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Standard Guide for Design and Construction of Chain Link Security Fencing[1]

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1. Scope

1.1 This guide provides the material and installation standards for selection in the design of a security chain link fence system. The proper material selection, system installation and layout can substantially increase the difficulty to penetrate; thereby, increasing the intrusion delay time.

1.2 This guide does not purport to address all of the physical protection security concerns. It is the responsibility of the user of this standard to establish the appropriate design for the level of physical protection required and determine the applicability of regulatory requirements or limitations prior to use.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 It is recommended that Guide F1553 be followed for the format of this guide.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A121 Specification for Metallic-Coated Carbon Steel Barbed Wire
A392 Specification for Zinc-Coated Steel Chain-Link Fence Fabric
A491 Specification for Aluminum-Coated Steel Chain-Link Fence Fabric
A817 Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire
A824 Specification for Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence
F552 Terminology Relating to Chain Link Fencing
F567 Practice for Installation of Chain-Link Fence
F626 Specification for Fence Fittings
F668 Specification for Polyvinyl Chloride (PVC), Polyolefin and Other Polymer-Coated Steel Chain Link Fence Fabric
F900 Specification for Industrial and Commercial Steel Swing Gates
F934 Specification for Colors for Polymer-Coated Chain Link Fence Materials
F1043 Specification for Strength and Protective Coatings on Steel Industrial Fence Framework
F1083 Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
F1184 Specification for Industrial and Commercial Horizontal Slide Gates
F1345 Specification for Zinc-5 % Aluminum-Mischmetal Alloy-Coated Steel Chain-Link Fence Fabric
F1553 Guide for Specifying Chain Link Fence
F1664 Specification for Poly(Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used with Chain-Link Fence
F1665 Specification for Poly(Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Barbed Wire Used With Chain-Link Fence
F1910 Specification for Long Barbed Tape Obstacles
F1911 Practice for Installation of Barbed Tape
F2200 Specification for Automated Vehicular Gate Construction
F2656 Test Method for Crash Testing of Vehicle Security Barriers
F2781 Practice for Testing Forced Entry, Ballistic and Low Impact Resistance of Security Fence Systems

2.2 *Chain Link Fence Manufacturers Institute:*

WLG 2445 Chain Link Fence Wind Load Guide for the Selection of Line Post and Line Post Spacing[3]
The Tested and Proven Performance of Security Grade Chain Link Fencing Systems

2.3 *U. S. Department of Defense:*

UFC 4-010-01 United Facilities Criteria, DOD Minimum Antiterrorism Standards for Buildings[4]

3. Terminology

3.1 Definitions, see Terminology F552.

[1] This guide is under the jurisdiction of ASTM Committee F14 on Fences and is the direct responsibility of Subcommittee F14.50 on High Security Fences and Perimeter Barriers.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Chain Link Fence Manufacturers Institute, 10015 Old Columbia Road, Suite B-215, Columbia, MD 21046, http://www.chainlinkinfo.org.

[4] Available electronically from United Facilities Criteria (UFC) Index, http://65.204.17.188//report/doc_ufc.html

4. Summary of Practice

4.1 Chain link fence systems can be designed to provide greater levels of security by selecting products and configurations that increase the difficulty to penetrate and in turn increase delay time. Some examples; increase the height of the fence, the configuration of chain link mesh size and wire gauge, securing the bottom of the fence by means of bottom rail, burying the chain link mesh, adding barbed wire to the top or barbed tape to the top, side or bottom of the fence, selecting stronger framework, adding multiple fence lines to create isolation zones, adding slats to the fencing to restrict visibility when required, and adding anti-ram cable systems to resist vehicle penetration into a protected perimeter.

5. Part 1—General

5.1 List the scope of work included; the performance requirements of the overall project security design criteria, the performance design criteria for the fence system, referenced contract documents, fence design and detail drawings, material specifications, related site work, site drawings with the specific fence layout, product and data submittals, certifications, site preparation, contractor qualifications, warranties and the fence integration with other security products.

5.1.1 Fence placement can be critical and should be well thought out and defined by the contract specifications and drawings. Placement should be coordinated with the grading plan to ensure it does not inhibit drainage flow by location or debris buildup.

5.1.2 Consideration should be given to the fence location to provide the proper offset to protect a building or provide a clear zone from trees, underbrush, buildings and structures. Qualifying Federal building sites require specified fence set back distances from the building in compliance with the DoD Minimum Antiterrorism Standards for Buildings, UFC 4-040-01.

5.1.3 Consideration should be given during design of the fence to ensure it will properly support the application of added intrusion detection devices. An integrated system using lighting with video surveillance requires a specific fence layout, for example, the fence must be located to avoid blocking the view or reduce shadows.

5.1.4 Signage posted along the fence line should always be a consideration.

5.1.5 Review Practice F2781 for testing security fence systems, and the Chain Link Fence Manufacturers Institute Tested and Proven Performance of Security Grade Chain Link Fencing Systems.

6. Materials and Sizes

6.1 *Chain Link Fabric:*

6.1.1 There are many chain link mesh design configurations; those to be considered for security fencing, in order of difficulty to penetrate are listed in Table 1.

6.1.2 Select the chain link mesh configuration from Table 1; choose the type of coating required from one of the following:

6.1.2.1 Zinc-Coated Steel in accordance with Specification A392, select Class 1 or Class 2 coating.

6.1.2.2 Aluminum Coated Steel in accordance with Specification A491.

6.1.2.3 Zinc-5% Aluminum-Mischmetal Alloy-Coated Steel in accordance with Specification F1345, Class 2.

6.1.2.4 Polyvinyl Chloride (PVC) and other Organic Polymer-Coated Steel in accordance with Specification F668, Class 2b. Select the color as listed in Specification F934.

6.2 *Fence Framework:*

6.2.1 *Line Posts*—Fences designed to provide increased security levels are generally of greater heights and utilize smaller mesh sizes, both of these factors result in added wind load resistance. Line post selection and the spacing of the posts should be designed to meet the anticipated wind loads based on the site geographical location and weather conditions. Increased post sizes or specific post spacing may be required to compensate for wind loading or increased security. The Chain Link Fence Manufacturers Institute's, Guide for the Selection of Line Posts and their Spacing, WLG 2445, guides the designer through the process to select the post size and post spacing. After calculating the post spacing and post dimensions select the post specification and protective coating from Specification F1043, Table 3, Heavy Industrial Fence Framework or Specification F1083.

6.2.1.1 *Terminal Posts*—End, corner, or pull posts are to be in accordance with Specification F1043, Table 3, Heavy Industrial Fence Framework or Specification F1083. Select the terminal post size based on the line post size in accordance with Table 2.

TABLE 1 Security Chain Link Mesh Configurations

Security Chain Link Fabric Considerations	Mesh Size and Gauge
Standard Industrial Commercial Chain Link Mesh	2 in. mesh 9 gauge
Heavier 6 gauge wire more difficult to cut	2 in. mesh 6 gauge
Smaller mesh size increases difficulty to climb and time to cut through	1 ¾ in. mesh 9 gauge
Heavier 6 gauge wire more difficult to cut	1 ¾ in. mesh 6 gauge
1 in. mesh increases difficulty to climb and increases time to cut through	1 in. mesh 11 gauge
9 gauge wire increases cutting time to that of 11 gauge, above	1 in. mesh 9 gauge
Small mesh sizes eliminates finger hold for climbing	⅝ in. mesh 11 gauge
Small mesh requires special equipment to cut through	½ in. mesh 11 gauge
Small mesh with larger wire, maximum security	½ in. mesh 9 gauge
Penetration time is increased to cut through small mesh	⅜ in. mesh 11 gauge
Metric Equivalents: 2 in. (50 mm,) 1¾ in. (44.45 mm), 1 in. (25 mm), ⅝ in. (16 mm), ½ in. (13 mm), ⅜ in. (10 mm)	
6ga. 0.192 in. (4.88 mm), 9 ga. 0.148 in. (3.76 mm), 11 ga. 0.120 in. (3.05 mm)	

TABLE 2 Security Fence Post Selection

Line Post Description, outside diameter	Terminal Post Description, outside diameter
2.375 in. (60.3 mm) Diameter Pipe	2.875 in. (73.0 mm) Diameter Pipe
2.25 by 1.70 in. (57.2 by 43.2 mm) C-Section	2.875 in. (73.0 mm) Diameter Pipe
2.875 in. (73.0 mm) Diameter Pipe	4.000 in. (101.6 mm) Diameter Pipe
3.25 by 2.50 in. (82.6 by 64.0 mm) C-Section	4.000 in. (101.6 mm) Diameter Pipe
4.000 in. (101.5 mm) Diameter Pipe	6.625 in. (168.3 mm) Diameter Pipe
4.500 in (114.3 mm) Diameter Pipe	6.625 in. (168.3 mm) Diameter Pipe
6.625 in. (168.3 mm) Diameter Pipe	6.625 in. (168.3 mm) Diameter Pipe
8.625 in. (219.1 mm) Diameter Pipe	8.625 in. (219.1 mm) Diameter Pipe

6.2.1.2 *Rails*—Top, intermediate and terminal post brace rails when specified shall be in accordance with Specification F1043, Table 3, Heavy Industrial Fence Framework or Specification F1083. See Specification F1043, Table 3 rails and braces for recommended size.

6.2.1.3 Polymer-coated framework, specify the type of coating in accordance with Specification F1043 and the color in accordance with Specification F934.

6.3 *Barbed Wire*—When specified, select the type and coating from one of the following:

6.3.1 If metallic coated steel barbed wire, specify A121 design number 12-4-3-14R having 4- point barbs spaced 3 in. (76 mm) on center or 12-4-5-14R having 4- point barbs spaced 5 in. (127 mm) on center.

6.3.1.1 *Aluminum Metallic-Coated*—specify Coating A for the strand wire and aluminum alloy barbs.

6.3.1.2 *Zinc Metallic-Coated*—specify Coating Type Z, Coating Class 3.

6.3.1.3 *Zinc-5% Aluminum-Mischmetal Alloy (Zn-5AL-MM) Metallic-Coated*—specify Coating Type ZA, Coating Class 80.

6.3.1.4 Polymer-coated barbed wire shall be in accordance with Specification F1665; specify coating type Class 2b, select barb spacing, Type I spacing at 5 in. (127 mm) on center or Type II spacing at 3 in. (76 mm) on center. The color shall match the system in accordance with Specification F934.

6.4 *Barbed Tape Obstacles*—Barbed tape when specified, select the diameter, design and configuration in accordance with Specification F1910.

6.5 *Tension Wire*—Tension wire when specified shall match the type coating of the chain link fabric. Metallic or polymer coated tension wire shall be a minimum of 7 gauge steel, 0.177 in. (4.50 mm) diameter.

6.5.1 Metallic-coated steel tension wire shall be in accordance with Specification A824. Select the type of metallic coating from one of the following as listed in Specification A817.

6.5.1.1 Type I Aluminum metallic-coated 0.40 oz/ft ^{2} (122 g/m^2)

6.5.1.2 Type II Zinc metallic-coated (galvanized), Class 4 1.20 oz/ft^2 (366 g/m^2)

6.5.1.3 Type III Zinc-5% Aluminum-Mischmetal metallic-coated, Class 100, 1.0 oz/ft^2 (305 gm^2)

6.5.2 Polymer-coated tension wire shall be in accordance with Specification F1664. Specify Class 2b coating and color to match the fence system in accordance with Specification F934.

6.6 *Fittings*—Fittings are to be in accordance with Specification F626. All fittings shall be steel having a hot dipped galvanized coating with a minimum 1.20 oz/ft^2 (366 g/m^2) of zinc coating of the surface area.

6.6.1 Post caps, barb arms, top rail sleeves, rail and brace rail ends and boulevard bands shall be manufactured using pressed steel.

6.6.2 Barbed wire arms are available in various configurations to accommodate three to six strands of barbed wire, select the design to meet the security requirement.

6.6.3 Tension and brace bands shall be ⅛ inch by 1 in. (3.17 mm by 25.4 mm) secured using ⅜ in. (9.5 mm) galvanized steel carriage bolts and nuts.

6.6.4 Tension bars shall be in compliance with Specification F626, galvanized steel, one-piece length 2 in. (50 mm) less than the fabric height with a minimum zinc coating of 1.2 oz/ft^2 (366 g/m^2). Bars for 2 in. (50 mm) and 1 ¾-in. (44-mm) mesh shall have a minimum cross section of 3/16 in. (4.8 mm) by ¾ in. (19 mm). Bars for 1 in. (25 mm) mesh shall have a cross section of ¼ in. (6.4 mm) by ⅜ in. (9.5 mm). Small mesh ⅜ in. (10 mm), ½ in. (13 mm) and ⅝ in. (16 mm) shall be attached (sandwiched) to the terminal post using a galvanized steel strap having a minimum cross section of 1½ in. (38 mm) by ¼ in. (6.4 mm) with holes spaced 12 in. (305 mm) on center to accommodate minimum ⅜ in. (9.5 mm) carriage bolts that are to be bolted through the strap, the mesh, and through the terminal post.

6.6.5 Truss rods shall be ⅜ in. (9.5 mm) diameter galvanized steel.

6.6.6 Polymer-coated bands, barb arms, top, truss rods, sleeves, rail ends, boulevards, when required, select the coating type to be the same as the fence framework and the color to match the fence system and in accordance with Specification F934.

6.7 *Post Ties, Rail Ties and Hog Rings*—Line post, rail ties, and hog rings shall be in accordance with Specification F626, 9 gauge, 0.148 in (376 mm) diameter galvanized steel.

6.7.1 Polymer-coated ties and hog rings, when required, shall be in accordance with Specification F668 Class 2b, color to match the fence system in accordance with Specification F934.

6.8 *Swing Gates*—Swing gates shall be constructed using 1.90 in. outside diameter (48.3 mm) or 2-in. square (50.8-mm) members in accordance with Specification F900.

6.8.1 Select the swing gatepost size based on the gate dimensions in accordance with Specification F900.

6.8.2 Gate hinges shall be manufactured of malleable iron having a hot dipped galvanized coating with a minimum 1.20 oz/ft^2 (366 g/m^2) of zinc coating of the surface area and shall be capable of providing 180 degree swing.

6.8.3 Gate latches and drop bar guides shall be manufactured of pressed steel. having a hot dipped galvanized coating with a minimum 1.20 oz/ft^2 (366 g/m^2) of zinc coating of the surface area.

6.8.4 Polymer-coated gates shall be of the same coating type as the fence framework in accordance with Specification F1043 and the color to match the system in accordance with Specification F934.

6.9 *Slide Gates*—Select the Type and Class of slide gate using Specification F1184.

6.9.1 Overhead slide gates shall be in accordance with Specification F1184, Type I. Gate frame members shall be as listed in Table 1 for gates over 6 ft (1.8 m).

6.9.2 Cantilever slide gates when specified, select Class 1, gates using external rollers or Class 2, gates using internal rollers.

6.9.3 Polymer-coated gates shall be of the same coating type as the fence framework in accordance with Specification F1043 and the color to match the system in accordance with Specification F934.

6.9.4 Select the slide gatepost size based on the gate size and design in accordance with Specification F1184.

6.9.5 Automated vehicle gates shall comply with Specification F2200.

6.10 *Vehicle Crash Gate:*

6.10.1 Vehicle crash gates, bollards, wedges, or barrier arms, when required, shall be specified in accordance with Test Method F2656.

7. Installation

7.1 Installation of the chain link fence shall be in accordance with Specification F567 with the following additional provisions or exceptions.

7.1.1 Prior to installation of a chain link fence, all necessary clearing and grading should be performed on both sides of the fence line. Grading along the fence line should minimize uneven surfaces that can lead to washouts and gaps under the fence. At gate locations, grade surface as level as practical consistent with drainage requirements between the hinged and latch posts and within the swing area of the gate. Grading for slide gates should comply with manufacturer's guidelines for smooth free of binding operation.

7.1.2 Where underground utility lines cross fence lines, consider how the framework and fastening can accommodate removal for maintenance should the need arise without comprising the perimeter.

7.2 The top of the concrete post footings shall be tapered to drain water away from the post and set 6 in. (152 mm) below grade to avoid heaving due to frost. Fence designs requiring larger posts or closer post spacings due to wind load or increased security may require larger, deeper concrete footings depending on soil conditions.

7.3 Chain link fabric shall be placed on the outside of the secured area.

7.3.1 Pre-coated chain link fabric is available in widths up to 20 ft (6.09 m). Consideration should be given to require the chain link fabric to be of one width.

7.3.2 The chain link fabric shall be sufficiently stretched taut so as not to deflect more than 3 in. (76 mm) in the center of the fence panel in between the two line posts when subjected to a 30 lb (133 N) horizontal force.

7.3.3 Fences constructed using chain link fabric greater than 12 ft (3.66 m) in height may require an intermediate rail based on chain link mesh and level of security. The intermediate rail, when specified, shall be installed no less than 8 ft (2.43 m) above grade.

7.4 Intermediate rail is required when two different chain link fabrics are installed such as ⅜-in. (10-mm) mesh at the top and 1-in. (25-mm) or 2-in. (50-mm) mesh at the bottom. The two fabrics shall be overlapped 6 in. (152 mm) and tied to the intermediate rail no greater than 12 in. (305 mm) on center

7.5 Based on the height of the fence, deleting the installation of top rail may be considered to eliminate a handhold for an intruder. For added security for fences using a top rail, install the rail 12 in. (305 mm) below the top of the mesh.

7.6 Tie wires for the line posts, top, mid or bottom rail and terminal post brace rail shall be installed no greater than 12 in. (305 mm) on center.

7.6.1 Post and rail ties shall be installed around the post or rail and the tie wire ends twisted around the chain link mesh a full three twists or wrapped a full 360 degrees around the post having the two ends of the tie wire twisted three full twists.

7.7 Tension wire shall be installed at the top or bottom of the fence in the absence of top or bottom rail. The tension wire shall be secured to the chain link fabric with hog rings spaced no greater than 12 in. (305 mm) on center.

7.7.1 Top tension wire, when installed shall be placed no less than 6 in. (152 mm) from the top of the mesh, bottom tension wire shall be installed no greater than 6 in. (153 mm) from the bottom of the mesh.

7.8 Barbed arms when specified shall be riveted or bolted to the post.

7.9 Bottom rail, when specified, shall be connected to the line post using boulevard clamps. The rail shall be secured to the boulevard clamp by drilling through the clamp, rail, and through bolting. The boulevard clamp shall be riveted or bolted to the post. Bottom rail shall be connected to the terminal post using a brace band and rail end. The rail end and bottom rail shall be through bolted and the brace band bolted or riveted to the post.

7.9.1 Additional security at the bottom of the fence can be obtained by securing and anchoring the bottom rail in the center of the two line posts using a ½-in. (25-mm) diameter galvanized steel hook set in a concrete footing.

7.9.2 Additional security can be obtained by burying a separate section of polymer coated chain link fabric of the same gauge and mesh as the adjacent fabric a minimum of 24 in. (610 mm) below grade. Overlap the buried fabric with

the fence fabric a minimum of 6 in. (153 mm). It is recommended not to hog ring the two fabrics together leaving the buried fabric free to adjust to possible movement due to frost.

7.10 Barbed tape shall be installed in accordance with Specification F1911.

7.11 All bolts, when applicable, shall be carriage bolts. All nuts and bolts, including those used on gates, hinges, latches, barbed arms, fittings, shall be installed having the nuts located on inside secured area and peened over to prevent removal.

7.12 *Installation of Anti-Ram Systems:*

7.12.1 Passive anti-ram systems, when required, shall be integrated with, attached to, or installed immediately behind the fence system.

7.12.2 Anti-vehicle crash gates when specified shall be installed in compliance with Test Method F2656 or as required to meet specified crash test rating.

7.13 Grounding of fence when required shall be installed by a licensed electrical contractor.

8. Keywords

8.1 barbed tape; heavy industrial framework; high security; K-rated vehicle crash barriers; mesh size; passive anti-ram system; security chain link fabric; vehicle restraint cable system; wire gauge