
USACE / NAVFAC / AFCEA / NASA UFGS-02821A (April 2004)

Preparing Activity: USACE MasterFormat™ 2004 - 32 31 00.00 10
Superseding
UFGS-02821A (February 2002)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UML dated 23 June 2005

Latest change indicated by CHG tags

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE CONSTRUCTION

SECTION 02821A

FENCING

04/04

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 APPROVAL OF POLYVINYL CHLORIDE-COATED FENCE MATERIALS

PART 2 PRODUCTS

- 2.1 FENCE FABRIC
 - 2.1.1 Chain Link Fence Fabric
 - 2.1.2 Woven Wire
- 2.2 GATES
- 2.3 POSTS
 - 2.3.1 Metal Posts for Chain Link Fence
 - 2.3.2 Metal Posts for Farm Style Fence
 - 2.3.3 Composite Polyester Resin Reinforced Line Posts
 - 2.3.4 Wood Posts
- 2.4 BRACES AND RAILS
- 2.5 WIRE
 - 2.5.1 Tension Wire
 - 2.5.2 Barbed Wire for Farm Style Fence
- 2.6 ACCESSORIES
- 2.7 BARBED TAPE
- 2.8 CONCRETE
- 2.9 PADLOCKS
- 2.10 GATE OPERATOR
- 2.11 ELECTRO-MECHANICAL LOCKS

PART 3 EXECUTION

- 3.1 INSTALLATION
- 3.2 EXCAVATION
- 3.3 POST INSTALLATION

- 3.3.1 Posts for Chain Link Fence
- 3.3.2 Posts for Farm Style Fence
- 3.4 RAILS
 - 3.4.1 Top Rail
 - 3.4.2 Bottom Rail
- 3.5 BRACES AND TRUSS RODS
- 3.6 TENSION WIRES
- 3.7 CHAIN LINK FABRIC
- 3.8 BARBED WIRE SUPPORTING ARMS AND BARBED WIRE
 - 3.8.1 General Requirements
 - 3.8.2 Barbed Wire for Farm Style Fence
- 3.9 GATE INSTALLATION
- 3.10 BARBED TAPE INSTALLATION
- 3.11 GROUNDING

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEA / NASA UFGS-02821A (April 2004)

Preparing Activity: USACE MasterFormat™ 2004 - 32 31 00.00 10
Superseding
UFGS-02821A (February 2002)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005

Latest change indicated by CHG tags

SECTION 02821A

FENCING

04/04

NOTE: This guide specification covers the requirements for chain link fence for general and high security applications and farm style fence.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

This guide specification includes tailoring options for chain link fence, high security fence, and farm style fence. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

NOTE: This section covers both general and high security applications for chain link fence and non security applications for farm style fences. Edit this section throughout for the applicable application(s).

Standard drawings STD 872-90-02 through 872-90-13 of

fence and gate types required will be included as part of the contract drawings; the standard drawings are available at <http://www.hnd.usace.army.mil/TECHINFO/index.htm>. Layout of fence will be shown including types and locations of gates, and gate sizes. Drawings will also indicate the extent of clearing required.

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C1	(2000) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C4	(1999) Poles - Preservative Treatment by Pressure Processes

ASTM INTERNATIONAL (ASTM)

ASTM A 116	(2000) Metallic-Coated, Steel Woven Wire Fence Fabric
ASTM A 121	(1999; R2004) Metallic-Coated Carbon Steel Barbed Wire
ASTM A 153/A 153M	(2004) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 176	(1999; R 2004) Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip

ASTM A 392	(2003) Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 478	(1997; R 2002) Chromium-Nickel Stainless Steel Weaving and Knitting Wire
ASTM A 491	(2003) Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 666	(2003) Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM A 702	(1989; R 2000) Steel Fence Posts and Assemblies, Hot Wrought
ASTM A 780	(2001) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 824	(2001) Metallic-Coated Steel Marcellled Tension Wire for Use With Chain Link Fence
ASTM C 94/C 94M	(2004a) Ready-Mixed Concrete
ASTM D 4541	(2002) Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM F 1043	(2004) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(2004) Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F 1184	(2003) Industrial and Commercial Horizontal Slide Gates
ASTM F 626	(1996a; R 2003) Fence Fittings
ASTM F 668	(2004) Poly(Vinyl Chloride) (PVC) and other Organic Polymer-Coated Steel Chain-Link Fence Fabric
ASTM F 883	(2004) Padlocks
ASTM F 900	(2003) Industrial and Commercial Swing Gates

1.2 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only

delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [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 instructions 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

NOTE: In salt-laden or corrosive industrial atmosphere, either Class 2 fabric with 610 grams (2.0 ounces) of zinc coating per square meter (foot) or Type I, aluminum-coated fabric, will be specified. In other areas, Class 1 with 370 grams (1.2 ounces) of zinc coating per square meter (foot) or Type I will be specified. Class 2b polyvinyl chloride-coated steel fabric may be specified for other than security purposes when esthetics is of prime importance and the additional cost is justified. Fabric height will be shown on the contract drawings. Fabric height shall be 1.83 m (6 feet) for controlled areas and 2.13 m (7 feet) for restricted areas.

[ASTM A 392, [Class 1] [Class 2], zinc-coated steel wire with minimum coating weight of [370] [610] grams [1.2] [2.0] ounces of zinc per square meter foot of coated surface, or ASTM A 491, Type I, aluminum-coated steel wire.] [Class 2b polyvinyl chloride-coated steel fabric with 92 grams 0.3 ounces of zinc coating per square meter foot in accordance with ASTM F 668.] Fabric shall be fabricated of 9 gauge wire woven in 50 mm 2 inch 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 [6] [7] feet [[_____] meters feet] [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

NOTE: Type of gates will be shown on the drawings, including degree of swing required. In heavy use conditions overhead slide gates should be considered if clearances permit, because these gates require less maintenance and repair than cantilever gates. Ground level track and roller systems should be avoided in climates where snow and ice may accumulate. Recessed tracks should never be used in

climates where the recess may fill with ice and snow. Where gates are to receive electric locks, the gate post foundations should be lowered to frost depth to help prevent misalignment of the lock components.

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 8 feet 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 2.44 m 8 feet 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

**NOTE: For high security fences that are to be
sensored, posts will be limited to Group IA or Group
IC steel pipe only.**

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, roll-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, roll-formed steel sections, or Group III steel H-sections and shall be zinc coated (Type A) and polyvinyl chloride coated 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

NOTE: Composite posts are not allowed for high security fences. Except for high security applications, composite posts may be used as an alternative to PVC coated steel line posts in salt-laden or corrosive industrial atmospheres. Since composite posts are non-conductive, fence grounding procedures need to be detailed where grounding of the fence is required.

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 8 to 12 mil minimum) and an acrylic based (0.05 mm 2 mil 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. 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 1/4 inch wide, splits in the end, and unsound knots. Size and shape of posts shall be as indicated. Posts shall be treated in accordance with AWP A C1 or AWP A C4 as applicable.

2.4 BRACES AND RAILS

NOTE: Normally rails will not be specified except where appearance is important and the added cost is justified. When top rails are not specified, top tension wire will be used. Bottom tension wire will be specified unless a bottom rail is required for high security fence.

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.

2.5 WIRE

2.5.1 Tension Wire

Tension wire shall be Type I or Type II, Class 4 coating, in accordance with ASTM A 824.

2.5.2 Barbed Wire for Farm Style Fence

Barbed wire shall conform to ASTM A 121 zinc-coated, Type Z, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire with 14 gauge, round, 4-point barbs spaced no more than 125 mm 5 inches apart.

2.6 ACCESSORIES

NOTE: Clips are not allowed on security fences.

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 0.006 inch, maximum thickness of 0.381 mm 0.015 inch. 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 provisions for adjustment. 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 16 gage 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 0.025 inch thick by 1 inch 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 0.025 inch thick by 1.21 inches 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 3/4 inch maximum size aggregate, and having minimum compressive strength of 21 MPa 3000 psi 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

NOTE: Type P01 is key operated. Grade 6 is the top grade commercial lock; in Option A the key is captive in cylinder when padlock is unlocked; in Option B the cylinder is removable; Option 6 is

environmentally resistant. For combination locks or other options and grades see ASTM F 883.

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 into master key system as specified in Section 08710 DOOR 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 electrically 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

NOTE: For farm style fence, the layout will be shown and will include fence section, height, mesh size, locations of straight-line and corner-post bracing, types and locations of gates, and gate sizes. Drawings will also indicate the extent of clearing required. Fences will not be located adjacent to natural or man-made terrain features that could provide easy access across the fence. The graded fence line will be indicated on the drawings where required.

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 [1] [2] inch clearance between the bottom of the fabric and finish grade.

3.3 POST INSTALLATION

3.3.1 Posts for Chain Link Fence

NOTE: For fences over 1.83 m (6 feet) tall in areas of frequent high winds (113 kph (70 mph) or greater), hole diameters of 406 mm (16 inches) for terminal posts and 305 mm (12 inches) for line posts will be specified.

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 a minimum depth 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 the 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 force is applied shall be less than or equal to 19 mm 3/4 inch from 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 9 inches 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

NOTE: Top rail will not be used on high security fences.

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

NOTE: This paragraph applies to high security fence applications only.

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

NOTE: For high security fence, the tension wire will be installed within the top 100 mm (4 inches) of the installed fabric.

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 [1 foot] [4 inches] 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

NOTE: Normally the bottom of fence fabric will be installed no higher than 50.8 mm (2 inches) from the ground. For Air Force projects, high security fence fabric will be installed no higher than 25 mm (1

inch) from the ground. The height requirement for fence fabric will be verified with the user. In areas where the soil along the fence line is prone to erosion, measures should be taken to maintain the level of security for which the fence is designed. Tension requirements are for high security fence applications. Fabric fastening requirement of 305 mm (12 inch) spacing to top tension wire and bottom rail is a high security fence requirement.

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 [24] [12] inch 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 [2] [1] plus or minus 1/2 inch 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

NOTE: Supporting arms for high security fence applications will be securely anchored with rivets to the line posts.

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 15 inch intervals unless indicated otherwise.

3.9 GATE INSTALLATION

Gates shall be installed at the locations 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

NOTE: Barbed tape is a high security fence option when required.

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

NOTE: Delete this paragraph if grounding is not required. If grounding is required and lightning protection is not part of project design, the requirements in the second set of brackets will be used in lieu of those in the first set of brackets. Provide fence grounding details when composite type posts are specified where grounding of the fence is required.

[Fences crossed by overhead powerlines in excess of 600 volts shall be grounded as specified in Section 13100A LIGHTNING PROTECTION SYSTEM. Electrical equipment attached to the fence shall be grounded as specified in [Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL] [Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND].] [Fences shall be grounded on each side of all gates, at each corner, at the closest approach to each building located within 15 m 50 feet of the fence, and where the fence alignment changes more than 15 degrees. Grounding locations shall not exceed 198 m 650 feet. 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 150 feet 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 12 inches deep and radially from the fence. The top of the electrode shall be not less than 610 mm 2 feet or more than 2.4 m 8 feet 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 --