the diagonal post.
- 9/ In-line braces in straight sections (no turns or bends that require a brace assembly) will be spaced no greater than 1320-feet apart on level or gently rolling terrain. In areas with steep or difficult terrain, braces will be spaced no greater than 660-feet apart (or closer if needed).

Table 3. Special Considerations for Suspension Fences

Component	Special Considerations
Suitability of Use	<p>Suspension fences are not suitable for rough or broken country, or where vegetation will interfere with the whipping action of the fence.</p> <p>Suspension fences should not be built on a curve. In-line directional changes will be accomplished by definite angle that are properly braced.</p>
Posts	<p>Posts for suspension fences are subjected to greater tensions than non-suspension fence posts. They should be built with double brace assemblies every 660-feet or closer. Any straight section of suspension fence more than 1320-feet long will have a minimum of 2 equally-spaced line anchors or pull post assemblies. Tie off all wires at stretch panels and start with new wire on the next section.</p> <p>All wood corner posts, brace and in-line pull posts will have an 8-inch diameter top and be imbedded at least 3.5-feet in the ground. The post(s) will extend 3 to 6-inches above the top wire.</p> <p>If wood line posts are used, they will have a minimum top diameter of 4-inches.</p> <p>Steel line posts will be at least 6-feet long, have anchor plates fully buried, and be driven or drilled into the ground at least 2-feet deep.</p>
Wire	<p>Suspension fences will have at least 4 wires spaced appropriately for the kind of animal control desired.</p> <p>The wire will be kept tight so there is no more than 3-inches of sag between posts.</p>
Stays or Droppers	<p>Stays or droppers of Class III galvanized twisted wire, wood, or fiberglass will be used to maintain wire spacing, serve as visual barriers to animals, and distribute pressure evenly to all wires in the span.</p> <p>An effective dropper for feral pig deterrent is a sheet of black-colored high density polyethylene (HDPE) material. Grommets should be installed in the HDPE material where it will be wired to the bottom of the suspension fence span, on the downslope side of the fence. After hanging the HDPE from the bottom wire through the grommets, shape the material to follow the contours of the ground surface, leaving at least 2-feet of extra material length to drape along the ground. Affix a 2x4-inch treated wood board to the HDPE material along the straightest length of the ground. The 2x4 should be as long as possible and affixed in the same direction as the suspension fence (e.g., across the drainage). During non-flood events, the HDPE acts as a visual "curtain" barrier to turn animals away. During flood events, the 2x4 and HDPE will float to allow water passage. When floodwaters subside, the HDPE and 2x4 (if still intact) should return to their original positions, although this should be checked after each event.</p> <p>Treated wood stays may be preferred due to their effective visual barrier to animals.</p> <p>Stay spacing between posts should be 15-20 feet.</p> <p>The lower ends of the stays must not touch the ground or otherwise interfere with the swaying motion of the fence.</p>

Table 4. Electric Fences -- Construction must meet or exceed these minimum specifications:

Kind of Post	Post Use and Treatment ^{1/}	Minimum Post Length (feet) ^{6/}	Minimum Post Diameter at Smallest End (inches) ^{7/}	Minimum Buried Depth (feet) ^{2/}	Minimum Staple Gage	Minimum Wire Fastener Gage	Maximum Angle Change Without Use of Brace Posts ^{4/}	Maximum In-Line Brace Spacing (feet)	Energizer and Grounding Requirements ^{5/ 8/}
Wood	Line Post	^{6/}	^{7/}	1.5	9	16	20°	N/A	Energizer minimum peak output = 5,000 volts at 35 to 65 pulses/minute. High power, low impedance. Grounding system required.
	Brace/Corner Post	7	5 ^{3/}	3	9	16	20°	N/A	
	In-Line Brace Post	6	4 ^{3/}	2	9	16	20°	1320	
	Gate Post	7	5 ^{3/}	3	9	16	N/A	N/A	
Steel	Line Post	^{6/}	^{7/}	1.5	N/A	16	20°	N/A	
	Brace/Corner Post	7	2-7/8 ^{3/}	3	N/A	16	20°	N/A	
	In-Line Brace Post	6	2-7/8 ^{3/}	2	N/A	16	20°	1320	
	Gate Post	7	2-7/8 ^{3/}	3	N/A	16	N/A	N/A	

^{1/} Post Use is specified for Line, Brace or Gate posts. Brace post requirements apply to corner post arrangements also. Post Treatment required: 1) Cut surfaces of Koa, Ohia or Eucalyptus posts will be hand-painted with approved wood preservative to prevent rot. All bark will be removed and all surfaces and cuts will be treated. Kiawe does not need to be treated with wood preservative. Ohia is not recommended for use in wet soil or climate conditions; 2) Redwood, Cedar or Pine posts will be treated with a creosote coal-tar solution, or pentachlorophenol, or chromated copper arsenate (CCA). In accordance with Federal Specification TT-W-571c or TT-W-571i, there will not be less than six pounds retention of the preservative per cubic foot of wood.

^{2/} Posts may be driven into soil if depth is sufficient to meet buried depth requirements. Posts may also be drilled into rock and then stabilized with concrete. Posts placed in dug-holes will be stabilized with a minimum of 12" x 12" concrete that fills the entire depth of the hole. If posts cannot be driven, drilled or dug into the ground, circular rock cribs can be used to stabilize the posts. Each rock crib will be constructed with woven wire (mesh openings no greater than 6" x 6"), and filled with rocks at least 6-inch diameter in size on the longest surface. The rock crib will equal the height of the line or brace posts, and will be ≥24 inches in diameter when finished.

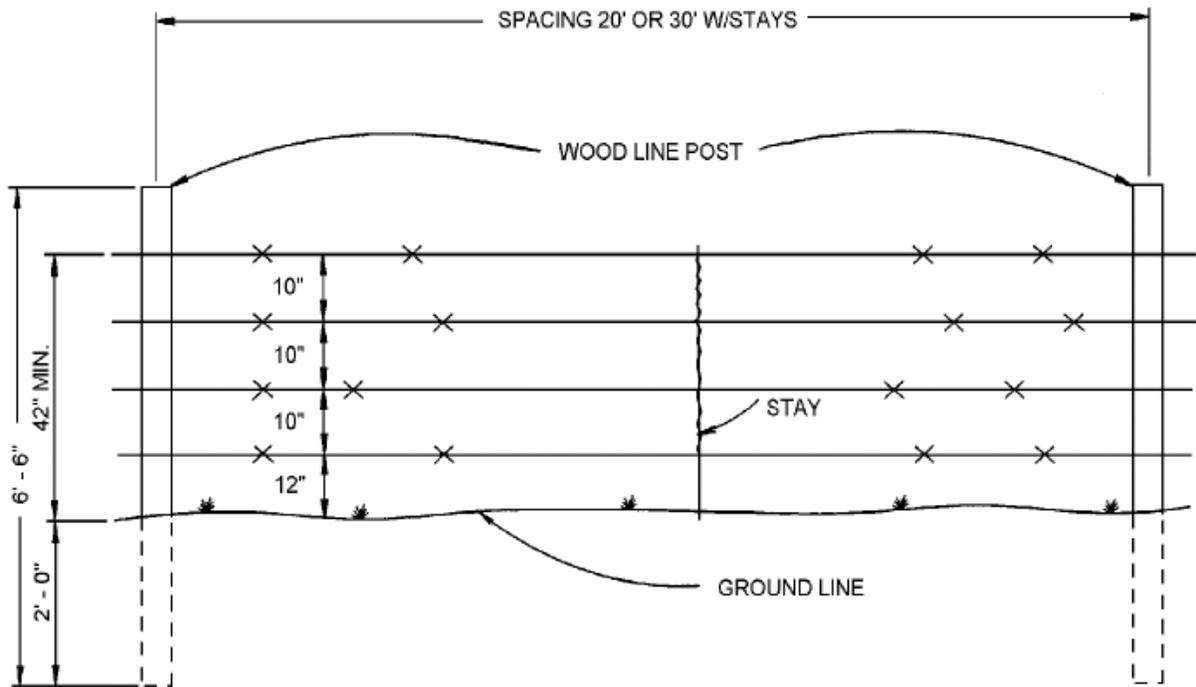
^{3/} The width of all braces will be at least 6 feet. Any compression members in H-braces will be at least 6 feet long. If using a diagonal brace configuration, the angle of the diagonal brace pole will be no less than 40-degrees and no more than 50-degrees. All diagonal brace poles will be supported at the ground on a flat surface (e.g., rock) or will abut to a buried post. Refer to Chart 1 in the 382-Fence specification for allowable modified bracing configurations when building single- or double-strand electric fences.

^{4/} For single- or double-strand electric fences only, a modified brace configuration is allowed when the angle of change differs. Refer to Chart 1 in the 382-Fence specification for the allowable modified bracing configurations for those types of fences.

^{5/} The energizer will deliver enough voltage to control the identified animals. At least 1,000 volts for cattle and horses; 3,000 volts for sheep and domestic goats; 5,000 volts for feral pigs and feral goats. The maximum wire length controlled by one energizer will not exceed the manufacturer's specifications. All circuitry will be solid state. Safety fuses will work properly. The energy source can be alternating current (AC), direct current (DC) or photovoltaic (PV). Follow manufacturer's recommendations when connecting the energizer to the energy source. If using DC (batteries), they must be capable of operating for at least 3 weeks without a recharge, they must be connected to a recharge system (PV, wind, etc.), must have a load regulator to prevent overloading of the battery during periods of high solar radiation or wind, and must have cutoff facilities to prevent deep discharge of the battery. Wet cell batteries are rechargeable, and deep-cycle marine batteries are preferred to conventional auto or tractor 12V batteries. Dry cell batteries last from 1 to 6 month and are not rechargeable. Dry cells batteries are only allowed for temporary grazing systems.

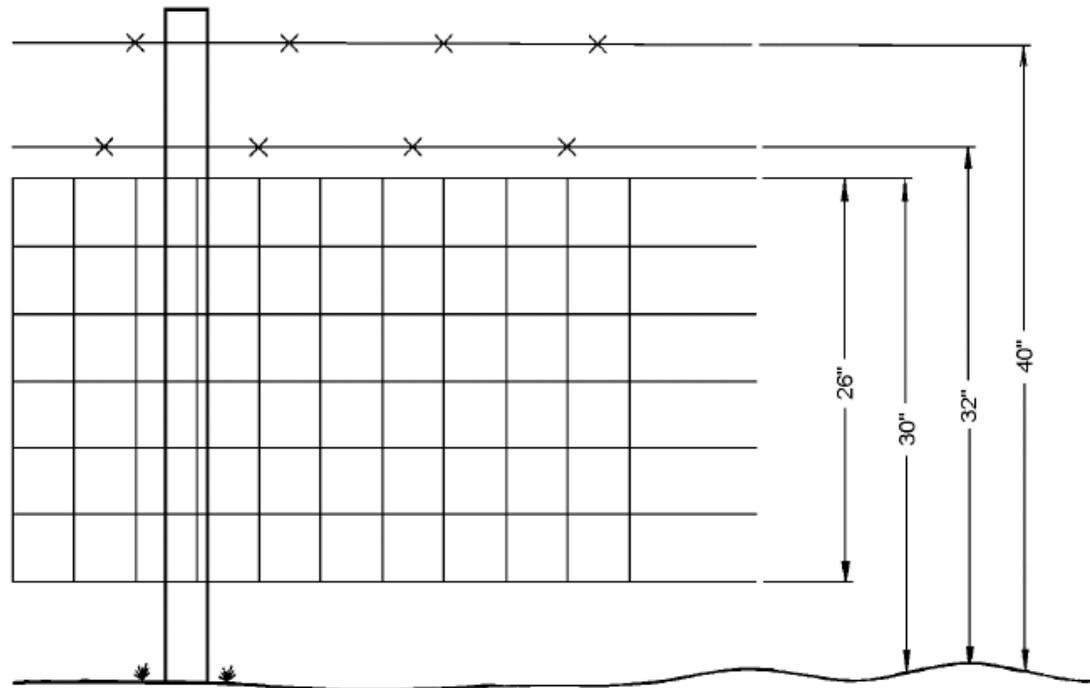
^{6/} Line posts must be long enough to allow for the desired height aboveground, including at least 3-inches above the top wire, plus at least 18-inches of buried depth.

- ^{7/} Wood line posts will be at least 2-inch diameter at the narrowest point. Tubular steel posts or steel pipe will be at least 1-inch inside diameter. T-posts will weigh at least 1.33 pounds/foot of length, exclusive of the anchor plate. Fiberglass or Insultimber posts will be at least 1/2-inch diameter. Rebar posts will be at least 5/8-inch diameter (size 5 rebar). All line posts, regardless of type, will be set into the ground at least 18 inches.
- ^{8/} All electric fences will be grounded. For fences with all the wires "hot" (electrified), the energizer ground wire will be connected to a series of ground rods driven into the ground. Follow manufacturer's specifications for grounding. As a rule of thumb, use at least 4 ground rods, spaced 10-feet apart and driven at least 4 feet into the ground. The ground wire will be connected to each ground rod with a secure clamp. Ground rods will be of the same type of metal -- either all steel or all copper, and will be at least 3/4-inch diameter or greater. Do not mix metal type among the ground rods. For optimal grounding success, the ground rods should be located in an area where soil moisture is moderate to high throughout the year. Dry areas are more difficult to maintain a consistent ground. For fences with both "hot" and "cold" wires (electrified wires and ground wires), the "hot" and "cold" wires will alternate. For example, a 3-strand electric fence would have the top and bottom wires hot, and the middle wire cold (ground). Fences of this type do not need a ground rod system. The grounding is accomplished by the presence of the ground ("cold") wires and the circuit is completed through animal contact.



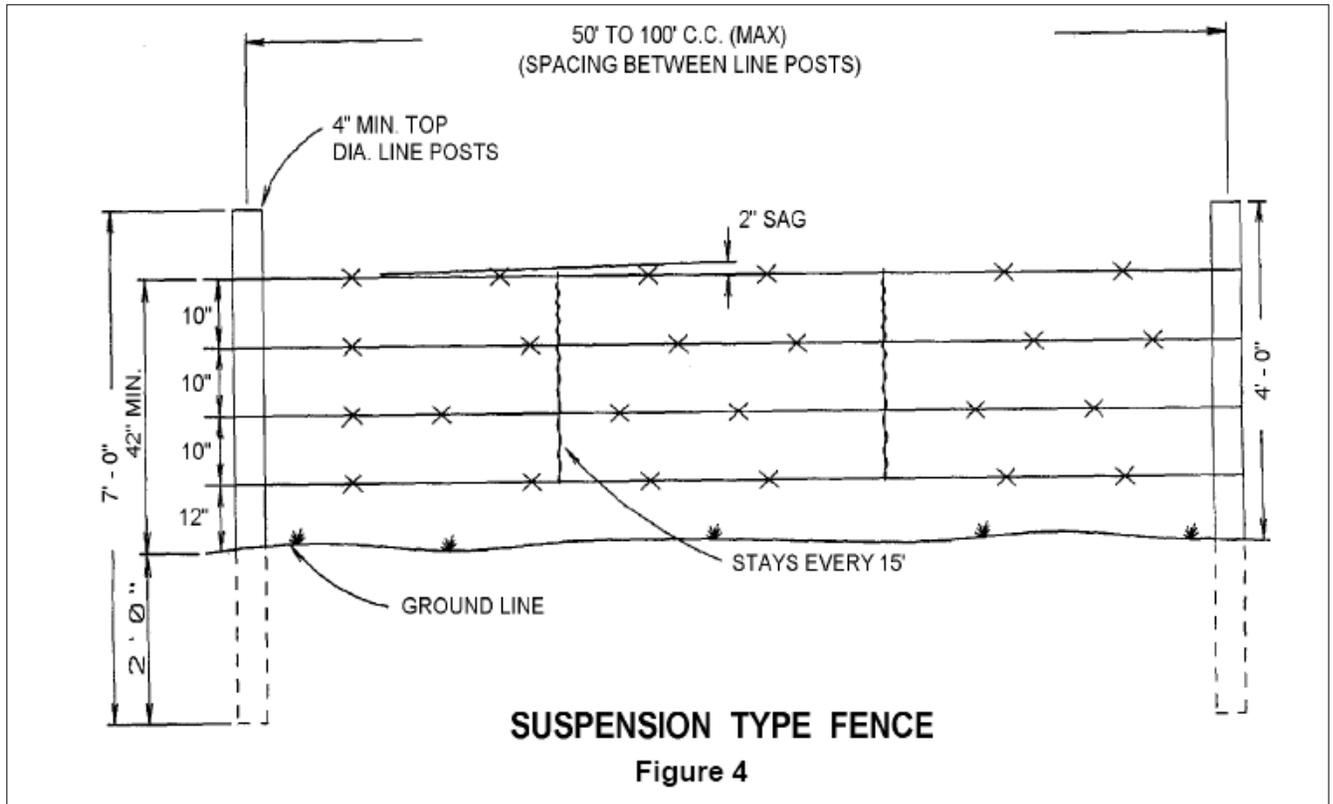
STANDARD 4 WIRE FENCE

Figure 2



WOVEN WIRE WITH 2 STRANDS BARBED WIRE

Figure 3



Steel diagonal-brace ends and corners have been used satisfactorily by setting the end or corner post in concrete and placing the diagonal braces in concrete. However, mixing the concrete and waiting for the concrete to cure add time and effort to the operation.

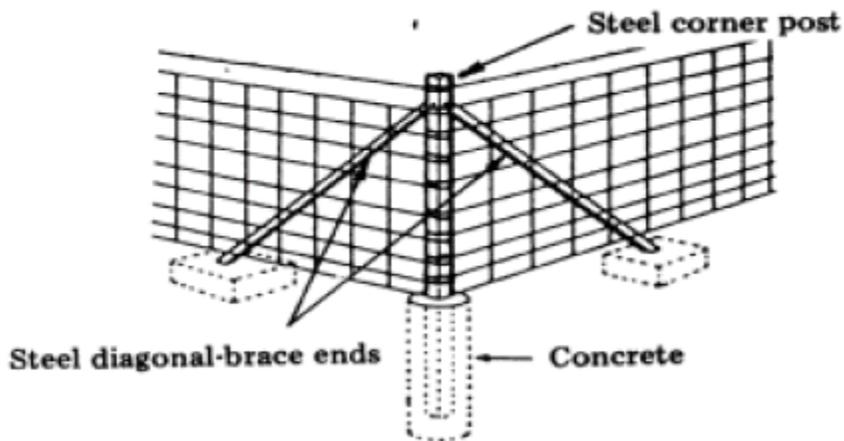


Figure 5

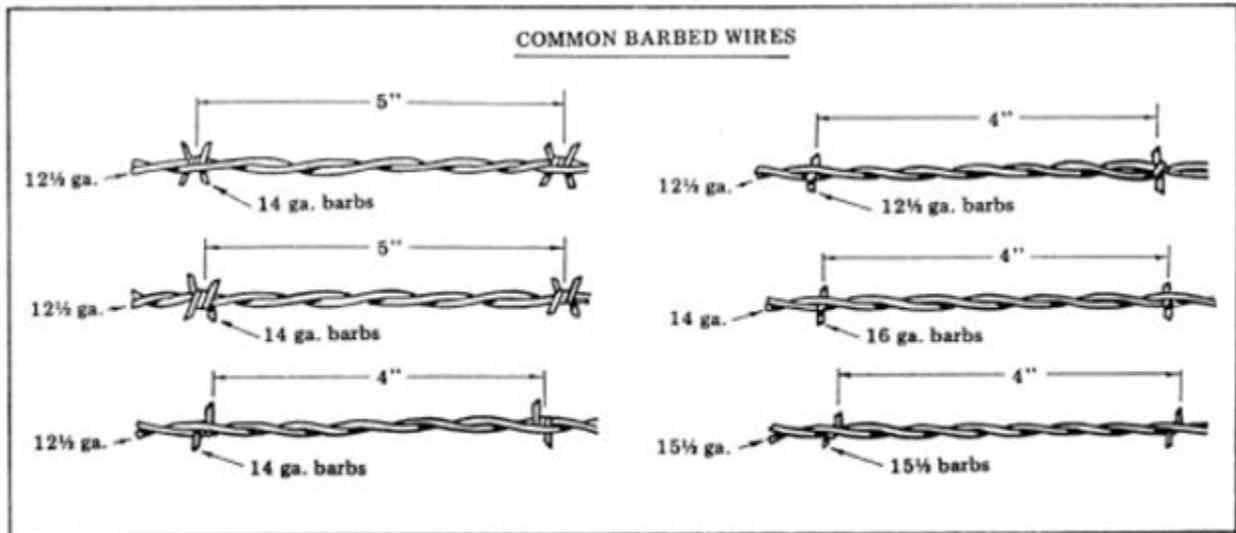
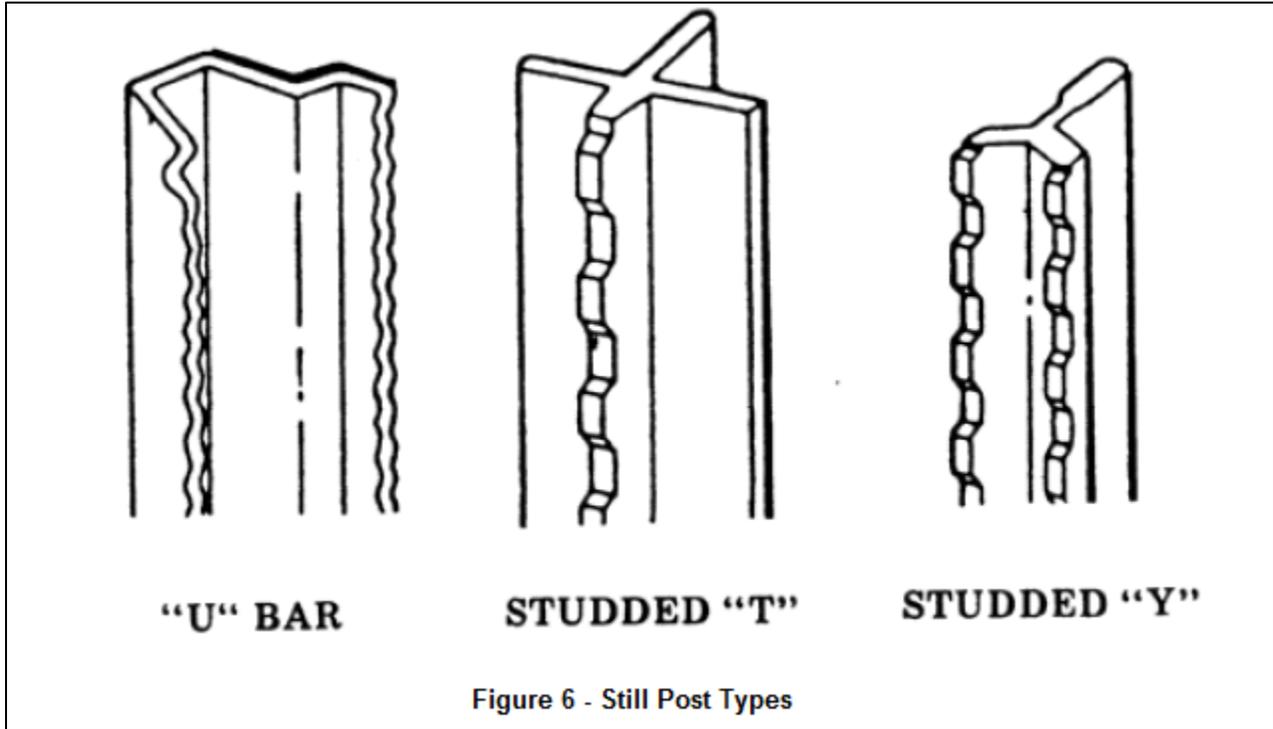


Figure 7

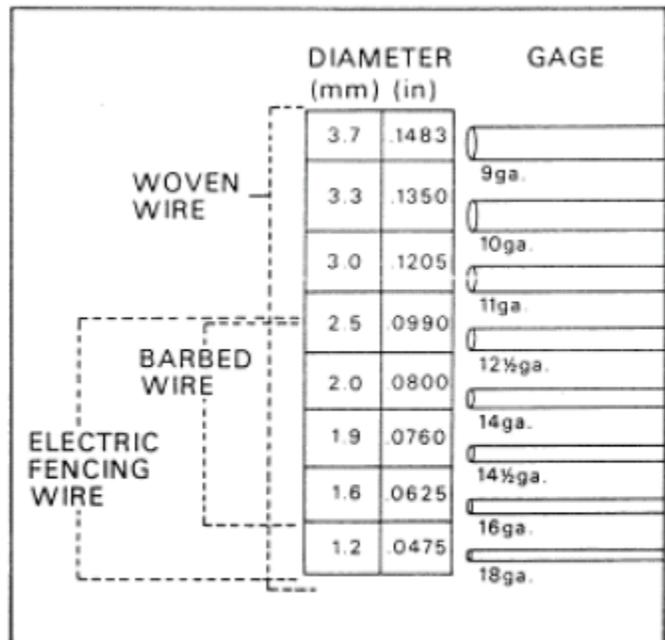


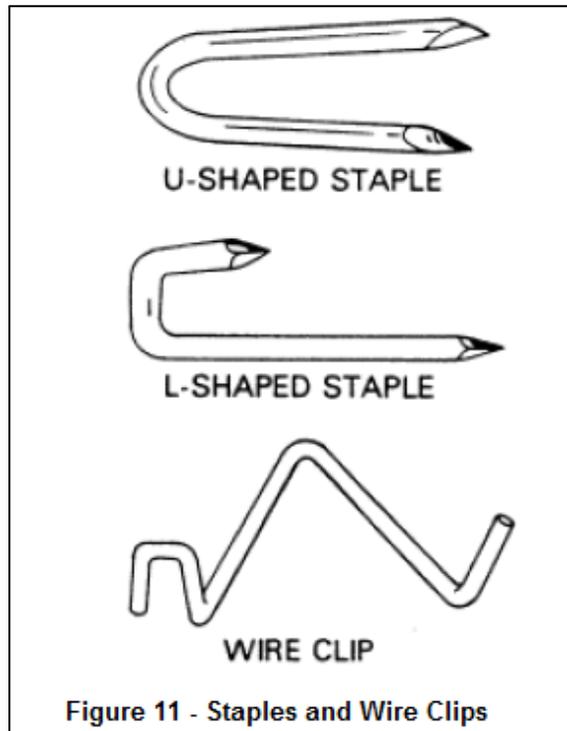
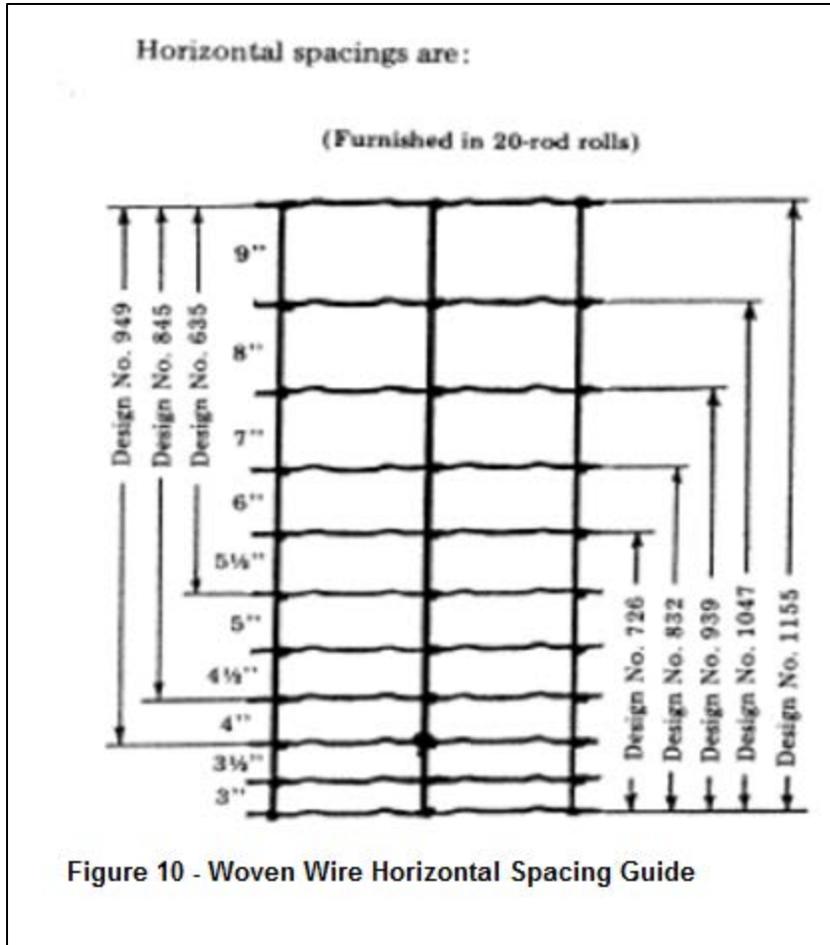
Figure 8 - Wire Diameter and Gauge

Relative Strength of Barbed Wire

<u>Gauge No.</u>	<u>Relative strength</u>
12½	1.0**
13½ H.T.*	1.1
14	0.6
15½ H.T.*	1.0

*High Tensile strength wire.
**12½ gauge used as the standard.

Figure 9



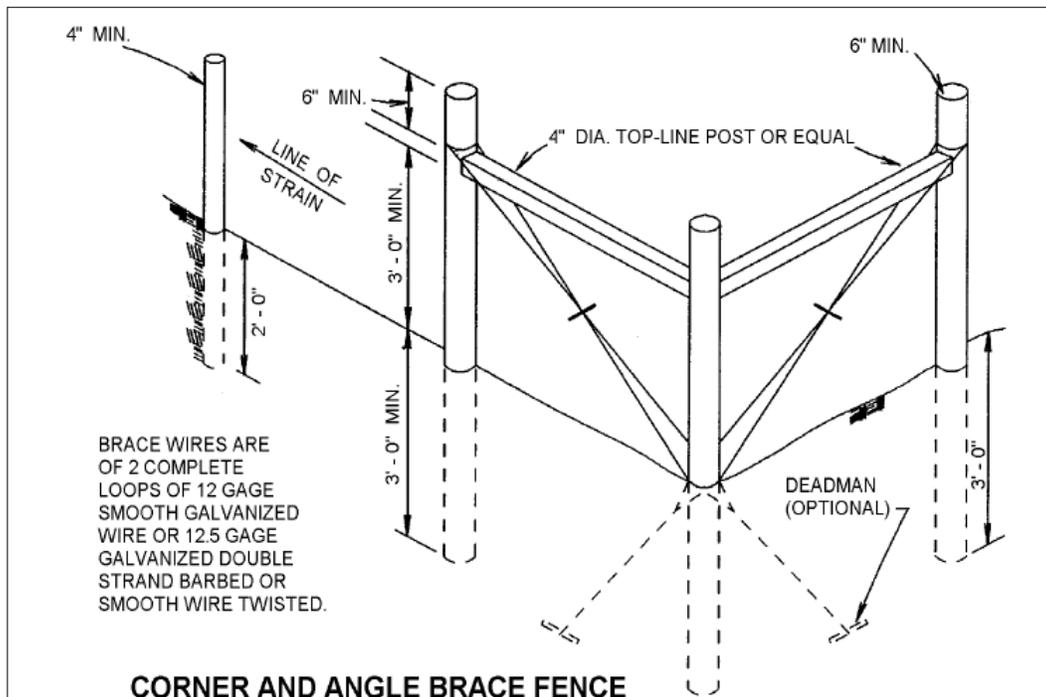
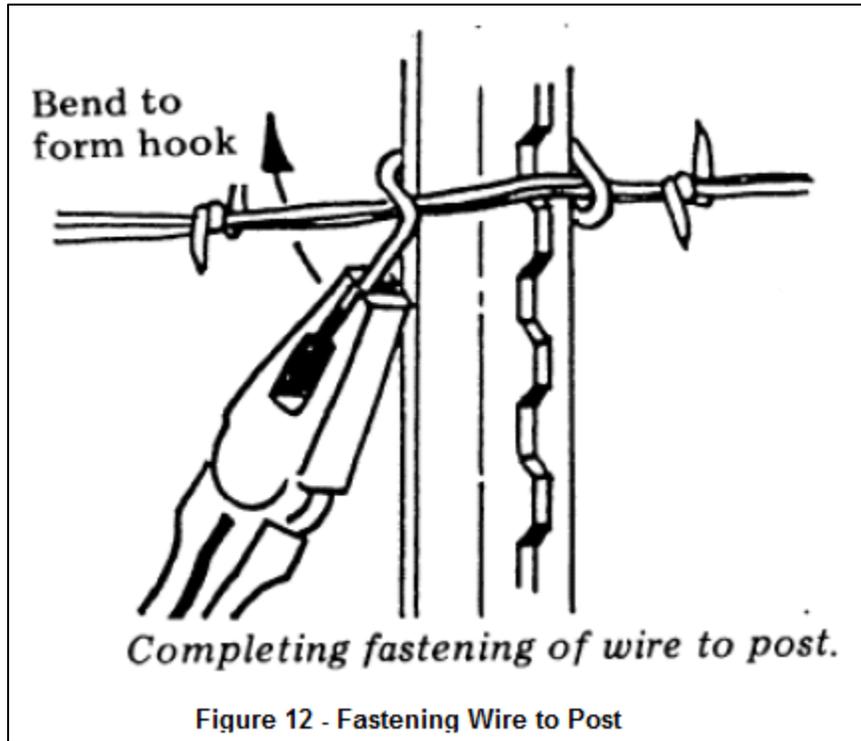


Figure 13 - Corner and Angle Brace Fence

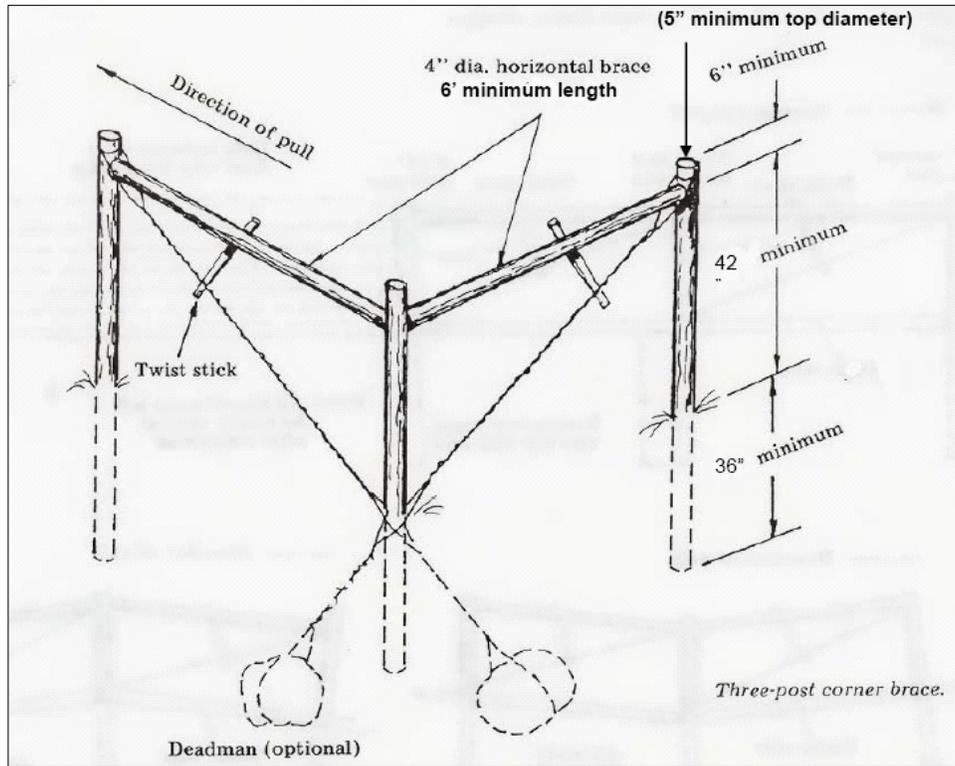


Figure 14 - Three-Post Corner Brace

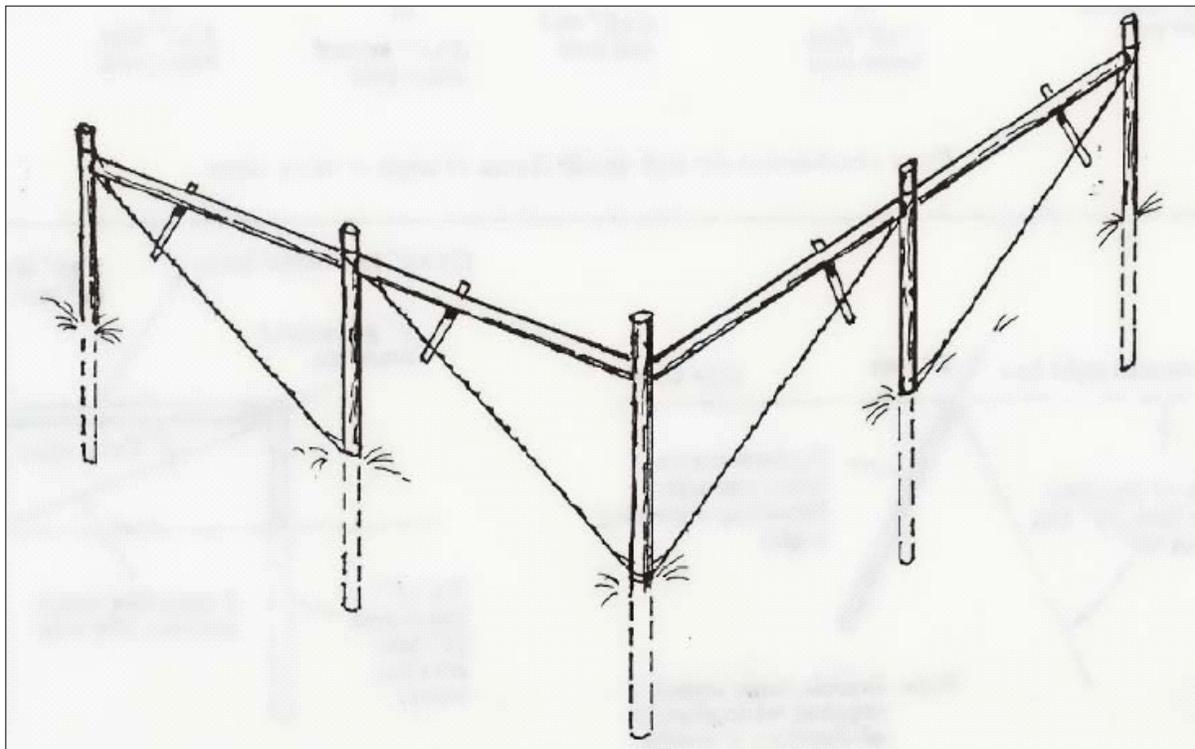
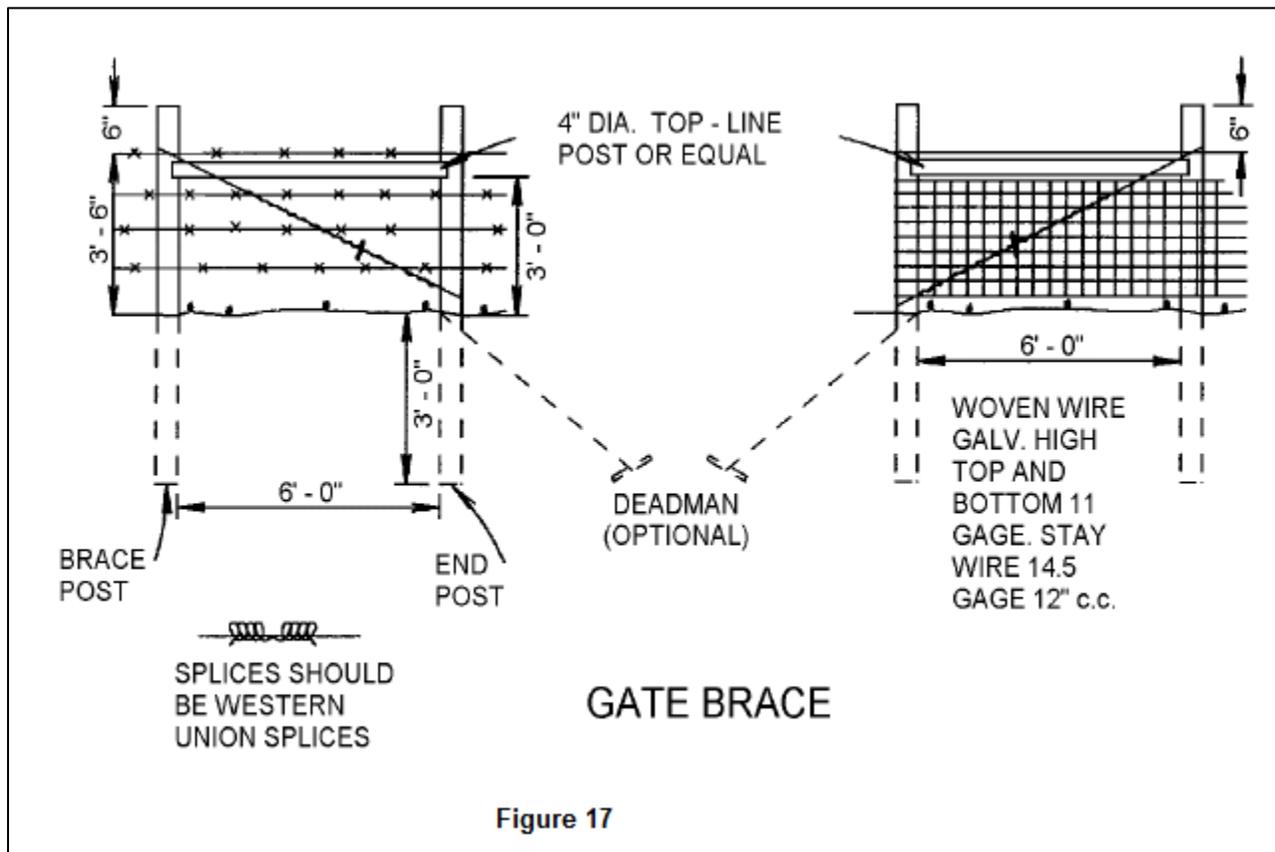
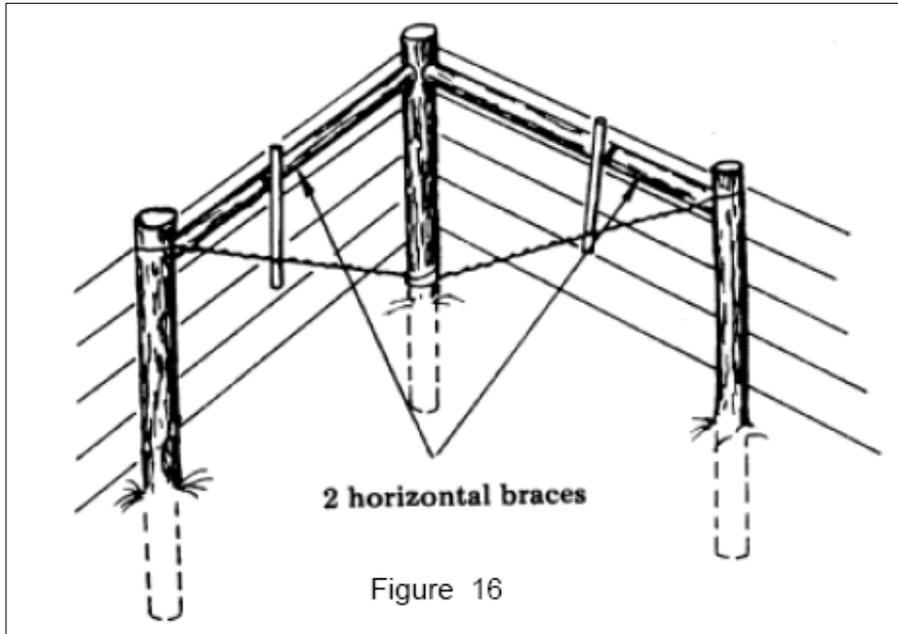


Figure 15 - Five-Post Corner Brace



Practical lengths for compression members of diagonal (or horizontal) fence strainers

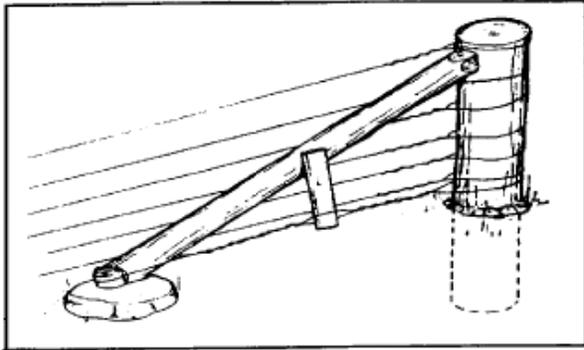


Figure 1 Diagonal gate or fence end strainer.

Pipe size (in)	Wood $\frac{1}{2}$ diameter (in)	Practical length (ft)	Allowable length (ft)
2		8	10
2½		9½	12
3		12	14½
3½		13½	17
4		15	19
	3	7½	
	4	10	
	5	12½	
	6	15	
	7	17½	
	8	20	

$\frac{1}{2}$ Diameter at center and straight length assumed.

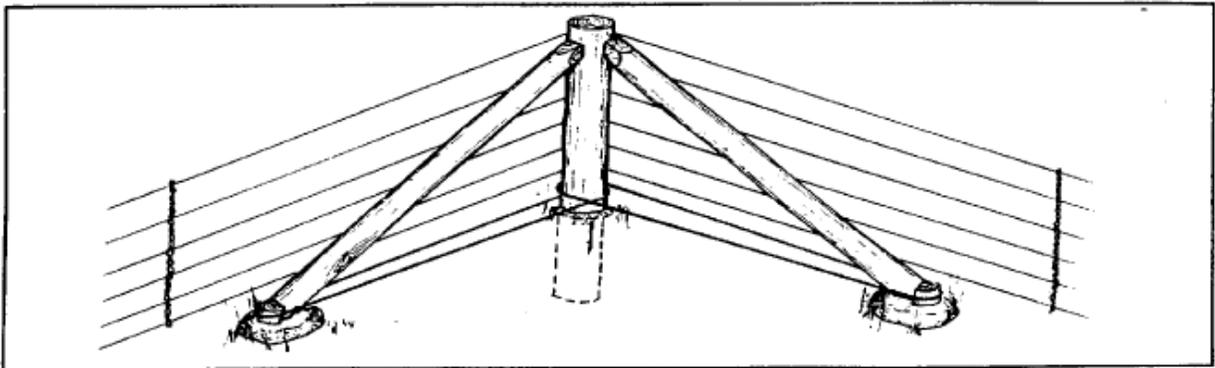


Figure 2 Two diagonal strainer corner braces.

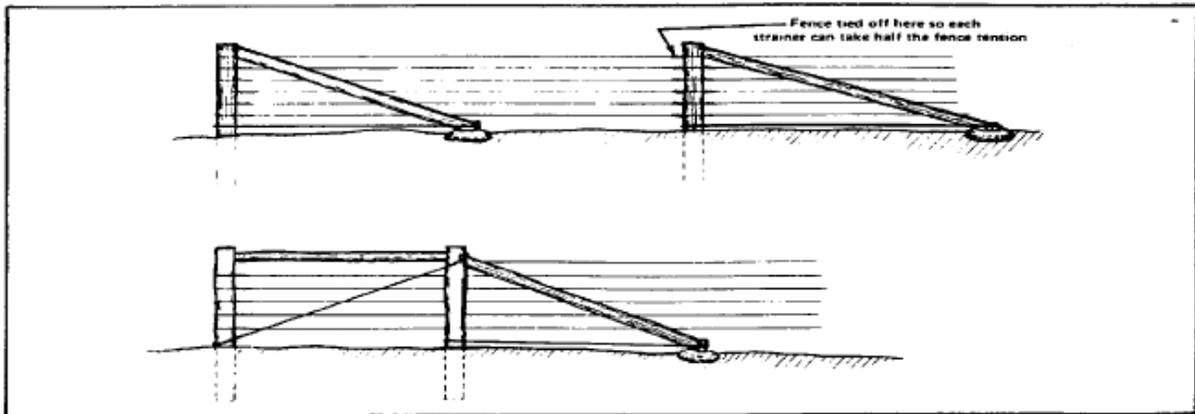


Figure 3 Use of two diagonal strainers for holding in soft soil. Also, one horizontal and one diagonal strainer could also be used as shown. Each of the diagonal strainers takes half of the tension in the fence; therefore, the fence must be tied off at each diagonal strainer.

Figure 18 - Diagonal Bracing and Strainers

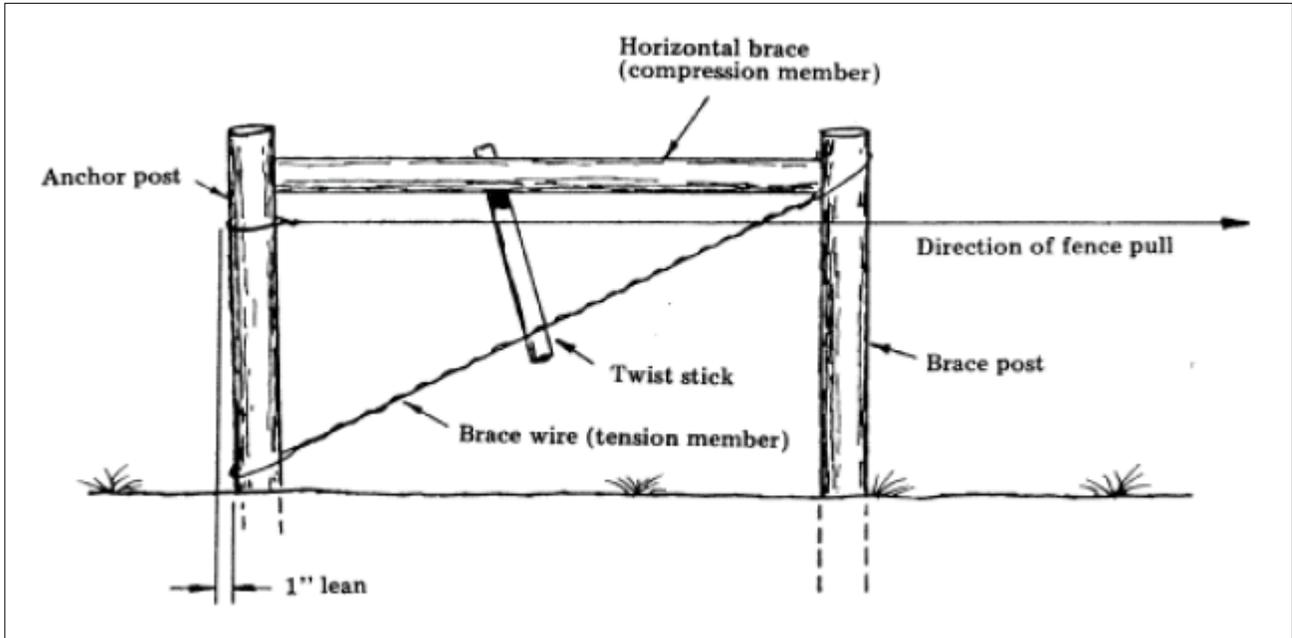


Figure 19 - Parts of Horizontal Brace

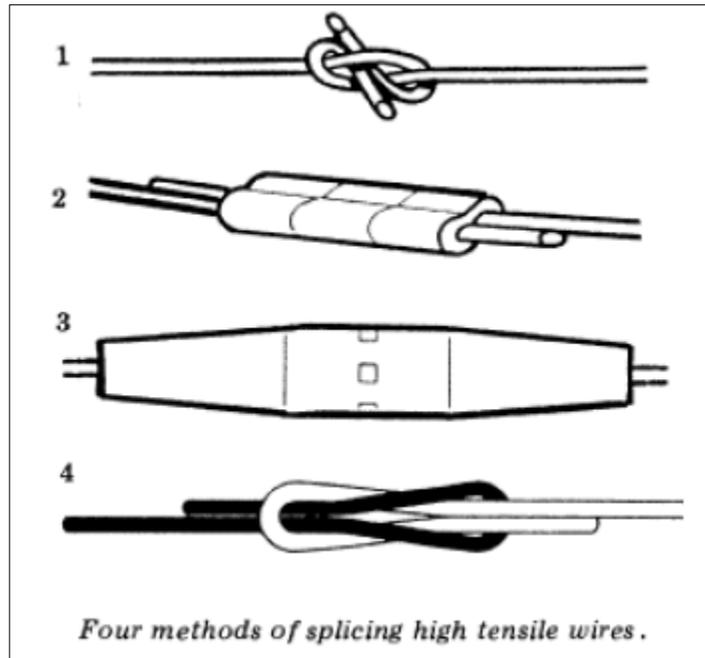
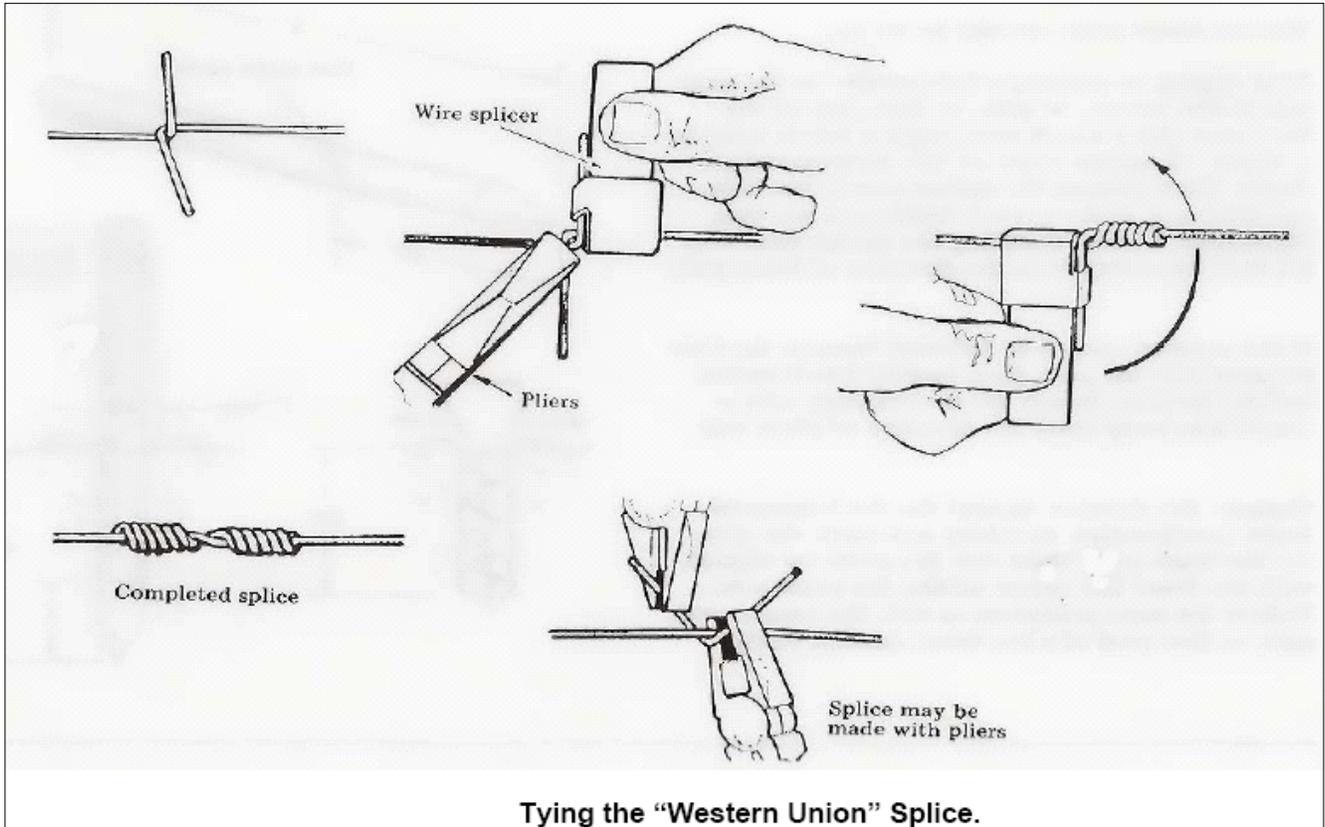


Figure 20



Tying the "Western Union" Splice.
Figure 21

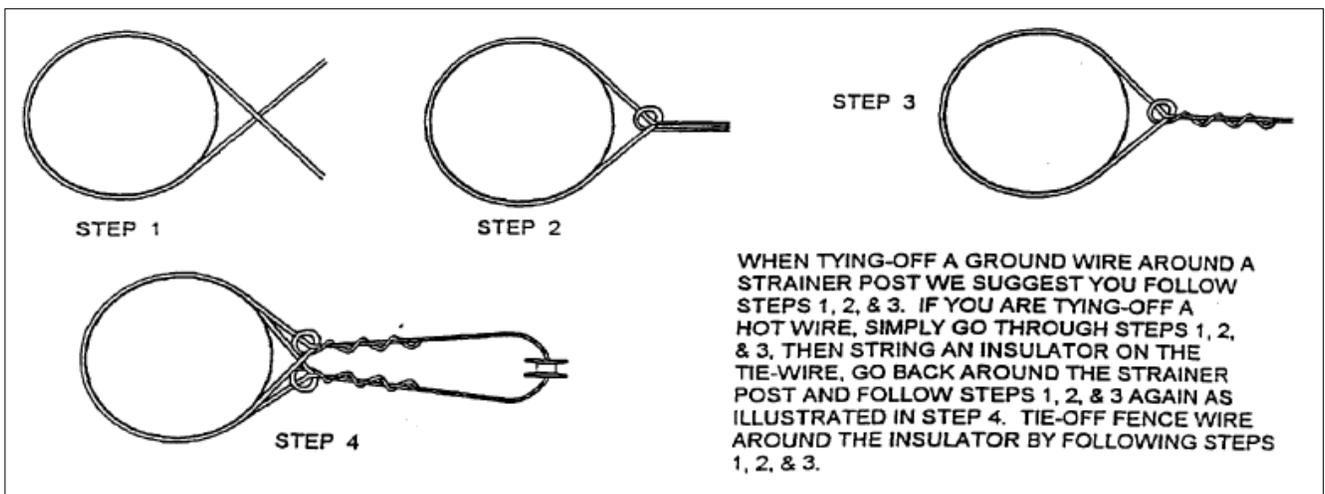


Figure 22 - Ground Wire Tying to Strainer Post

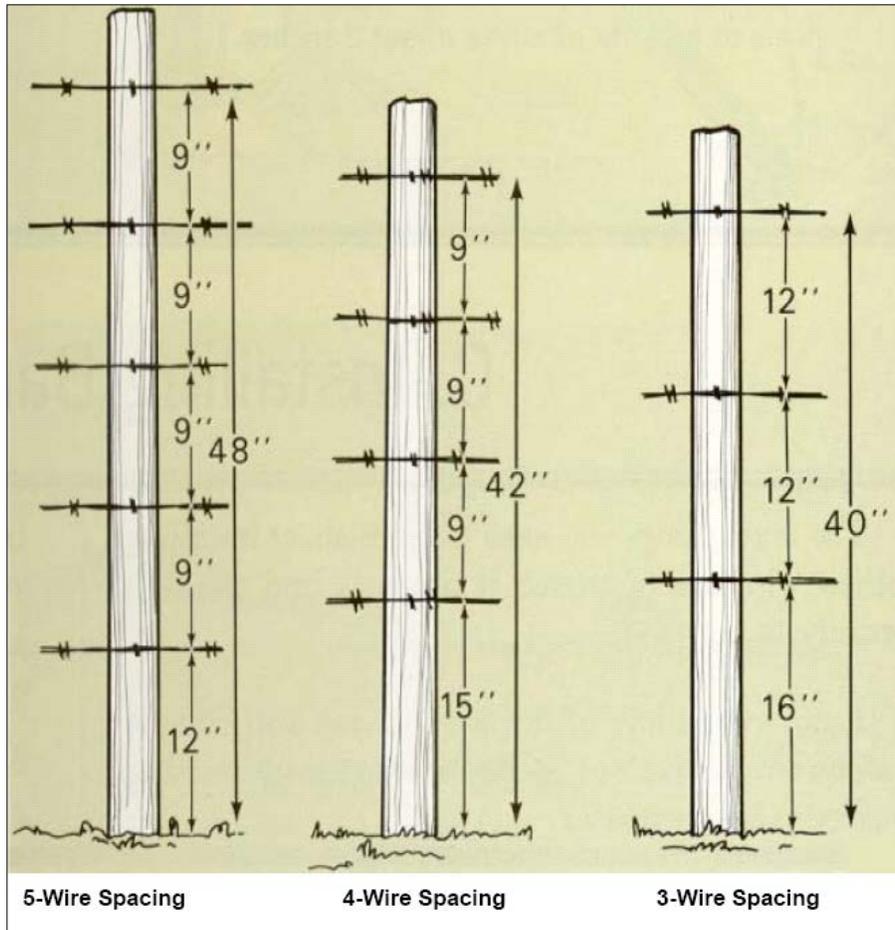


Figure 23 - Typical Barbed or Smooth Wire Spacing for Cattle

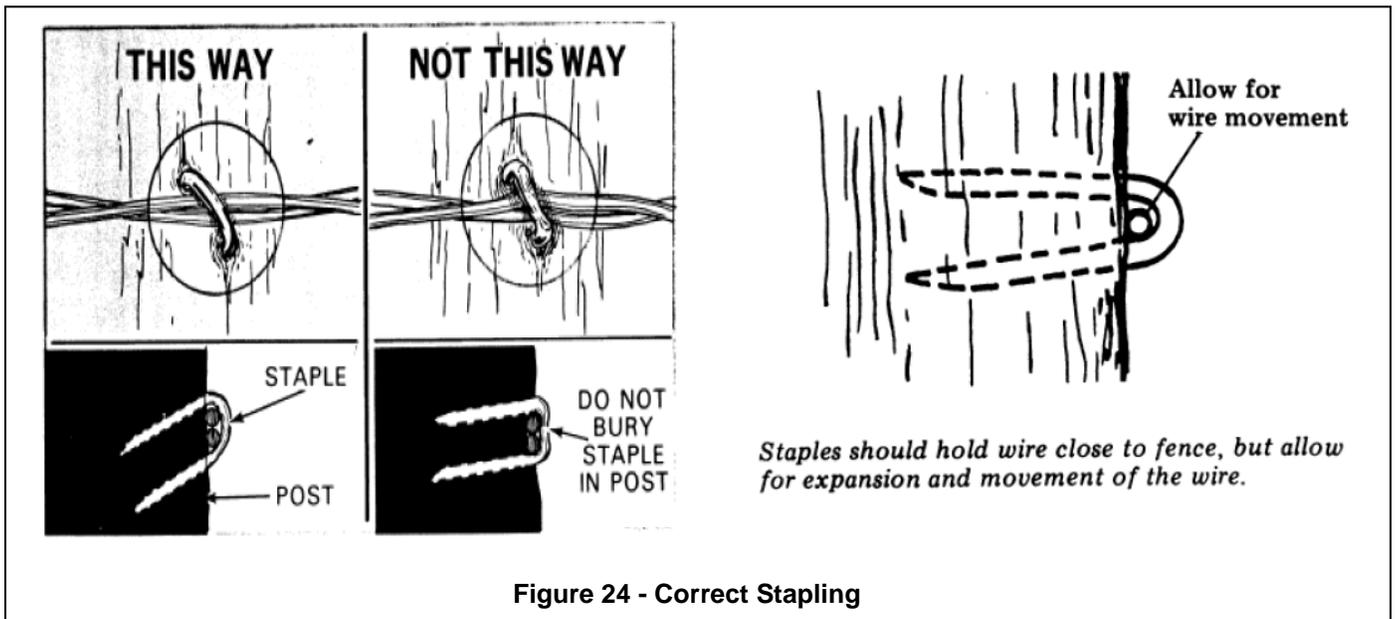


Figure 24 - Correct Stapling

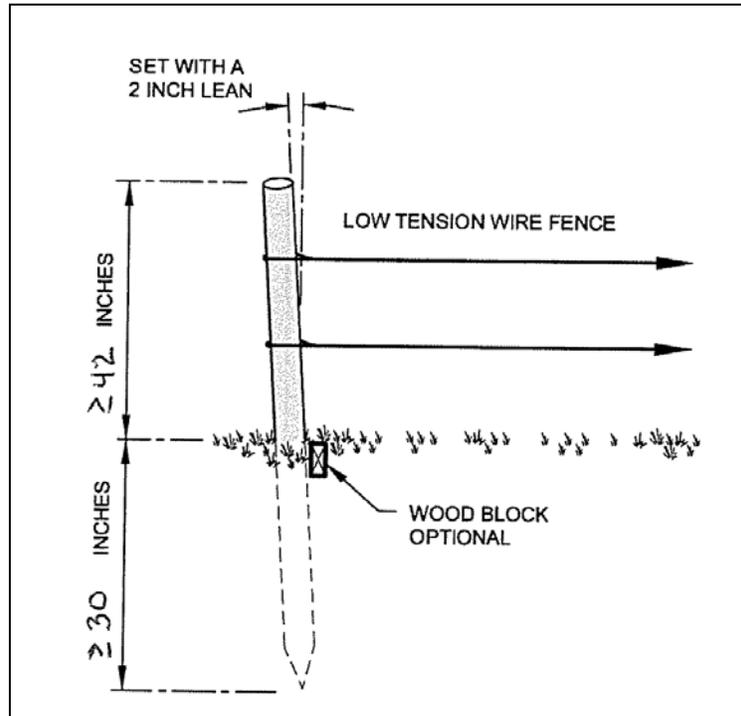


Figure 25 - Single Post Brace for Electric Fences Only

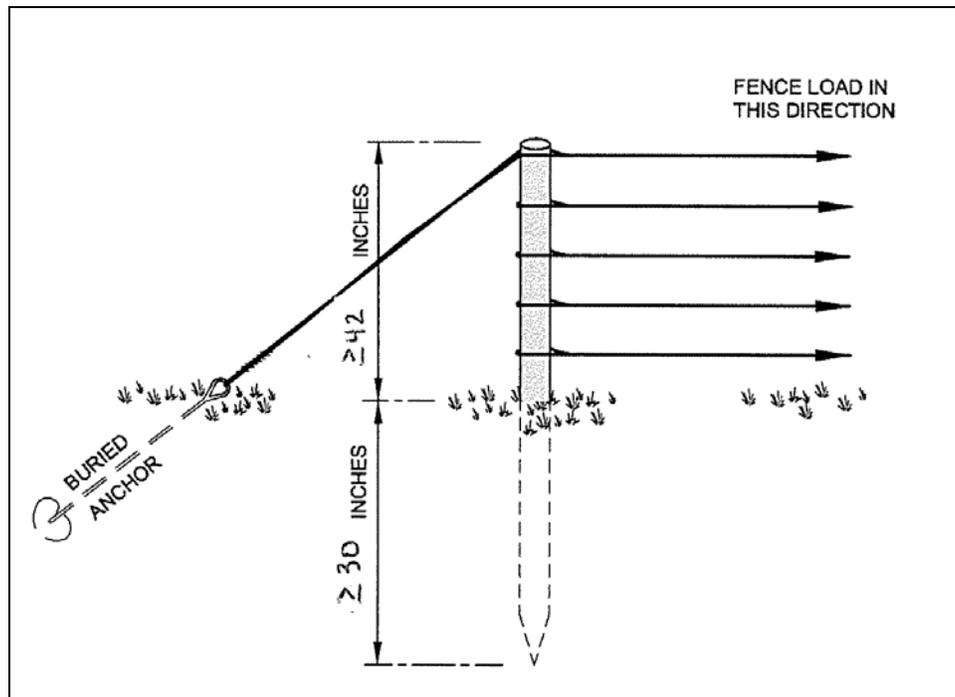


Figure 26 - Single Post with Anchor Deadman Brace for Electric Fences Only

Chart 1. Modified Diagonal Bracing Requirements for Single- or Double-Strand Electric Fences

Amount of Turn or Bend in Fence (degrees)	Vertical Post Minimum Diameter (in)	Vertical Post Minimum Length (ft)	Vertical Post Minimum Buried Depth (ft)	12-gauge Guy Wire Required*	Diagonal T-Post Deadman Required	Minimum Length of T-post Deadman (ft)	Minimum T-post Deadman (diagonal) Buried Depth (ft)
<20	4	6	2.5	no	no	N/A	N/A
21-45	4	6	2.5	maybe**	maybe**	4	3
46-68	4	6	2.5	yes	yes	5	4
>68	Use traditional H-Brace or Diagonal Brace as shown in 382-Fence specification.						

* If Guy Wire is needed, it will not interfere with the position of the electric wire.

** Use of a deadman and guy wire is not required when this fence angle bend is encountered. If the producer and planner do use them, also follow the minimum length and depth requirements for the deadman as shown. If neither are used, NRCS advises the producer to closely monitor the vertical posts for any weakness or leaning over time, and correct with installation of the deadman and guy wire as part of normal maintenance.

Chart 2. Wall Thickness of Steel Pipe.

Name	Schedule	O.D.	Actual I.D.	Wall Thickness	Lbs. / FT
1 ½ inch	40	1.900	1.610	0.145	2.72
2 inch	10	2.375	2.157	0.109	
	40	2.375	2.067	0.154	3.65
2 ½ inch	80	2.375	1.939	0.218	5.02
	10	2.875	2.635	0.120	
	40	2.875	2.469	0.203	5.82
3 inch	80	2.875	2.323	0.276	7.66
	10	3.500	3.260	0.120	
	40	3.500	3.068	0.216	7.58
	80	3.500	2.900	0.300	10.25

Chart 3. Rebar Sizes and Dimensions.

The size designations up through size 8 are the number of eighths of an inch in the diameter of a plain round bar having the same weight per foot as the deformed bar. So, for example, a number 5 bar would have the same mass per foot as a plain bar 5/8 inch in diameter. The metric size is the same dimension expressed to the nearest millimeter.

Bar designation number	Nominal diameter in inches (not including the deformations)	Metric designation number	Weight in pounds per foot
3	0.375	10	0.376
4	0.500	13	0.668
5	0.625	16	1.043
6	0.750	19	1.502
7	0.875	22	2.044
8	1.000	25	2.670
9	1.128	29	3.400
10	1.270	32	4.303
11	1.410	36	5.313
14	1.693	43	7.650
18	2.257	57	13.60

APPENDIX 1 – SMALL MAMMAL DETERRENT FENCE

Small Mammal-Deterrent Fence: Feral cats, dogs, mongoose and other mammals of comparable size are targeted for exclusion. The fence must be constructed following these specifications:

Vertical Fence Panels (Figure 27):

1. Use woven wire fence with mesh openings not greater than 6" x 6" as the "foundation wire". If using wire with graduated mesh openings, the small openings will be installed closest to the ground surface. The wire must be between 11 and 14.5 gauge, fixed-knot, high-tensile, bezinal coated. Select the preferred wire gauge and use that throughout the entire project. Do not vary gauge of the foundation wire. Finished height of the foundation wire will be no less than 6-feet (72 inches) above the ground surface. Common material available on the islands that will meet the requirement is 1775-6-12.5 Bekaert solidlock woven wire.
2. Overlay and fasten hexagonal mesh (no greater than 1-inch opening) chicken wire against all parts of the woven wire ("foundation wire"). The chicken wire goes on the outside of the fence when affixed to the posts. All chicken wire will be galvanized and fuse-bonded with polyvinyl chloride (PVC) to resist corrosion. Finished height of the chicken wire will equal the finished height of the foundation wire (no less than 6-feet above the ground surface), plus at least 1-foot to run along the ground on the outside of the fence and be anchored to the ground.
3. Fasten the woven mesh ("foundation wire") to the PVC-fused chicken wire with stainless steel wire clips or hog-rings. Use of stainless steel for all clips, fasteners, etc. is imperative to protect against corrosion. Fasten both wire meshes to all line, brace, corner and gate posts with stainless steel wires, clips or hog-rings.



Figure 27. Close up detail of woven wire and chicken wire overlay. Chicken wire is on the outside of the fence, woven wire is on the inside.

Floppy Top above the Vertical Panels (Figures 28 and 29):

1. At the top of the vertical mesh panels (foundation wire + chicken wire, described in items 1-3 above), construct a “floppy top” using the chicken wire supported by 7- or 9-gauge bezinal soft tie wire, or 12.5 gauge high-tensile bezinal coated wire, supports located at intervals no greater than 6-feet along the horizontal distance of the fence/floppy top. The wire supports need to be formed by hand and cut at the appropriate length to support the full arch of the floppy top.
2. Shape the floppy top into an arch that extends away from the vertical panels in the direction outside of the area protected by the fence. For example, if the area protected from small mammals is located on the left side of the fence, the floppy top will be arched over the right side of the fence (into the area were the small mammals are).
3. The outside end of the floppy top will be located at least 2 feet away from the vertical fence panel.



Figure 28. Floppy top showing the 9-gauge supports for the chicken wire and the arch.



Figure 29. Side view of floppy top construction.

Acceptable Posts, Spacing, Ground Wire Anchors, and Post Treatment (Figure 30):

1. Overall vertical fence height will be no less than 6 feet tall. Refer to Table 5 for appropriate post lengths and requirements.
2. All posts (line, corner, brace) will be either copper naphthenate (CuNap) double-treated wood, galvanized steel, or a combination of either. Refer to the Tables 5 and 6 for details on post treatment and specifications. The copper naphthenate treatment for wood posts lasts longer than CCA (chromated copper arsenate) in saturated and brackish soil conditions.
3. Line posts will be spaced at intervals between 8 to 10 feet along the length of the fence.
4. Install a length of hexagonal PVC-fused chicken wire along the ground on the outside of the fence (the side with the small mammals) to a horizontal distance of at least 1-foot. The wire will be anchored to the ground in 2 evenly-spaced intervals between every line post. For example, if the

line post spacing is 8 feet, the ground chicken wire can be anchored at 3-feet on either side each line post. If bedrock is encountered, run the chicken wire on top of it and drill the anchor pins into the rock to secure the wire. Water crossings will be encountered, and specific on-site guidance for installation will be provided by the NRCS State Rangeland Management Specialist or designee.

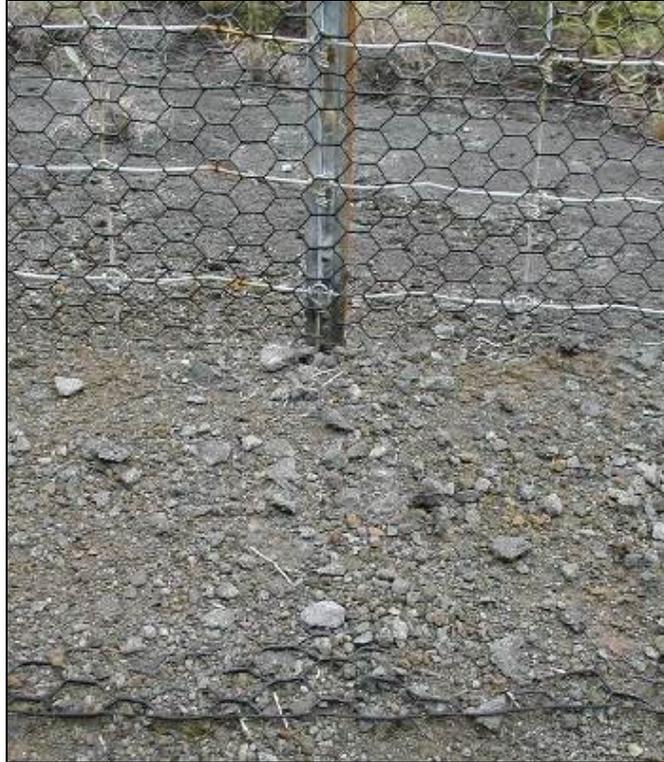


Figure 30. Ground lay with chicken wire and anchored to ground with fill placed over the wire.

Gates (Figures 31 and 32):

1. Gates should be of sufficient width to access the wetland complexes with machinery or equipment in order to maintain the integrity and function of the constructed ponds and wildlife habitat.
2. Gates can be either pre-fabricated tubular steel (e.g., Powder River type), hand-constructed wire with stays to retain their shape, chain link, or any other type that will maintain the ability of the fence to deter small mammals.
3. Because gates are often a main ingress/egress point for predators, all gates will have mesh openings not greater than 6" x 6" size and will be covered with the PVC-fused chicken wire. If the gates selected do not come from the manufacturer with mesh openings (e.g., 2" x 4" welded mesh), they will be covered with the foundation wire + PVC-fused chicken wire. At all gate hinges and openings, the foundation wire + chicken wire of the adjacent fence will overlap the hinge and opening locations at least 8-inches.
4. Once the gate is hung, if it does not come in close contact with the ground surface, the foundation wire + chicken wire will extend below the gate and come in contact with the ground surface, or a concrete sill will be installed at the bottom (see Figure 31) to prevent predator entry underneath each gate.



Figure 31. Access gate. Notice the concrete sill on the ground to prevent predator entry.



Figure 32. Close-up of access gate showing the use of mesh overlaps to prevent predator entry.

Additional Requirements:

Refer to Tables 5 through 11 for material and installation specifications and requirements.

MATERIAL SPECIFICATIONS

Small Mammal-Deterrent fences will be constructed that equal or exceed the strength and durability of a fence built in accordance with the materials specifications in the following tables: Table 5. Material Specifications for Corner Braces and Gate Posts; Table 9. Material Specifications for Line Posts; and Table 11. Material Specifications for Wire.

INSTALLATION SPECIFICATIONS

The fence will be installed in accordance with proper safety procedures. The completed job will 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 will be undertaken or installed. Installation requirements are detailed in the following tables: Table 6. Installation Specifications for Corner Braces and Gate Posts; Table 7. Installation Specifications for In-Line Horizontal (H) Braces; Table 8. Installation Specifications for In-Line Diagonal Braces; and Table 10. Installation Specifications for Line Posts.

BASIS FOR ACCEPTANCE

After the fence has been installed, a site inspection will be made to determine if the location, materials, design and installation were adhered to based on all site-specific documentation.

Table 5. 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, or eucalyptus (insultimber). • Redwood, cedar, or pine posts treated with a copper naphthenate double-treatment.
Rot Treatment	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 is 9 feet, including minimum 3 feet set in the 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: 8 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 is 9 feet, including minimum 3 feet set in the ground. • Minimum diameter: 5 inches at the smaller end. • Compression Member (horizontal or diagonal brace) of in-line brace assembly: <ul style="list-style-type: none"> ○ Minimum length: 8 feet ○ Minimum diameter: 4 inches.
Steel	
Corner Braces and Gate Posts	<ul style="list-style-type: none"> • Minimum length is 9 feet for Small Mammal-Deterrent, including minimum 3 feet set in ground. • Minimum diameter: 3 inches. • 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". • 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 angle 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. • Minimum length is 9 feet for Small Mammal-Deterrent, 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: 8 feet ○ Minimum inside diameter: 3 inches. • Posts will be set in concrete.

Table 6. Installation Specifications for Corner Braces and Gate Posts

Parameter	Specifications
Design and Installation	<p>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).</p> <p>The installation of the fence will conform to any provided figures, drawings or photographs.</p> <p>Consider the general landscape topography and fencing angles during the design phase to ensure that adequate fence height is achieved during construction. Pay close attention to potential access areas and design taller fence sections where predators may gain access in creative ways. For example, do not locate the fence where predators may climb adjacent obstacles such as trees, or where they may utilize adjacent topography or natural features to jump over the fence. If trees or natural features are close to the fence and may enable predator access, consider removing the trees/natural features, or relocate the fence.</p>
Horizontal Movement	<p>All in-ground posts will be placed to the required depth and will 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.</p> <p>Steel pipe, angle iron, U, T, or Y steel in-ground posts will be set in concrete.</p>
Soil Conditions and Vegetation Considerations	<p>Soil conditions; e.g., low strength (sandy or wet soils), 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, straddle jacks or rock cribs may have to be used.</p> <p>Remove adjacent vegetation (e.g., trees or shrubs) which may enable predator access into the fenced area. If obstructing vegetation cannot be removed (or should not be removed), seriously consider realigning or relocating the fence to provide optimal predator deterrence.</p>
Bracing	<p>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°).</p>
Post Length	<p>Minimum length of 9 feet, including minimum 3 feet set in the ground.</p>

Table 7. Installation Specifications for In-line Horizontal (H) Braces

Parameter	Specifications
Placement	<p>H compression posts will be installed at least 5 feet above the ground level and at least 6 inches from the top of the in-ground posts.</p>
Attachment	<p>H compression members will be secured to the in-ground posts with steel pins or dowels (rebar) or notched and spiked to the in-ground posts.</p>
Spacing	<p>Depending on the topography and design, in straight sections, brace units (pull posts) will be spaced at intervals from 66 feet to 990 feet.</p>
Anchor Post	<p>The anchor (end) post of an H-brace will be set with a one-inch (1") lean away from the direction of pull.</p>
Brace Wire	<p>A 12.5 gauge, 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.</p>

Table 8. Installation Specifications for In-line Diagonal Braces

Parameter	Specifications
Selection Considerations	<p>Diagonal braces using 12.5 gauge, doubled, twisted, smooth wire or wood or steel posts can be used in lieu of two horizontal braces.</p> <p>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.</p>
Design and Installation Principles	<p>In the design and installation of a diagonal brace or strainer, several principles should be kept in mind:</p> <ul style="list-style-type: none"> • Make the diagonal brace as long as possible (minimum of 8’). • 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 9. Material Specifications for Line Posts

Wood	
Specifications for Acceptable Wood Material	<ul style="list-style-type: none"> • Untreated posts of kiawe, koa, or eucalyptus (insultimber). • Redwood, cedar, or pine posts treated with a copper naphthenate double treatment.
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 is 8 feet, including minimum 2 feet set in ground. • 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 8 feet for small mammal-deterrent fences (2 feet buried + 6 feet above ground). Use of steel pipe, minimum 2 inch diameter, is acceptable. • Steel line posts will be rolled from high carbon steel and will 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 will be studded, embossed or punched for the attachment of wire to the posts.

Table 10 -- Installation Specifications for Line Posts

Parameter	Specifications
Minimum Depth and Setting	Line posts will be set at least two feet (2') in the ground. All fence posts will be erect within 2 inches (2") of plumb. All fence posts will deviate no more than 3 inches (3") of centerline.
Spacing	Maximum post interval will not exceed 10 feet.
Locations	All fence posts, particularly line posts, will be located on high points of corridor or grade breaks to prevent the woven wire course from "bellying".

Table 11 -- Material Specifications for Wire

Parameter	Specifications
Acceptable Materials	<p><u>Woven "Foundation" Wire:</u> A minimum of 72" height, no greater than 6" x 6" woven wire mesh using fixed-knot, high-tensile, bezinal coated wire. Use of 11-gauge wire is preferred, but wire no lighter than 14.5-gauge is acceptable. This foundation wire is to be located on the inside of the fence, and will be paired and overlain with:</p> <p><u>PVC-Fused Hexagonal "Chicken Wire" Mesh:</u> The chicken wire will be galvanized and fuse-bonded with PVC. It will be a minimum of 72" vertical height + at least 12" distance along the ground on the outside of the fence. Mesh openings not to exceed 1" in diameter. Additional mesh will be used to create the "floppy-top" arch that extends to the outside of the fence. The arch terminus will be at least 2-feet away from the vertical fence panels, and will be held rigid by the floppy-top support wires described below.</p> <p><u>Fasteners and Clips:</u> All fasteners and clips used to join the woven "foundation" wire to the PVC-fused chicken wire will be stainless steel. All clips used to join the mesh wires to all posts will be stainless steel. Staples may be used on wood posts:</p> <ul style="list-style-type: none"> • Gauge: Will be nine (9) or heavier polished (bright) hard wire. <ul style="list-style-type: none"> ○ Length: The shanks will 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. <p><u>Floppy-Top Support Wires:</u> The chicken wire floppy top will be supported by 7- or 9-gauge bezinal coated soft tie wire, or 12.5 gauge high-tensile bezinal coated wire. These supports will need to be cut and formed by hand to make the support braces for the arch. The arch of the floppy top will extend to the outside of the fence.</p>
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. • High Tensile Wire must conform to ASTM Standards: A854/A854M-98 and A679/A679M-00.
Galvanization	<ul style="list-style-type: none"> • Where stainless steel, PVC fusion, or bezinal coating is not specifically required, all remaining wire will be of new galvanized material. • 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.

APPENDIX 2 – GAME-PROOF FENCE

- **Game-Proof Fence:** Woven wire topped with 2 strands of barbed or smooth wire, minimum height 8 feet (8'). (Figure 33.)

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

MATERIAL SPECIFICATIONS

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 12. Material Specifications for Corner Braces and Gate Posts; Table 16. Material Specifications for Line Posts; Table 18 Material Specifications for Wire; and Table 20. Material Specifications for Fasteners and Stays.

INSTALLATION SPECIFICATIONS

The fence will be installed in accordance with proper safety procedures. The completed job will 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 will be undertaken or installed. Installation requirements are detailed in the following tables: Table 13. Installation Specifications for Corner Braces and Gate Posts; Table 14. Installation Specifications for In-Line Horizontal (H) Braces; Table 15. Installation Specifications for In-Line Diagonal Braces; Table 17. Installation Specifications for Line Posts; Table 21. Installation Specification for Channel Skirts; Table 22. Installation Specifications for Staples; and Table 23. Installation Specifications for Gates.

Table 12. 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"> • 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. <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 13. Installation Specifications for Corner Braces and Gate Posts

Parameter	Specifications
Design and Installation	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	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	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	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	Minimum: 11', including minimum 3' set in-ground.

Table 14. 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 (See Figure 19)	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 15. Installation Specifications for In-line Diagonal Braces

Parameter	Specifications
Selection Considerations (See Figures 18 and 19)	<p>Diagonal braces using doubled, twisted, smooth wire or wood or steel posts can be used to in lieu of two horizontal braces.</p> <p>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.</p>
Design and Installation Principles	<p>In the design and installation of a diagonal brace or strainer, several principles should be kept in mind:</p> <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 16. 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 17. Installation Specifications for Line Posts

Parameter	Specifications
Minimum Depth and Setting	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	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	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 18. Material Specifications for Wire

Parameter	Specifications
Acceptable Materials	<ul style="list-style-type: none"> 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.
Galvanization (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 7 and 9)	<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.
Galvanization (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 18. Material Specifications for Wire (continued)

Parameter	Specifications
Woven Wire	
Federal Specification (See Figure 10)	<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.
Galvanization (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.

Table 19. Protection and Half-Strength of Galvanization in Various Climates

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 20. Material Specifications for Fasteners and Stays

Parameter	Specifications
Fasteners (for attaching wire to posts) (See Figures 11 and 12)	<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.

Table 21. Installation Specifications for Channel Skirts

Specifications
<ul style="list-style-type: none"> • 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. • If the soil substrate is least 2 feet or greater in depth, the following anchor specifications shall be followed: <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. • If the soil substrate is less than 2 feet in depth, the following anchor specifications shall be followed: <ul style="list-style-type: none"> ○ The soil substrate shall be cleaned off the rock substrate at the anchor point with a shovel. <u>Option 1 (Eyebolt):</u> <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. <u>Option 2 (26-inch long Anchor):</u> <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 22. Installation Specifications for Staples

Specifications
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 23. Installation Specifications for Gates

Specifications
<ul style="list-style-type: none">• Standard 6-panel, galvanized steel ranch gates can be utilized as necessary. (Figure 34.)<ul style="list-style-type: none">○ 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 34.○ 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.

