

CORPS OF ENGINEERS

SECTION 02821A

FENCING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 116	(1995) Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric
ASTM A 121	(1999) Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 153/A 153M	(1998) Zinc-Coated (Hot Dip) on Iron and Steel Hardware
ASTM A 176	(1999) Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A 392	(1996) Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 478	(1997) Chromium-Nickel Stainless Steel Weaving and Knitting Wire
ASTM A 491	(1996) Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 585	(1997) Aluminum-Coated Steel Barbed Wire
ASTM A 666	(1999) Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM A 702	(1989; R 1994e1) Steel Fence Posts and Assemblies, Hot Wrought
ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 824	(1995) Metallic-Coated Steel Marcellled Tension Wire for Use with Chain Link Fence
ASTM C 94/C 94M	(2000) Ready-Mixed Concrete
ASTM D 4541	(1995e) Pull-Off Strength of Coatings Using Portable Adhesion Testers

ASTM F 626	(1996a) Fence Fittings
ASTM F 668	(1999a) Poly (Vinyl Chloride) (PVC)-Coated Steel Chain-Link Fence Fabric
ASTM F 883	(1997) Padlocks
ASTM F 900	(1994) Industrial and Commercial Swing Gates
ASTM F 1043	(1999) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1997) Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F 1184	(1994) Industrial and Commercial Horizontal Slide Gates
ASTM F 1664	(1995) Specification for Poly (Vinyl Chloride) (PVC)-Coated Steel Tension Wire Used with Chain-Link Fence
ASTM G 23	(1996) Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 26	(1996) Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 53	(1996) Operating Light – and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C1	(1997) All Timber products – Preservative Treatment by Pressure Processes
AWPA C4	(1995) Poles – Preservative Treatment by Pressure Processes

1.2 SUBMITTALS

Government approval is required for submittals with a “G” designation; submittals not having a “G” designation are for information only. When used, a designation following the “G” designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-07 Certificates

Chain Link Fence; (_____), (_____)

Statement, signed by an official authorized to certify on behalf of the manufacturer, attesting that the chain link fence and component materials meet the specified requirements.

SD-10 Operation and Maintenance Data

Electro-Mechanical Locks; (_____), (_____)
Gate Operator; (_____), (_____)

(Six) (_____) copies of operating and maintenance instructions, a minimum of 2 weeks prior to field training. Operating instructions shall outline the step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance instruction shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include the general gate layout, equipment layout and simplified wiring and control diagrams of the system as installed.

1.3 APPROVAL OF POLYVINYL CHLORIDE-COATED FENCE MATERIALS

Polyvinyl chloride-coated fence materials shall be thoroughly inspected for cracking, peeling, and conformance with the specifications by the Contracting Officer's Representative prior to installation. Any fence materials rejected by the Contracting Officer's Representative shall be replaced by the contractor with approved materials at no additional cost to the Government.

PART 2 PRODUCTS

2.1 FENCE FABRIC

Fence fabric shall conform to the following:

2.1.1 Chain Link Fence Fabric

(ASTM A 392, [Class 1] [Class 2], zinc-coated steel wire with minimum coating weight of [370] [610] grams of zinc per square meter of coated surface, or ASTM A 491, Type I, aluminum-coated steel wire.) [Class 2b polyvinyl chloride-coated steel fabric with 92 grams of zinc coating per square meter in accordance with ASTM F 668.] Fabric shall be fabricated of 9 gauge wire woven in 50 mm mesh. [Polyvinyl chloride coating for fabric and all other fence components shall be manufacturer's standard [_____] in color.) Fabric height shall be ([1.8] [2.1] m) ([_____] meters) (as shown). Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

2.1.2 Woven Wire

Woven wire shall conform to ASTM A 116 (No. 9 farm) (No. 12-1/2 close mesh) (No. 14-1/2 wolf-proof) (No. 13 poultry and garden) (No. 14-1/2 chick) fence; grade, size as indicated.

2.2 GATES

ASTM F 900 and/or ASTM F 1184. Gate shall be the type and swing shown. Gate frames shall conform to strength and coating requirements of ASTM F 1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 1-1/2. Gate frames shall conform to strength and coating requirements of ASTM F 1043, for Group IC, steel pipe with external coating Type A or Type B, nominal pipe size (NPS) 1-1/2. [Gate frames shall be polyvinyl chloride-coated steel pipe (Group IA) (Group IC) with external coating Type A, a nominal pipe size (NPS) 1-1/2, conforming to ASTM F 1043. Gate fabric shall be as specified for chain link fabric. Gate leaves more than 2.44 m wide shall have either intermediate members and diagonal truss rods or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 2.44m wide shall have truss rods or intermediate braces. Intermediate braces shall be provided on all gate frames with an electro-mechanical lock. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that the padlock will be accessible from both sides of the gate. Stops shall be provided for holding the gates in the open position. For high security applications, each end member of gate frames shall be extended sufficiently above the top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence.

2.3 POSTS

2.3.1 Metal Posts for Chain Link Fence

ASTM F 1083, zinc-coated. Group IA, with external coating Type A steel pipe. Group IC steel pipe, zinc-coated with external coating Type A or Type B and **Group II formed steel sections, shall meet the strength and coating requirements of ASTM F 1043.** Group III, ASTM F 1043 steel H-section may be used for line posts in lieu of line post shapes specified for the other classes. (Post shall be either Group IA steel pipe, Group IC, Group II, formed steel sections, or Group III steel H-sections and shall be zinc coated [Type A] and polyvinyl chloride coating conforming to the requirements of ASTM F 1043.) Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate and pull) posts selected shall be of the same designation throughout the fence. Gate post shall be for the gate type specified subject to the limitation specified in ASTM F 900 and/or ASTM F 1184.

2.3.2 Metal Posts for Farm Style Fence

Metal posts shall conform to ASTM A 702 zinc-coated, (T-Section) (U-Section); length as indicated. Accessories shall conform to ASTM A 702.

2.3.3 Composite Polyester Resin Reinforced Line Posts

Polyester resin reinforced line posts shall be produced from unsaturated polyester resin reinforced with E-glass. Posts shall be filled with an appropriate filler material to form a rigid structural support member. The post shall meet the strength requirements of ASTM F 1043 for heavy industrial fencing. Posts shall be protected from UV and moisture degradation by a protective veil impregnated with resin (0.2 to 0.3 mm minimum) and an acrylic based (0.05 mm minimum) coating system. Posts shall exhibit corrosion and ultraviolet resistance as demonstrated when exposed to accelerated environmental test chamber for not less than 3,600 hours. The post shall show no structural failure (i.e. less than 10% loss of strength) as a result of exposure to moisture and lamps required in ASTM G 23, ASTM G 26 and ASTM G 53. Post coating system strength shall be tested in accordance with ASTM D 4541 for 90% adhesion strength. Posts shall be (green) (black) (brown) in color. Provide outside diameter as specified in ASTM F 1043 for round steel pipe.

2.3.4 Wood Posts

Wood posts shall be cut from sound and solid trees free from short or reverse bends in more than one plane. Tops shall be convex rounded or inclined. Posts shall be free of ring shake, season cracks more than 6 mm wide, splits in the end, and unsound knots. Size and shape of posts shall be as indicated. Posts shall be treated in accordance with AWWA C1 or AWWA C4 as applicable.

2.4 BRACES AND RAILS

ASTM F 1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F 1043. (Braces and rails shall be [Group IA] [Group IC], steel pipe, size NPS 1-1/4 or **Group II, formed steel sections, size 42 mm [1-21/32 inch] and shall be zinc coated [Type A] and polyvinyl chloride-coated conforming to the requirements of ASTM F 1043.** **Group II, formed steel sections, size 42 mm (1-21/32 inch), conforming to ASTM F 1043, may be used as braces and rails if Group II line posts are furnished.**

2.3.5 WIRE

2.5.1 Tension Wire

Tension wire shall be Type I or Type II, Class 2 coating, in accordance with ASTM A 824.

2.5.2 Barbed Wire for Farm Style Fence

Barbed wire shall conform to ASTM A 121 (uncoated) (zinc-coated) (copper-coated), Class 1, 13 gauge wire with 13-1/2 gauge 4-point barbs spaced no more than 150 mm apart.

2.6 ACCESSORIES

ASTM F 626. Ferrous accessories shall be zinc or aluminum coated. (Ferrous accessories shall also be polyvinyl chloride-coated, minimum thickness of 0.152 mm, maximum thickness of 0.381 mm. Color coating of fittings shall match the color coating of the fabric.) Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provision for adjustment. Barbed wire shall be 2 strand, 12-1/2 gauge wire, zinc-coated, Class 3 in accordance with ASTM A 121 or aluminum coated Type I in accordance with ASTM A 585. Barbed wire shall be four-point barbed type steel wire. Barbed wire support arms shall be the (single) (V) arm type and of the design required for the post furnished. Tie wire for attaching fabric to rails, braces, and posts shall be 9 gauge steel wire and match the coating of the fence fabric. (Tie wires for attaching fabric to tension wire on high security fences shall be 1.6 mm stainless steel. The tie wires shall be a double loop and 165 mm stainless steel. The tie wires shall be a double loop and 165 mm [6.5 inches] in length.) Miscellaneous hardware coatings shall conform to ASTM A 153/A 153M unless modified. (Threaded hardware shall be painted to match polyvinyl chloride coatings.)

2.7 BARBED TAPE

Reinforced barbed tape, (double coil) (single coil), for fence toppings shall be fabricated from 430 series stainless steel with a hardness range of Rockwell (30N) 37-45 conforming to the requirements of ASTM A 176. The stainless steel strip shall be 0.6 mm thick by 25 mm wide before fabrication. Each barb shall be a minimum of 30.5 mm (1.2 inch) in length, in groups of 4, spaced on 102 mm (4 inch) centers. The stainless steel core wire shall have a 2.5 mm (0.098 inch) diameter with a minimum tensile strength of 9.68 MPa (140 psi) and shall be in accordance with ASTM A 478. (Reinforced barbed tape, single coil, for ground application shall meet the above requirements.) (Non-reinforced barbed tape, single coil, for ground applications shall be fabricated from 301 series stainless steel, with a hardness range of Rockwell [30N] 50-55, in accordance with ASTM A 666. The stainless steel strip shall be 0.6 mm thick by 31 mm wide before fabrication. Each barb shall be a minimum of 30.5 mm [1.2 inch] in length, in groups of 4, spaced on 102 mm [4 inch] centers.) Sixteen gauge stainless steel twistable wire ties shall be used for attaching the barbed tape to the barbed wire (and to the fence for ground application).

2.8 CONCRETE

ASTM C 94/C 94M, using 19 mm maximum size aggregate, and having minimum compressive strength of 21 MPa at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

2.9 PADLOCKS

Padlocks shall conform to ASTM F 883, Type (PO1) (_____), Option(s) (A, B and G) (_____) (and) (_____), Grade (6) (_____). (EPB), Size 44 mm (1-3/4 inch). (All padlocks shall be keyed alike.) (All padlocks shall be keyed alike.) (All padlocks shall be keyed into master key system as specified in Section 08700 BUILDERS' HARDWARE.)

2.10 GATE OPERATOR

Electric gate operators for sliding gates shall be as follows: Electrical gate operators shall have a right angle gearhead instantly reversing motor with magnetic drum-type brake, friction disc clutch, reversing starter with thermal overload protection, and a chain-driven geared rotary-type automatic limit switch. Gears shall consist of a hardened steel machine cut worm and mating bronze gear. All gears and bearings shall operate in a bath of oil. Gate operators with V-belt pulleys will not be allowed. Gate operators shall be equipped with an emergency release to allow the gate to be operated manually. The emergency release mechanism shall be capable of being locked in the engaged or disengaged position. Positive stops shall be provided on the gate tracks as a backup to the limit switches.

2.11 ELECTRO-MECHANICAL LOCKS

Electro-mechanical locking devices for sliding gates and personnel gates shall be solenoid actuated such that the deadbolt retracts when the solenoid is energized and remains electronically retracted until the gate is closed. The solenoid shall be the continuous duty type, rated for 120V AC, 60Hz operation. The locking device shall be unlockable by key and shall be keyed on both sides. Status of the electro-mechanical lock shall be monitored by two limit switches (integral to the locking device) wired in series. One switch shall monitor the deadlock lever and the other switch shall monitor the locking tongue.

PART 3 EXECUTION

3.1 INSTALLATION

Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Line posts shall be spaced equidistant at intervals not exceeding 3 m (10 feet). Terminal (corner, gate and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 152.4 m (500 feet). Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A 780.

3.2 EXCAVATION

Post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a (25) (50) mm clearance between the bottom of the fabric and finish grade.

3.3 POST INSTALLATION

3.3.1 Posts for Chain Link Fence

Posts shall be set plumb and in alignment. Except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 457 mm (18 inches) in rock. Where solid rock is

covered with an overburden of soil or loose rock, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 457 mm (18 inches) in solid rock is achieved before reaching the indicated depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than diameter shown on the drawings. Diameters of holes in solid rock shall be at least 25 mm (1 inch) greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. Group II line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Driven posts shall be set to a minimum depth of 914 mm (3 feet) and shall be protected with drive caps when being set. For high security fences, fence post rigidity shall be tested by applying a 222.4 newtons (50 pound) force on the post, perpendicular to the fabric, at 1.52 m (5 feet) above ground; post movement measured at the point where the relaxed position; every tenth post shall be tested for rigidity; when a post fails this test, further tests on the next four posts on either side of the failed post shall be made; all failed posts shall be removed, replaced, and retested at the Contractor's expense.

3.3.2 Posts for Farm Style Fence

For wood posts, the Contractor shall excavate to depth indicated and brace post until backfill is completed. Backfill shall be placed in layers of 229 mm or less, moistened to optimum condition, and compacted with hand tampers or other approved method. Posts shall be set plumb and in proper alignment. Metal posts shall be driven or set in concrete as indicated.

3.4 RAILS

3.4.1 Top Rail

Top rail shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail. Top rail, if required for high security fence, shall be installed as indicated on the drawings.

3.4.2 Bottom Rail

The bottom rail shall be bolted to double rail ends and double rail ends shall be securely fastened to the posts. Bolts shall be peened to prevent easy removal. Bottom rail shall be installed before chain link fabric.

3.5 BRACES AND TRUSS RODS

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over 1.83 m (6 feet) in height. A center brace or 2 diagonal truss rods shall be installed on 3.66 m (12 foot) fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal. No bracing is required on fences 1.83 m (6 feet) high or less if a top rail is installed.

3.6 TENSION WIRES

Tension wires shall be installed along the (top and) (bottom) of the fence line and attached to the terminal posts of each stretch of the fence. Top tension wires shall be installed within the top (305) (102) mm of the installed fabric. Bottom tension wire shall be installed within the bottom 152 mm (6 inches) of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

3.7 CHAIN LINK FABRIC

Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 381 mm (15 inch) intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 381 mm (15 inch) intervals and fastened to all rails and tension wires at approximately (610) (305) mm intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be (50) (25) mm plus or minus 13 mm above the ground. For high security fence, after the fabric installation is complete, the fabric shall be exercised by applying a 222 newtons (50 pound) push-pull force at the center of the fabric between posts; the use of a 133 newtons (30 pound) pull at the center of the panel shall cause fabric deflection of not more than 63.5 mm (2-1/2 inches) when pulling fabric from the post side of the fence; every second fence panel shall meet this requirement; all failed panels shall be resecured and retested at the Contractor's expense.

3.8 BARBED WIRE SUPPORTING ARMS AND BARBED WIRE

3.8.1 General Requirements

Barbed wire supporting arms and barbed wire shall be installed as indicated and as recommended by the manufacturer. Supporting arms shall be anchored (to the posts in a manner to prevent easy removal with hand tools) (with 9.5 mm [3/8 inch] diameter plain pin rivets or, at the Contractor's option, with studs driven by low-velocity explosive-actuated tools for steel, wrought iron, ductile iron, or malleable iron. Studs driven by an explosive-actuated tool shall not be used with gray iron or other material that can be fractured. A minimum of two studs per support arm shall be used.) Barbed wire shall be pulled taut and attached to the arms with clips or other means that will prevent easy removal.

3.8.2 Barbed Wire for Farm Style Fence

Wire shall be installed on the side of the post indicated. Wire shall be pulled taut to provide a smooth uniform appearance, free from sag. Wire shall be fastened to line posts at approximately 381 mm intervals unless indicated otherwise.

3.9 GATE INSTALLATION

Gates shall be installed at the location shown. Hinged gates shall be mounted to swing as indicated. Latches, stops, and keepers shall be installed as required. (Slide) (Lift) gates shall be installed as recommended by the manufacturer. Padlocks shall be attached to gates or gate posts with chains. Hinge pins, and hardware shall be welded or otherwise secured to prevent removal. For farm style fencing, standard metal gate assemblies with frame and fittings necessary for complete installation or wood gates shall be furnished as shown.

3.10 BARBED TAPE INSTALLATION

Stainless steel reinforced barbed tape shall be installed as detailed on the drawings. Barbed tape shall be stretched out to its manufacturer's recommended length, set on top of the barbed wire and "V" shaped support arms, and then secured to the barbed wire. The barbed tape shall be secured to the barbed wire at the two points and at every spiral turn of both coils as shown on the drawings. Stainless steel (reinforced) (non-reinforced) barbed tape for ground applications shall be installed (per manufacturer's recommendations) (as shown on the drawings).

3.11 GROUNDING

(Fences crossed by overhead powerlines in excess of 600 volts shall be grounded as specified in Section 13100 LIGHTENING PROTECTION SYSTEM. Electrical equipment attached to the fence shall be grounded as specified in [Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL] [Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND].) (Fences shall be grounded on each side of all gates, at each corner, at the closest approach to each building within 15 m of the fence, and where the fence alignment changes more than 15 degrees. Grounding locations shall not exceed 198 m. Each gate panel shall be bonded with a flexible bond strap to its gate post. Fences crossed by powerlines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 45 m on each side of crossing. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be 19 mm [3/4 inch] by 3.05 m [10 foot] long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 152 mm [6 inches] below the grade. Where driving is impracticable, electrodes shall be buried a minimum of 305 mm deep and radially from the fence. The top of the electrode shall not be less than 610 mm or more than 2.4 m from the fence. Ground conductor shall be clamped to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. After installation the total resistance of fence to ground shall not be greater than 25 ohms.)

--End of Section--