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Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets[1]

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1. Scope

1.1 This specification establishes the minimum requirements for coated tubular picket ornamental fence systems fabricated from galvanized steel components.

1.2 The requirements of this specification do not apply to vertical bar fence systems utilizing solid bar or wrought iron materials.

1.3 The values stated with in-pound units are to be regarded as standard. The SI values in parentheses are provided for information.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A239 Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles

A653/A653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

A1008/A1008M Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

A1011/A1011M Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

B117 Practice for Operating Salt Spray (Fog) Apparatus

D523 Test Method for Specular Gloss

D714 Test Method for Evaluating Degree of Blistering of Paints

D822 Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings

D1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

D2794 Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)

D3359 Test Methods for Measuring Adhesion by Tape Test

E4 ~~Practices for Force Verification of Testing Machines~~ Practices for Force Verification of Testing Machines

F2814 Guide for Design and Construction of Ornamental Steel Picket Fence Systems for Security Purposes

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *tubular picket ornamental metal fence system*—an architectural metal fence system that combines ornamental fence structural components (that is, tubular pickets, rails, and posts) with ornamental accessories and fasteners, assembled and evaluated as a complete installed structure.

3.1.2 *fence panel*—fabricated unit consisting of rails and pickets. Also referred to as a fence section.

3.1.3 *rail*—horizontal structural component of a fence panel.

3.1.4 *tubular picket*—hollow vertical ornamental component of a fence panel.

3.1.5 *post*—vertical fence structural component that supports the panel in the ornamental metal fence system.

3.1.6 *ornamental accessory*—any fitting that adds further decoration to an ornamental metal fence system including items such as finials, caps, picket collars, rings, scrolls, or other ornamental panel inserts.

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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.

3.1.7 *adhesion*—the bonding integrity of an organic coating to the base metal substrate.

3.1.8 *corrosion resistance*—the ability of an organically coated metal product to resist attack due to the base metal attempting to return to a more passive oxidized state.

3.1.9 *impact resistance*—the measure of an organically coated metal product to resist indention; the ability of a coating to resist cracking or loss of adhesion due to reforming the metal during bending or a shape change from abuse.

3.1.10 *weathering resistance*—the ability of an organically coated metal product to resist loss of coating gloss or color change due to excessive humidity or ultra-violet (UV) sunlight exposure.

4. Significance and Use

4.1 The purpose of this specification is to define minimum selection criteria and test procedures to ensure product users that a tubular picket ornamental metal fence system has the strength necessary to withstand reasonable loads and penetration forces, and has the appropriate combination of material and surface protection to withstand the harmful effects of corrosion and weathering for an extended period of time.

4.2 For security applications, more definitive requirements are listed in Guide F2814.

5. Materials and Manufacture

5.1 Steel material for tubular picket ornamental fence system structural components shall be galvanized by the hot-dip process, either after forming (in accordance with 5.1.1), or prior to forming (in accordance with 5.1.2).

5.1.1 Steel material for fence structural components (that is, tubular pickets, rails, and posts), when galvanized after forming, shall conform to the requirements of Specification A1008/A1008M or Specification A1011/A1011M, with a minimum yield strength of 45 000 psi (310 MPa). The exterior shall be hot-dip galvanized with a 0.3 oz/ft^2 (92 g/m^2) minimum zinc weight. The exterior galvanized surface shall be chemical treated or conversion coated to adhere a polymeric coating. A polymeric coating shall be applied and provide a minimum of 95 % surface coverage as disclosed by Practice A239, Procedure 7.1. The interior surface shall be coated with a thermosetting coating containing zinc or other rust inhibitors and have 0.3 mils (0.0076 mm) minimum thickness.

5.1.2 Steel material for fence structural components (that is, tubular pickets, rails, and posts), when galvanized prior to forming, shall conform to the requirements of Specification A653/A653M, with a minimum yield strength of 45 000 psi (310 MPa). For Industrial applications (see Table 1), the steel shall be hot-dip galvanized to meet Specification A653/A653M with a minimum zinc coating weight of 0.9 oz/ft^2(276 g/m^2), Coating Designation G-90. For Light Industrial and Residential applications (see Table 1), the steel shall be hot-dip galvanized to meet Specification A653/A653M with a minimum zinc coating weight of 0.6 oz/ft^2 (184 g/m^2), Coating Designation G-60.

5.2 *Organic Coating Materials*:

5.2.1 Powder coatings applied to the exterior surface of fence components shall be polymer material: polyester or epoxy and polyester combinations having a minimum thickness of 3 mils; polyolefin elastomer having a minimum thickness of 7 mils; or PVC having a minimum thickness of 10 mils.

5.2.2 Wet coating applied to the exterior surface of fence components shall be a two-coat paint application system (one coat of epoxy, polyester or polyurethane primer; one coat of polyester, polyurethane, or acrylic liquid) with the total combined coating having a minimum thickness of 2 mils.

5.3 Fittings, fasteners, and decorative accessories for ornamental steel fence systems shall be manufactured with a material and finish coating that meets the same protective coating performance requirements as required for panels and posts.

6. Physical Dimensions

6.1 Cross-section and thickness dimensional requirements for ornamental metal fence structural components shall be as specified by the manufacturer, provided that the performance criteria of Section 8 are met. Table 1 is provided as a guideline to show nominal values typically used for residential, light industrial (commercial) and industrial applications.

TABLE 1 Nominal Sizes for Ornamental Fence Structural Components

Application	Component	Typical Cross-Section	Wall Thickness
Residential	Picket	⅝ by ⅝ in. (15.9 by 15.9 mm)	18 Ga.
	Rail	1 by 1 in. (25.4 by 25.4 mm)	18 Ga.
	Post	2 by 2 in. (50.8 by 50.8 mm)	16 Ga.
Light Industrial (Commercial)	Picket	¾ by ¾ in. (19.0 by 19.0 mm)	16 Ga.
	Rail	1-⅜ by 1-½ in. (34.9 by 38.1 mm) or 1-½ by 1-½ in. (38.1 by 38.1 mm)	14 Ga.
	Post	2-½ by 2-½ in. (63.5 by 63.5 mm)	14 Ga.
Industrial	Picket	1 by 1 in. (25.4 by 25.4 mm)	16 Ga.
	Rail	1-⅜ by 1-½ in. (34.9 by 38.1 mm) or 1-½ by 1-½ in. (38.1 by 38.1 mm)	14 Ga.
	Post	3 by 3 in. (76.2 by 76.2 mm)	12 Ga.

6.2 Fence height and space between rails may vary in accordance with manufacturer's standards, provided local ordinances and building codes do not limit these dimensions for a specific application, such as might be the case for pool safety, gate safety, or structural wind load bearing capacity. No sharply pointed picket tops shall be used on fences less than four ft (1.22 m) in height.

NOTE 1—Fence height is a nominal value and is typically the distance from grade to the top of the fence.

6.3 The spacing between pickets shall be four in. (101.6 mm) or less; however, if applicable local regulations (such as may be applied to pool fencing, child care facility fencing, public railing systems, or fencing adjacent to automated gates, and so forth) have more restrictive spacing requirements, then those local regulations shall govern.

7. Workmanship

7.1 All ornamental metal fence system components shall be produced using materials and finishes specified in Section 5, and shall be free from defects in workmanship.

8. Testing—Structural

8.1 *Structural Test Method A—Application of Horizontal Concentrated Load*:

8.1.1 *Installation of Test Specimen*—One line of fence with a minimum of three panels of the fence system to be tested shall be installed in accordance with the manufacturer's specifications and drawings. Selection of the test specimen should consider the maximum range of styles and sizes to be certified (see Section 10).

8.1.2 *Apparatus*:

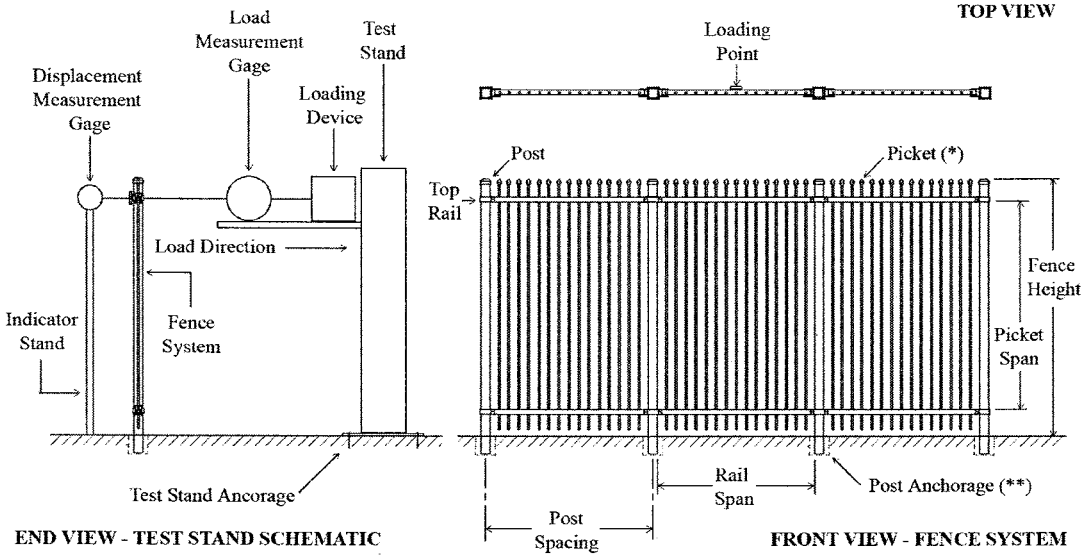
8.1.2.1 *Testing Machine*—Any testing machine or loading device, capable of imposing forces accurate to within 1 % (plus or minus), when calibrated in accordance with Practices E4, is suitable and may be used, provided the requirements of specified rate of loading and unloading are met. The testing device shall be of sufficient capacity to prevent yielding of its various components and shall ensure that the applied load remains essentially parallel to the relevant axis of the assembly during testing.

8.1.2.2 *Test System*—A diagrammatic test set-up for applying horizontal tension forces to the assembly is shown in Fig. 1. The bearing plate, normally 6 in. (150 mm) long, shall be of sufficient size to prevent local failure of the surrounding structural members or components. The loading device shall be attached to the assembly by means of pins or a swivel connector to prevent the direct transfer of any flexural forces through the connection.

8.1.2.3 *Deflection Measurements*—Dial gauges, having a smallest division of not more than 0.01 in. (0.25 mm), or any suitable measurement devices or calibrated sensors of at least comparable accuracy and sensitivity shall be used to measure the horizontal displacements of the top rail relative to its original location at each loading point prior to load application. These devices shall have sufficient measurement capability to indicate the displacement throughout the test range.

8.1.3 *Procedure*:

8.1.3.1 *Positioning*—Position the test stand in such a way that the load is applied, as shown in Fig. 1, to the structural member perpendicular to the plane of the fence system without causing any local failure at the point of load application.



* Note 1 - Any picket point style is acceptable on tested system; pickets may extend through the rails (as shown) or may terminate at the rails. Range of qualification is based on maximum picket span.
** Note 2 - Anchorage should be to concrete surface using core-drilled holes filled with grout or welded base plates and anchor bolts. Anchorage is not intended to be part of the structural test; failure of the anchorage system will void the test.

FIG. 1 Test Set-Up for Application of Horizontal Concentrated Load

8.1.3.2 *Mounting of Instruments*—Mount the dial gauge, measurement device, or sensor at the loading point as is shown in Fig. 1. Place the sensing element of the instrument in contact with and normal to the surface or an extension of the surface of the top rail of the fence system being tested in such a way as to measure displacement in the direction of the applied load.

8.1.4 *Load Application*:

8.1.4.1 *Initial Load Application*—Apply an initial load corresponding to 50 % of the required test load (see Table 2) for a minimum of two minutes in order to bring all members into full bearing. Reduce load to 25 % of the required test load (50 % of the preload), and observe the initial deflection. The deflection at this initial test load shall be the base point for subsequent deflection readings.

8.1.4.2 *Step Load Application*—Once the initial deflection point has been established, load application shall proceed at a uniform rate (see 8.1.4.3) to the required test load and the final deflection shall be calculated (by subtracting the deflection reading at initial test load from the deflection reading at the required test load) for comparison with the maximum allowable deflection. If more detailed information on deformation rate versus load application is desired, the load may be applied in constant-level steps to the required test load instead of the single step load application. For multiple step loads, each step (equal to approximately 15 % of the required test load) should be released to the initial test load for observation of the corresponding residual deflection. The initial and incremental readings of the force and deflection gauges at each load point can then be recorded in the form of load-deformation curves.

8.1.4.3 *Rate of Loading*—The rate of loading to the required test load (or between increments if multiple steps are chosen) shall be uniform throughout the test and such that the load is applied at a constant rate of deformation of 0.20 in. ± 0.10 in. (5.0 mm ± 2.5 mm) per minute. If this rate of loading cannot be achieved because of the type of testing machine used or the equipment available, the rate of loading shall be as near to that required in this subsection.

8.2 *Structural Test Method B—Application of Vertical Concentrated Load*:

8.2.1 *Installation of Test Specimen*—A minimum of one panel of the fence system to be tested shall be installed in accordance with the manufacturer's specifications and drawings. Selection of the test specimen should consider the maximum range of styles and sizes to be certified (see Section 10). The bottom of the fence panel shall be elevated by an offset distance of approximately 12 in. (305 mm) to allow for downward elastic deformation during test load application.

8.2.2 *Apparatus*:

8.2.2.1 *Testing Machine*—Any testing machine or loading device, capable of imposing forces accurate to within 1 % (plus or minus), when calibrated in accordance with Practices E4, is suitable and may be used, provided the requirements of specified rate of loading and unloading are met. The testing device shall be of sufficient capacity to prevent yielding of its various components and shall ensure that the applied load remains essentially parallel to the relevant axis of the assembly during testing.

8.2.2.2 *Test System*—A diagrammatic test set-up for applying vertical forces to the assembly is shown in Fig. 2. The bearing plate, normally 4 in. (101.6 mm) long, shall be of sufficient size to prevent local failure of the surrounding structural members or components. The bearing plate shall be positioned flush to the top rail and shall have a hole at its center sufficiently sized to fit over a picket if the style being tested has pickets that extend above the top rail. The loading device shall be attached to the assembly by means of pins or a swivel connector to prevent the direct transfer of any flexural forces through the connection.

8.2.2.3 *Deflection Measurements*—One dial gauge, having a smallest division of not more than 0.01 in. (0.25 mm), or any suitable measurement device or calibrated sensor of at least comparable accuracy and sensitivity shall be used to measure the vertical displacements of the top rail relative to the original location at the loading point after release of the preload.

8.2.3 *Procedure*:

8.2.3.1 *Positioning*—Position the test frame (or moveable head of testing machine) in such a way that the load is applied, as shown in Fig. 2, to the structural member parallel to the plane of the fence system and normal to it without causing any local failure at the point of load application.

8.2.3.2 *Mounting of Instruments*—Mount the dial gauge, measurement device, or sensor at each loading point as is shown in Fig. 2. Place the sensing element of the instruments in contact with the surface or an extension of the surface of the top rail of the fence panel being tested in such a way as to measure displacement in the direction of the applied load.

8.2.4 *Load Application*—Initial load application, step load application and rate of loading shall be in accordance with 8.1.4.

8.3 *Structural Test Method C—Application of Horizontal Thrust Load to Infill Areas*:

8.3.1 *Installation of Test Specimen*—A minimum of one panel of the fence system to be tested shall be installed in accordance with the manufacturer's specifications and drawings. Selection of the test specimen should consider the maximum range of styles and sizes to be certified (see Section 10). Test specimens used for Test Methods A or B may be used again to perform Test Method

TABLE 2 Required Test Load Capabilities

Class	Required Test Load—Method A (Based on Residual Deflection Less Than ½ in. (12.7 mm)	Required Test Load—Method B (Based on Residual Deflection Less Than ½ in. (12.7 mm)	Required Test Load—Method C (Based on Residual Deflection Less Than ¼ in. (6.4 mm)	Required Test Load—Method D (Based on Residual Deflection Less Than ¼ in. (6.4 mm)[A]
Industrial	300 lbf (1330 N)	400 lbf (1780 N)	100 lbf (440 N)	100 lbf (440 N)
Commercial	200 lbf (890 N)	300 lbf (1330 N)	75 lbf (330 N)	75 lbf (330 N)
Residential	100 lbf (440 N)	200 lbf (890 N)	50 lbf (220 N)	50 lbf (220 N)

[A] Test Method D Capability also requires that the test cone never penetrates beyond the tapered portion during any step load increment including the required test load.