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Standard Specification for Enameling System, Baking, Metal Joiner Work and Furniture¹

This standard is issued under the fixed designation F 1178; 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.

^{ε1} NOTE—Section 13 was added editorially in June 1994.

1. Scope

1.1 This specification covers requirements for cleaning, pretreatment, and application of a baking primer and enamel on metal for use on fabricated metal products, including marine furniture and joiner work.

1.2 The values stated in inch-pound units are to be regarded as standard. The metric (SI) units, given in parentheses, are for information only.

1.3 Painting facilities shall comply with all applicable Federal and State regulations regarding emissions and waste disposal. All painting facilities constructed, modified, or reconstructed after November 28, 1980 shall comply with the Environmental Protection Agency's new source performance standard (NSPS) for the surface coating of metal furniture as promulgated in 40 CFR Subpart EE.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- A 366 Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality²
- A 525 Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process³
- B 117 Test Method of Salt Spray (Fog) Testing⁴
- B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate⁵
- D 522 Test Methods for Mandrel Bend Test of Attached Organic Coatings⁶
- D 1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base⁶
- D 1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base⁶

D 3359 Test Methods for Measuring Adhesion by Tape Test⁶

D 3363 Test Method for Film Hardness by Pencil Test⁶

2.2 *American Institute of Steel Construction Manual: AISC Wire and Sheet Metal Gages—Equivalent Thickness in Decimals of an Inch, U.S. Standard Gauge (USSG) for Uncoated Hot and Cold Rolled Sheets and Galvanized Sheet Gage (GSG) for Hot-Dipped Zinc Coated Sheets⁷*

2.3 *Code of Federal Regulations:*

40 CFR 60 Subpart EE—Standard of Performance for Surface Coating of Metal Furniture⁸

3. Terminology

3.1 *Description of Terms Specific to This Standard:*

3.1.1 *air dry touch-up enamel*—an air drying enamel that matches the factory applied enamel in color and gloss and is compatible with it.

3.1.2 *baking finish*—an enamel that requires baking at temperatures above 150°F (65°C) for the development of desired properties.

3.1.3 *blister*—an enclosed raised spot on the paint surface caused by moisture or solvent trapped under the surface.

3.1.4 *cleaning*—the first phase of the metal pretreatment prior to painting.

3.1.5 *cure*—to condense or polymerize a material by heating, resulting in the full development of desired properties.

3.1.6 *degreasing*—See *cleaning*.

3.1.7 *dry film thickness (DFT)*—the actual thickness of the cured paint system. It is measured in mils or thousandths of an inch (0.001 in. or 25.4 μm).

3.1.8 *Enamel*—a paint characterized by the ability to form an especially smooth film.

3.1.9 *galvanized steel*—Zinc coated steel sheet in conformance with Specification A 525, Coating Designation A 01.

3.1.10 *gloss*—the degree to which a painted surface reflects light.

3.1.11 *joiner work*—doors, frames, ceilings, bulkheads, window casings, and all trim pieces in accommodation spaces aboard ship.

3.1.12 *low gloss*—finish that shows a gloss of 25 to 35

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² *Annual Book of ASTM Standards*, Vol 01.03.

³ *Annual Book of ASTM Standards*, Vol 01.06.

⁴ *Annual Book of ASTM Standards*, Vol 03.02.

⁵ *Annual Book of ASTM Standards*, Vol 02.02.

⁶ *Annual Book of ASTM Standards*, Vol 06.01.

⁷ Available from the American Institute of Steel Construction, 400 N. Michigan Avenue, Chicago, IL 60611.

⁸ Available from the U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402.

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when measured with 60° glossmeter. A ceiling gloss is 6 to 16 when measured the same way.

3.1.13 *pretreatment*—usually restricted to mean the chemical treatment of unpaired surfaces before painting.

4. Ordering Information

4.1 Unless otherwise specified, a smooth, low-gloss enamel finish will be applied.

4.1.1 Color of enamel top coat.

4.1.2 *Finish*:

4.1.2.1 Smooth.

4.1.2.2 Textured.

4.1.3 *Gloss* (measured with 60° glossmeter):

4.1.3.1 Low gloss—25 to 35.

4.1.3.2 Ceiling gloss—6 to 18.

5. Materials and Manufacture

5.1 *Metal substrate*—This specification is intended for use on metal furniture and joiner work of either steel or aluminum.

5.2 For a smooth, low-gloss finish, the furniture or joiner work manufacturer shall follow the procedures in the order and as listed in Sections 6 through 9.

5.3 If a textured finish is specified, the furniture or joiner work manufacturer shall follow the procedures in the order and as listed in Sections 6 through 10.

6. Cleaning and Degreasing

6.1 All exterior and interior surfaces, both visible and concealed, and all joints shall be thoroughly cleaned and degreased by vapor, spray, or immersion process, and thoroughly rinsed in clear water prior to pretreatment. Hand wiping is not satisfactory.

6.2 The cleaning/rinsing process shall remove dirt, oil grease, moisture, and other foreign matter.

6.3 No detrimental residue from this process shall remain deposited on any surface.

7. Pretreatment

7.1 All metal surfaces, accessible to spray, shall receive a pretreatment base coating that will, when applied in accordance with the manufacturer's recommendations, produce a surface that will enable both primer and enamel to meet the requirements as set forth in Section 11 of this specification.

8. Priming

8.1 All exterior and interior surfaces, both visible and concealed, shall be primed with a modified epoxy or other primer. The quality of the resulting system of surface preparation and primer shall meet the requirements stated in 11.2.2.3 and 11.2.2.4.

8.2 Primer application shall be by the dip or spray method. The resulting coating shall be sufficient to produce a dry film thickness as follows:

	Average	Minimum
Epoxy or other primers	0.75 mil (0.00075 in. (19.1 μm))	0.5 mil (0.0005 in. (12.7 μm))

9. Enameling

9.1 All surfaces contributing to the appearance of the final

product shall be enameled to a smooth, low-gloss finish in colors specified in the ordering documents.

9.2 Enamel shall be applied in an amount sufficient to produce a total minimum dry film thickness of 1.5 mils (0.0015 in. (38.1 μm)) for joiner doors and frames. For other joiner materials and furniture, 1 to 1.5 mils (0.001 to 0.0015 in. (25.4 to 38.1 μm)) is acceptable.

9.3 The enamel required under this specification shall be a thermosetting type, requiring a high baking schedule for proper cure. This enamel shall be an acrylic, or equivalent, resin finish and shall satisfy the requirements of Section 11.

10. Texturing (Optional)

10.1 If a textured finish is required by ordering documents, the enamel chosen shall be capable of producing a suitable raised textured finish when using equipment and techniques recommended by the manufacturer.

10.2 All requirements for cleaning, pretreatment, priming, and enameling of the textured finish shall remain as written for the smooth, low-gloss finish except that the gloss shown in 11.2.3.2 shall be 6 minimum to 16 maximum for ceiling panels. Other items may vary according to paint specified.

11. Performance Criteria

11.1 *Test Panel Description*—Test panels shall be 4½ in. (114 mm) minimum width and 7½ in. (191 mm) maximum length of material and thickness as listed below:

11.1.1 *Cold rolled steel sheet*, in accordance with Specification A 366, USSG 20 gauge (0.0359 in. or 0.91 mm) thick.

11.1.2 *Galvannealed steel sheet*, in accordance with Specification A 525 with coating designation A 01, CSG 20 gauge (0.0396 in. or 1.01 mm) thick.

11.1.3 *Type 5052-H32 aluminum alloy*, in accordance with Specification B 209, 0.040 in. (1.02 mm) thick.

11.2 Prepare test panels for testing, test, and evaluate in accordance with the following requirements:

11.2.1 *Dry Film Thickness*—Measure the total dry film thickness, either prime coat or prime coat plus enamel, on metal test panels or products in accordance with Test Method D 1400. Where only steel products are being enameled, the dry film thickness may be measured in accordance with Test Methods D 1186.

11.2.2 *Primer*:

11.2.2.1 *Preparation of Primer Test Panels*—Clean, pretreat, and coat two metal test panels with primer on both sides and on all edges in the production cycle. After baking the primed test panels, scribe one side of each panel with two diagonal scribe lines that extend through the prime coat down to the base metal. For scribing, use a sharp instrument and a suitable straightedge. Hold the scribing tool perpendicular to the surface of the test panel, and make two intersecting diagonal scribe marks. Begin each scribe line at a point approximately ½ in. (13 mm) from a corner and continue to a point approximately ½ in. (13 mm) from the diagonally opposite corner. The scribe must penetrate the prime coating down to the metal, leaving a uniformly bright line.

11.2.2.2 *Salt Spray Exposure of Primer Test Panels*—Expose the metal panels in accordance with Method B 117 for 250 h at 95°F (35°C). Remove test panels from the salt

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spray cabinet and rinse them using a gentle stream of water at a temperature of $100 \pm 10^\circ\text{F}$ ($37.8 \pm 5.5^\circ\text{C}$). Dry the test panels and vigorously scrape the scribed side of each panel with a dull knife blade or a suitable piece of sheet metal having a similar dull edge. Hold the scraper with its face perpendicular to the specimen surface and parallel to the scribe, moving it back and forth across the scribed line. Complete the scraping within 15 min of the drying of the surface. Masking tape, 1 in. (25 mm) wide, shall be pressed onto all scribed marks and pulled away clearly. Evaluate the performance of these test panels per 11.2.2.3 and 11.2.2.4.

11.2.2.3 *Evaluation of the Blistering Resistance of Primer Test Panel*—There shall be no evidence of blistering of these primed metal panels after 250-h exposure in accordance with Method B 117.

11.2.2.4 *Evaluation of the Corrosion Resistance of Primer Test Panel*—Measure creepage, or loss of adhesion due to corrosion, at the scribe marks. This creepage shall not extend more than $\frac{1}{8}$ in. (3.2 mm) on either side of scribe mark. The total width of gap in prime coat shall not exceed $\frac{1}{4}$ in. (6.4 mm).

11.2.3 Enamel:

11.2.3.1 *Preparation of Enamel Test panels*—Clean, pretreat, and coat two metal test panels with primer and enamel in the production cycle to a total dry film thickness of 1 to 1.5 mils (0.001 to 0.0015 in. (25.4 to 38.1 μm)).

11.2.3.2 *Gloss*—The enamel test panel shall show a gloss of 25 minimum to 35 maximum when measured using a 60° glossmeter (Gardner, Photovolt, or equal) unless otherwise specified in ordering documents or, if a textured finish, gloss shall be as noted in 10.2.

11.2.3.3 *Hardness*—Conduct this hardness test in accordance with Test Method D 3363 using a standard 2H drafting pencil sharpened to expose the full diameter of the pencil lead. The lead is sanded to a blunt-ended but sharp-edged shape by using sanding strokes perpendicular to the centerline of the lead. Holding the end of the pencil lead firmly against the enamel test panel, with the pencil centerline at an angle of 45° with the painted surface, apply four gouging or scraping strokes to the enameled surface. The strokes shall be a minimum of $\frac{1}{4}$ in. (6.4 mm) long and applied forward, trying to gouge the lead into the enameled surface. The enameled surface shall remain undamaged when subjected to this test.

11.2.3.4 *Paint Cure*—The solvent cure test determines if the enamel finish is properly cured. Conduct the test as follows: Wrap finger in a rag and dip in a solvent recommended by the paint manufacturer. Apply 20 two-way strokes (40 rubs) with heavy finger pressure to the painted surface. When subjected to this solvent cure test, the primed and enameled test panel shall show no ill effects, such as removal or softening of finish or change of gloss.

11.2.3.5 *Adhesion*—Evaluate adhesion between enamel and prime coat and between prime coat and steel substrate by a cross-hatch test in accordance with Test Methods D 3359 and as follows: Scribe the enameled test panel with a sharp knife or similar instrument to give a cross hatch pattern with overall size of 1 in.² (6.45 cm²). Make 17 parallel cuts at about $\frac{1}{16}$ in. (2 mm) spacing and extending through the coating to the base metal. Make 17 similar cuts at 90° to and crossing the first 17, giving a cross-hatched area

of 256 squares. Press masking tape 1 in. (25 mm) wide firmly onto the entire hatched area and then immediately jerk cleanly away from the panel. Examine the hatched area. Normally, no paint squares will be lifted by this test, but a classification of 3B, in accordance with Test Methods D 3359, for one panel out of three is permissible.

11.2.3.6 *Flexibility*—Test the enameled metal test panel for flexibility of the paint system by bending 180° over a conical mandrel in accordance with Test Method D 522. The paint system shall not flake or exhibit loss of adhesion during this test. Slight cracking of paint finish, less than $\frac{1}{4}$ in. (6.4 mm) long, at conical mandrel diameters less than $\frac{1}{2}$ in. (12.7 mm) is permissible.

11.2.3.7 *Impact Resistance*—The enameled metal test panel shall withstand a minimum of 40 in. lb (4.52 J) direct impact without cracking or loss of adhesion. The impact test consists essentially of a 2 lb (0.91 kg) bar dropping 20 in. (508 mm) onto a $\frac{1}{2}$ in. (12.7 mm) diameter sphere in contact with the test panel. The surface of the test equipment beneath the test panel shall have a circular, concave surface greater than $\frac{1}{2}$ in. in diameter directly under the point of contact.

11.2.3.8 *Color Stability*—The enameled metal test panel, when subjected to an additional bake of 350°F (177°C) for 30 min, shall show no significant change in color or gloss.

11.2.4 Air Dry Touch-Up Enamel:

11.2.4.1 *Conditions for Use*—This air dry touch-up enamel is intended for use in the field for minor scratches or defects only. It shall be compatible with, and adhere to, the scratched surface.

11.2.4.2 *Preparation of Scratched Surface*—Where appearance is important, use fine sandpaper and taper edges of scratch to blend in and conceal scratch before applying touch-up enamel. Wipe surface clean of dust or moisture.

11.2.4.3 *Application*—Apply by brush, roller, or spray, as recommended by the manufacturer of the touch-up enamel, one or more coats as required.

11.2.4.4 *Color*—Color must match the color of the scratched surface.

11.2.4.5 *Gloss*—Gloss must match the gloss of the scratched surface. The gloss shall be as follows, when measured with a 60° glossmeter:


Furniture and metal joiner work	25 to 35
Ceiling panels	6 to 16

11.2.4.6 *Curing Rate*—Cure this touch-up enamel as follows:

Dust free	30 min
Dry enough to handle	1–2 h
Dry enough to sand and recoat	24 h

12. Quality Assurance

12.1 *Cleaning/Rinsing Process*—Perform testing and control of the cleaning/rinsing process in accordance with recommendations by the supplier of the cleaning/rinsing materials. Maintain and retain records, showing test and control data of the cleaning/rinsing process, for historical documentation in accordance with 12.6. See Fig. X1.1 for a record-keeping form suitable for use with a spray cleaning and degreasing system. A similar form, but tailored to suit the needs of the individual painting system, may be used for other types of cleaning and degreasing systems.

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12.2 Pretreatment Process—Perform testing and control of the pretreatment process in accordance with recommendations by the supplier of the pretreatment materials. Maintain and retain records, showing test and control data of the pretreatment process, for historical documentation in accordance with 12.6. See Fig. X1.1 for a record-keeping form suitable for use with a spray pretreatment system. A similar form, but tailored to suit the needs of the individual painting system, may be used for other types of cleaning and degreasing systems.

12.3 Priming Process—Perform testing and control of the priming process in accordance with recommendations by the supplier of the primer materials. Maintain and retain records showing test and control data of the priming process for historical documentation in accordance with 12.6. See Fig. X1.2 for a record-keeping form suitable for use with an electrodeposition priming system. A similar form, but tailored to suit the needs of the individual painting system, may be used for other types of immersion priming systems.

12.4 Daily Test Panels (NOTE):

12.4.1 Prepare four test panels of each of the following three metals daily: USSG 20 gage (0.0359 in. or 0.91 mm) thick cold-rolled carbon steel in accordance with Specification A 366, GSG 20 gage (0.0396 in. or 1.01 mm) thick galvanized steel in accordance with Specification A 525 with coating designation A 01, and 0.040 in. (1.02 mm) thick type 5052-H32 aluminum alloy in accordance with Specification B 209. Two panels of each metal shall be prime coated only, and two panels of each metal shall be prime coated and enameled. Test the two prime coated and enameled panels and one prime-coated only panel of each metal as follows and record the results (see Fig. X1.3).

NOTE—This specification is intended for use on steel, galvanized steel and aluminum furniture and joiner work. Even if the product is basically all aluminum, such as for U.S. Navy furniture, it may contain parts of galvanized steel and painted steel. By daily testing all three metals all possibilities are covered.

12.4.1.1 Dry Film Thickness—See 11.2.1.

12.4.1.2 Hardness—See 11.2.3.3.

12.4.1.3 Paint Cure—See 11.2.3.4.

12.4.1.4 Adhesion—See 11.2.3.5.

12.4.1.5 Flexibility—See 11.2.3.6.

12.4.1.6 Impact Resistance—See 11.2.3.7. Test the remaining set of prime coated only panels in salt spray in accordance with 11.2.2.1 and 11.2.2.2, evaluate them in accordance with 11.2.2.3 and 11.2.2.4, and report results on the form shown in Fig. X1.3.

12.4.2 Maintain and retain copies of these daily tests and their results for historical documentation in accordance with 12.6. See Fig. X1.4 for a sample of a suitable record-keeping form.

12.4.3 See 12.7 for test panel retention requirements.

12.5 Perform in-process tests for color match, gloss, paint cure, and film thickness, on the finished product, for each color change or at least once each hour on large color runs.

12.5.1 Maintain and retain copies of these tests and results for historical documentation in accordance with 12.6. See Fig. X2.1 for sample of a suitable record-keeping form.

12.6 Retain process control records and paint test panel results for as long as is required by the procurement documents. If not addressed in these procurement documents, retain all process control records and paint test panel results only until the product has been accepted by the procuring agency and payment has been made to the product supplier.

12.7 Normally, test panels shall be retained for a period of one month but may be discarded sooner if inspected and test results are recorded on the appropriate test results form by a cognizant inspector.

12.8 Maintain an inspection of the final product for adequate paint coverage and proper appearance to produce a quality product. See X2.

13. Keywords

13.1 baking finish; baking primer; enamel; fabricated metal products; joiner work; marine; marine furniture; metal painting; ship

APPENDIX

(Nonmandatory Information)

X1. LAB TECHNICIAN

X1.1 Perform tests on cleaning, pretreatment, and electrodeposition systems and maintain at proper operating ranges. Record results on the Titration Log Sheet (Fig. X1.1) and the Electrodeposition Control Tests Form (Fig. X1.2).

X1.2 Paint Sample Tests:

X1.2.1 Run (four) sample panels each of mild steel, aluminum, and galvanized steel sheet each day as follows:

X1.2.1.1 Two of each material to be prime-coat only, and

X1.2.1.2 Two of each material to be top-coated over prime.

X1.2.2 Test top-coated panels and one set of prime-

coated only panels as follows and record the results on the Lab Technician—Paint Sample Quality Assurance Tests Form (Fig. X1.3).

X1.2.2.1 Film thickness.

X1.2.2.2 Hardness.

X1.2.2.3 Paint cure.

X1.2.2.4 Adhesion.

X1.2.2.5 Flexibility.

X1.2.2.6 Impact resistance.

X1.2.3 Test the remaining set of prime-coated samples in salt spray and record the results on the Salt Spray Data Form (Fig. X1.4).

