Designation: F2780 – 09 (Reapproved 2014)

Standard Guide for Design and Construction of Expanded Metal Security Fences and Barriers[1]

This standard is issued under the fixed designation F2780; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide provides assistance for the site security designer to select the proper components required to design a site specific expanded metal physical security perimeter barrier.

1.2 This standard does not purport to address all of the physical protection security concerns, if any, associated with its use. 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 It is recommended that Specification F2548 to be used in conjunction with this guide.

1.4 The values stated in inch-pound units are to be regarded as standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A121 Specification for Metallic-Coated Carbon Steel Barbed Wire

A123/A123M Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A307 Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

F626 Specification for Fence Fittings

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

F1910 Specification for Long Barbed Tape Obstacles

F2200 Specification for Automated Vehicular Gate Construction

F2548 Specification for Expanded Metal Fence Systems for Security Purposes

F2656 Test Method for Vehicle Crash Testing of Perimeter Barriers

2.2 *US Dept. of Defense:*

UFC 4-010-01 United Facilities Criteria, DoD Minimum Antiterrorism Standards for Buildings

UFC 4-020-01 United Facilities Criteria, DoD Security Engineering Facilities Planning Manual

2.3 *US Dept. of State:*

SD-STD-02.01 Revision A, March 2003 Test Method for Vehicle Crash Gate Testing of Perimeter Barriers and Gates

2.4 *General Services Administration:*

The Site Security Design Guide, U.S. General Services Administration (GSA)

2.5 *American Society of Civil Engineers (ASCE):*

ASCE/SEI 7-05 Minimum Design Loads for Buildings and Other Structures (Manufacturer shall demonstrate framework design for wind load criteria for the selection of line posts and line post spacing)

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *access control*—for the purposes of these standards, any combination of barriers, gates, electronic security equipment, or guards, or a combination thereof, that can deny entry to unauthorized personnel or vehicles.

3.1.2 *active barrier*—abarrier that requires manual or motorized action to operate. Action barriers may be command or sensor activated to prevent or impede unauthorized passage.

3.1.3 *anti-ram vehicle barrier*—a device or barrier that prevents vehicle access to provide pedestrian protection and/or building security. Anti-Ram vehicle barriers may be either active or passive barriers. A rated anti-ram barrier is a Department of State-approved perimeter barrier that does not exceed the defined penetration level for a 15,000-lb gross weight vehicle traveling perpendicular to the barrier at nominal speeds of 50, 40, or 30 mph. Reference Test Method F2656 for performance criteria.

[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.

Current edition approved May 1, 2014. Published May 2014. Originally approved in 2009. Last previous edition approved in 2009 as F2780– 09. DOI: 10.1520/F2780-09R14.

[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.

3.1.4 *asset*—tangible or intangible items, personnel, or outdoor gatherings, (in whole or in part), which may be subject to manmade or natural hazards.

3.1.5 *barrier*—an object used to separate or impede the movement of a vehicle or pedestrian.

3.1.6 *design basis tactics*—identify the specific acts and methods that the building and site's countermeasures must protect against and form the basis for the site security design. (U.S. General Services Administration)

3.1.7 *design criteria*—defines the design direction that emerges, based on inputs from the risk assessment, consideration of the design basis tactics, and the required level of protection. (U.S. General Services Administration)

3.1.8 *level of protection*—the degree to which an asset (for example, a person, a piece of equipment, or an object, etc.) is protected against injury or damage from an attack.

3.1.9 *passive vehicle barrier*—stationary barriers creating perimeter or edge protection, such as fixed bollards, concrete walls, concrete jersey barriers, concrete planters, boulders, excavations and ditches, vehicle restraint cable systems, king tut blocks, bastion barriers, bin barriers, reinforced masonry walls, berms, ponds/basins, existing trees, intrusion detection devices, and reinforced streetscape elements sculpture etc. Passive vehicle barriers have no moving parts. A passive vehicle barrier system consists of a permanent or portable structure positioned to slow, delay or deny access to a protected site or restricted area.

3.1.10 *perimeter barrier*—a fence, gate, bollard, wall, fence, planter, other structure, or natural topographic feature that provides protection against a vehicle gaining access to a compound or facility.

3.1.11 *physical security*—the part of security concerned with physical measures designed to safeguard personnel; to prevent unauthorized access to equipment, installations, material, and documents; and to safeguard against espionage, sabotage, damage and theft. (U.S. Army)

3.1.12 *portable barrier*—a passive or active barrier designed to be removed and relocated as required. Includes any movable object that can be moved in place to stop the movement of vehicles and/or people.

3.1.13 *risk acceptance*—the degree of risk associated with an asset or endeavor that a decision-maker perceives and will accept under a given set of circumstances and with associated costs.

3.1.14 *standoff*—the area between a protected structure and the perimeter protecting the asset against potential attacks. Sometimes referred to as setback. Distance from the inside edge of a barrier to the nearest surface of the building being protected.

4. Summary of Guide

4.1 It is the responsibility of the design team to consider the design criteria, understand the design basis tactics, and levels of protection that shaped them, and provide effective and balanced design solutions that respond to the threat.

4.2 Concerns for security throughout the design process will identify the need for appropriate levels of protection around the site perimeter, site access, required standoff distances, parking, and other specific assets. All of these areas may require some form of physical security to equally balance the level of security with an acceptable risk.

4.3 Perimeter barriers are used to define the limits of a perimeter, standoff, activity, or area, to define ingress and egress points, to form a psychological deterrent, and to establish an acceptable level of protection. They delay unauthorized individuals to facilitate their apprehension by response forces, direct traffic along designated routes of travel for enhanced surveillance and control, and can preclude visual compromise by unauthorized individuals.

5. Design Criteria for Perimeter Fences and Barriers

5.1 *Cost Effectiveness*—Budgetary allotments for security plans should be set after the performance requirements for fences and barriers have been determined.

5.2 Determine the threat and risk acceptance. This standard guide should be used in conjunction with site-specific risk assessments as necessary to attain an appropriate level of protection from natural and or manmade hazards.

5.3 Determine the level of security for the fence system required based on acceptable risk. Part of this determination would be the height of the fence. Fences used for the purpose of security shall be a minimum of 8-ft high.

5.4 Determine the function for the fence or barrier based on the application icons listed in Fig. 1.

5.4.1 Expanded metal barriers may take different forms and provide perimeter security and access control to protect assets. Expanded metal fencing can be mounted on moveable K Rated concrete highway barriers creating active barriers that are also

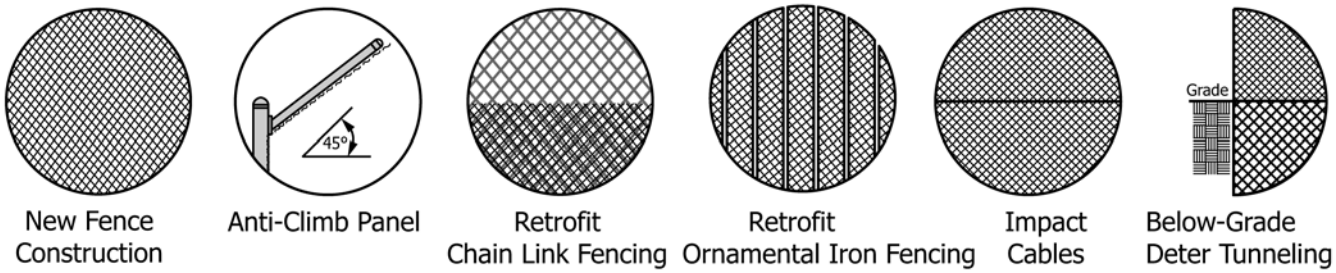

FIG. 1 Applications

portable barriers to meet changing or evolving levels of security. Reference Fig. 2.

6. Materials and Sizes

6.1 *Expanded Metal Mesh Panels:*

6.1.1 Select the expanded mesh panel material from Table 1 and Fig. 3. The panel descriptions listed in Fig. 3 are commonly used with expanded metal fence systems used in security applications. Other patterns offering different sizes and shapes may be used as long as the mesh panel dimensions meet Specification F2548.

6.1.2 After selecting expanded metal mesh panels choose the type of coating:

6.1.2.1 Hot dip galvanized in accordance with Specification A123/A123M.

6.2 *Fence Framework:*

6.2.1 Terminal and Line Posts Determine the size and strength of the fence framework. When designing a fence as a formidable structure intended to deny, deter and delay access the heightened level of security generally results in an increase in the height of the fence and or a reduction in the size of the openings of the mesh. Both of these factors will 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. Determine the wind load requirements for a minimum 90 mph up to 150 mph wind. For basic recommendations refer to ASCE/SEI 7-05 or consult the fence system manufacturer. 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.

6.2.2 Gate posts shall be specified by the expanded metal fence manufacturer. Reference 6.6.

6.3 Rails top, bottom, and intermediate rail(s) when specified shall be in accordance with Specification F1043, Table 3, Heavy Industrial Fence Framework or Specification F1083.

6.3.1 Top rail should be installed 8 in. below the top of the expanded metal mesh panel and the bottom rail should be installed 8 in. above the bottom of the mesh panel.

6.3.2 Constructed of an expanded metal fence greater than 10 ft in height requires an intermediate rail.

6.3.3 The intermediate rail shall be installed at a midpoint between the top and bottom rails. When two panels are stacked to reach a required height the upper panel shall overlap the lower panel and be secured to a rail.

6.4 *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 of zinc coating of the surface area.

6.4.1 When an expanded metal mesh fence is supported by a chain link type framework, (vertical posts and horizontal rails) post caps, barb arms, offset line rail clamps may be required and shall be manufactured using pressed steel in accordance with Specification F626.

6.4.2 Consideration should be given to the overall strength of the fittings used in a security fence system. There is a direct relationship between the strength of material connectors and the level of security provided by the design of the fence system. For expanded metal security fences and barriers fittings securing the mesh to the framework shall be a minimum of 10GA steel and having a width of 1 in. Wire ties as used with chain link fencing are not acceptable for expanded metal security fencing applications.

6.4.3 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.

6.4.4 Barbed wire when specified select design number 12-4-3-14R having 4-point barbs spaced 3 in. on center or 12-4-5-14R having 4-point barbs spaced 5 in. on center in accordance with Specification A121.

6.4.5 Barbed tape when specified, select the diameter, design and configuration in accordance with Specification F1910.

6.5 *Threaded Fasteners:*

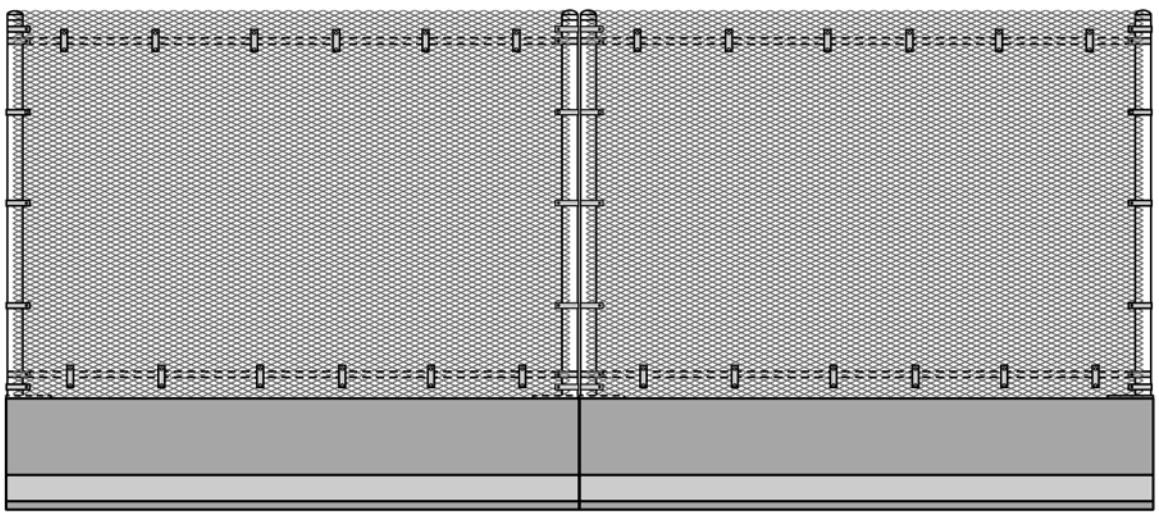

FIG. 2 Expanded Metal on Concrete Barriers—Portable Barriers

TABLE 1 Panel Description

Description	Panels Used in Security Fence Applications					
	½-in.—13R	½-in.—13R (0.188)	¾-in.—9R	¾-in.—9F	1 in.—7R (0.240)	1½-in.—6R
Width of Panel (ft)	3–6	3–6	3–6	3–6	3–5	3–5
Height of Panel (ft)	6–12	6–12	6–12	6–12	6–12	6–12
Diamond Dimensions (in.) SWD by LWD	0.500 by 1.20	0.500 by 1.20	0.923 by 2.00	0.923 by 2.10	1.00 by 2.40	1.330 by 3.00
Percent Open Area	57 %	25 %	68 %	63 %	52 %	63 %
Strand Thickness (in.)	0.092	0.09	0.134	0.120	0.170	0.198
Strand Width (in.)	0.096	0.188	0.150	0.164	0.240	0.203
Weight per ft^2	1.47	2.82	1.80	1.71	3.50	2.50
Weight galvanized per ft^2	1.73	3.1	1.95	1.86	3.70	2.73

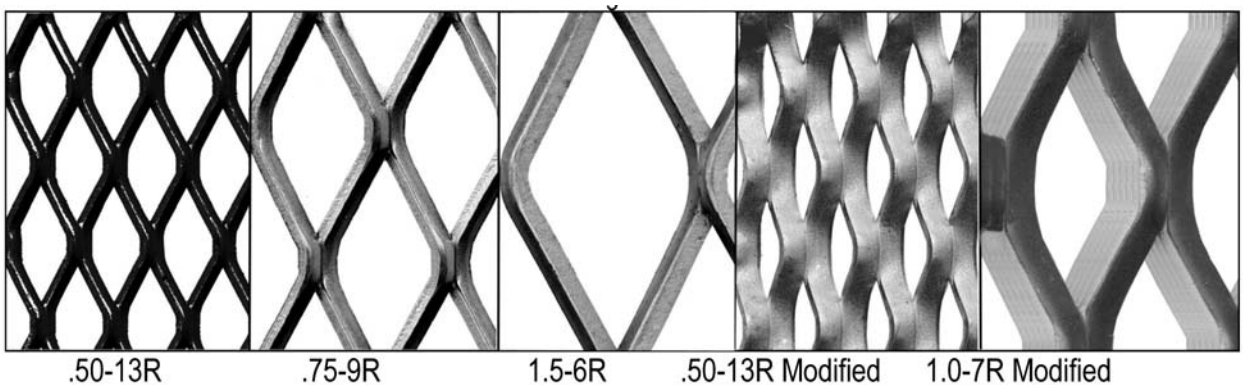

FIG. 3 Mesh Styles

6.5.1 All bolts securing fabric to framework or rails to posts, 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 the inside of the secured area, and peened or welded to prevent easy removal. Reference Specification A307 to further understand the strength of the fasteners used in different expanded metal fence systems and the varying levels of security they may provide.

6.6 Gates should be constructed with special attention to the added weight of expanded metal. When specifying swing gates, cantilever gates and or overhead slide gates contact the expanded metal fence manufacturer for assistance.

6.7 *Post Setting:*

6.7.1 Set posts in concrete in holes of a diameter and depth as follows. Intended use, local conditions and codes shall determine post footing dimensions; that is, under normal conditions the diameter shall be four times the largest cross section of the post. The depth shall be a minimum of 24 in. plus an additional 3 in. for each 1-ft increase in the fence height over 4 ft.

6.7.2 Dig or drill holes in the line of the fence in accordance with 5.1. Forms are not necessary.

6.7.3 Set posts in a vertical position, plumb and in line. Backfill concrete (2500 psi minimum) into the excavation and extend 2 in. above grade. An alternative method is to stop footing 2 in. below grade to allow for cover with sod, black top, or other materials. Crown the concrete at the top to shed water and extend the concrete encasement a minimum of 2 in. below the bottom of the post.

6.8 *Installation of Anti-Ram Vehicle Barrier Systems:*

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

6.8.2 K rated anti-vehicle crash gates when specified shall be installed in compliance with SD-STD-02.01, Revision A, March 2003. It is recommended to specify an on going preventative maintenance program for each vehicle crash barrier to ensure the barrier is always safe and functional.

6.9 *Additional Design Criteria Considerations for Fences and Barriers:*

6.9.1 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.

6.9.2 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 inhibit drainage flow by location or debris buildup.

6.9.3 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, Reference UFC 4-010-01.

6.9.4 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.

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

6.9.6 Security, location, terrain, and other design parameters govern rules of installation as recommended by the expanded metal fence manufacturer.

7. Keywords

7.1 barriers; expanded metal fencing; fences; fence specification; metal fencing; security fencing; steel fencing