



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

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1. Scope

1.1 This specification covers the performance 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.

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 1008 Specification for Steel, Sheet, Cold-Rolled, Carbon Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability²

A 653/A 653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process³

B 117 Practice for Operating Salt Spray (Fog) Apparatus⁴

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 *Definitions of Terms Specific to This Standard:* 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.

¹ This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.01 on Structures.

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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.

3.1.9 *galvanized steel*—Zinc coated steel sheet in conformance with Specification A 653/A 653M, 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 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 7.

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 8.

6. Cleaning and Degreasing

6.1 All exterior and interior surfaces, both visible and concealed, and all joints shall be thoroughly cleaned and degreased.

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. Enameling

7.1 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.

7.2 Enamel shall be applied in an amount sufficient to produce a 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.

7.3 The enamel required under this specification shall be a thermosetting type, requiring a high baking schedule for proper cure. This enamel shall satisfy the requirements of Section 9.

8. Texturing (Optional)

8.1 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.

8.2 All requirements for enameling of the textured finish shall remain as written for the smooth, low-gloss finish except that the gloss shown in 9.2.3.2 shall be 6 minimum to 16 maximum for ceiling panels. Other items may vary according to paint specified.

9. Performance Criteria

9.1 *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:

9.1.1 *Cold rolled steel sheet*, in accordance with Specification A 1008, USSG 20 gauge (0.0359 in. or 0.91 mm) thick.

9.1.2 *Galvannealed steel sheet*, in accordance with Specification A 653/A 653M with coating designation A 01, CSG 20 gauge (0.0396 in. or 1.01 mm) thick.

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

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

9.2.1 *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.

9.2.2 *Primer*:

9.2.2.1 *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.

9.2.2.2 *Salt Spray Exposure of Primer Test Panels*—Expose the metal panels in accordance with Practice B 117 for 250 h at 95°F (35°C). Remove test panels from the salt spray cabinet and rinse them using a gentle stream of water at a temperature of 100 ± 10°F (37.8 ± 5.5°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 9.2.2.3 and 9.2.2.4.

9.2.3.3 *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 Practice B 117.

9.2.3.4 *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 1/8 in. (3.2 mm) on either side of scribe mark. The total width of gap in prime coat shall not exceed 1/4 in. (6.4 mm).

9.2.3 *Enamel:*

9.2.3.1 *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)).

9.2.3.2 *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 8.2.

9.2.3.3 *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 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.

9.2.3.4 *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.

9.2.3.5 *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 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.

9.2.3.6 *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 1/4 in. (6.4 mm) long, at conical mandrel diameters less than 1/2 in. (12.7 mm) is permissible.

9.2.3.7 *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 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 1/2 in. in diameter directly under the point of contact.

9.2.3.8 *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.

9.2.4 *Air Dry Touch-Up Enamel:*

9.2.4.1 *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.

9.2.4.2 *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.

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

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

9.2.4.5 *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

9.2.4.6 *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

10. Quality Assurance

10.1 *Daily Test Panels*—(NOTE):

10.1.1 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 1008, GSG 20 gage (0.0396 in. or 1.01 mm) thick galvanized steel in accordance with Specification A 653/A 653M with coating designation A 01, and 0.040 in. (1.02 mm) thick type 5052–H32 aluminum alloy in accordance with Specification B 209. Test the enameled panels of each metal as follows and record the results (see Fig. X1.1).

NOTE 1—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.

10.1.1.1 *Dry Film Thickness*—See 9.2.1.

10.1.1.2 *Hardness*—See 9.2.3.3.

10.1.1.3 *Paint Cure*—See 9.2.3.4.

10.1.1.4 *Adhesion*—See 9.2.3.5.

10.1.1.5 *Flexibility*—See 9.2.3.6.

10.1.1.6 *Impact Resistance*—See 9.2.3.7. Test the remaining set of prime coated only panels in salt spray in accordance with 9.2.2.1 and 9.2.2.2, evaluate them in accordance with 9.2.2.3 and 9.2.2.4, and report results on the form shown in Fig. X1.1.

10.1.2 Maintain and retain copies of these daily tests and their results for historical documentation in accordance with 10.3. See Fig. X1.2 for a sample of a suitable record-keeping form.

10.1.3 See 10.4 for test panel retention requirements.

10.2 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.

10.2.1 Maintain and retain copies of these tests and results for historical documentation in accordance with 10.3. See Fig. X2.1 for sample of a suitable record-keeping form.

10.3 Retain process control records and paint test panel results for as long as is required by the procurement docu-

ments. 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.

10.4 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.

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

11. Keywords

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

APPENDIXES

(Nonmandatory Information)

X1. LAB TECHNICIAN

X1.1 Perform tests on cleaning, pretreatment, and electrodeposition systems and maintain at proper operating ranges.

X1.2 *Paint Sample Tests:*

X1.2.1 Run (four) sample panels each of mild steel, aluminum, and galvanealed 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. X1.1).

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. X1.2).

Company _____

LAB TECHNICIAN—PAINT SAMPLE QUALITY ASSURANCE TESTS

Date		Tests	Prime Coat			Top Coat		
Painted	Tested		AL	JP	ST	AL	JP	ST
		Dry Film Thickness, in. (µm)						
		Hardness						
		Paint Cure						
		Adhesion						
		Flexibility						
		Impact Resistance						
		Salt Spray (Prime Coat Only)						
		Dry Film Thickness, in. (µm)						
		Hardness						
		Paint Cure						
		Adhesion						
		Flexibility						
		Impact Resistance						
		Salt Spray (Prime Coat Only)						
		Dry Film Thickness, in. (µm)						
		Hardness						
		Paint Cure						
		Adhesion						
		Flexibility						
		Impact Resistance						
		Salt Spray (Prime Coat Only)						
		Dry Film Thickness, in. (µm)						
		Hardness						
		Paint Cure						
		Adhesion						
		Flexibility						
		Impact Resistance						
		Salt Spray (Prime Coat Only)						
		Dry Film Thickness, in. (µm)						
		Hardness						
		Paint Cure						
		Adhesion						
		Flexibility						
		Impact Resistance						
		Salt Spray (Prime Coat Only)						

FIG. X1.1 Lab Technician—Paint Sample Quality Assurance Tests Form

Company _____

SALT SPRAY DATA

Date Painted	Film Thickness, in. (μm)	250			500			750			1000			Comments	
		AL	JP	ST	AL	JP	ST	AL	JP	ST	AL	JP	ST		

NOTE—AL = Type 5052h-32 aluminum alloy sheet, 0.050 in. (1.27 mm) thick, in accordance with Specification B 209.
 JP = GSG 24 gage 0.0276 in. or (0.70 mm) thick galvanized steel sheet in accordance with Specification A 525 with coating designation A 01.
 ST = USSG 24 gage 0.0239 in. or (0.61 mm) thick cold-rolled carbon steel sheet in accordance with Specification A 366.

FIG. X1.2 Salt Spray Data Form

X2. FINAL PRODUCTION PRODUCT INSPECTION

X2.1 The following quality assurance checks are to be made at least once every hour on large color runs or on each color change. Record results on the Paint Shop Production Line, Quality Assurance Check List Form Fig. X2.1).

- X2.1.1 Color match.
- X2.1.2 Gloss.

- X2.1.3 Paint cure.
- X2.1.4 Dry film thickness.

X2.2 The following quality assurance checks are to be made on each item as it is removed from the paint line.

- X2.2.1 Paint coverage.

PAINT SHOP PRODUCTION LINE, QUALITY ASSURANCE CHECK LIST

Company _____ Date _____

Check No.	Time	Color	Color Match	Gloss	Cure	Film Thickness	Item Description
Example	8:00 a.m.	C646	OK	28°	OK	1.6 mil	Furniture Drawers, Aluminum
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							

Paint Temperature at Spray Guns
°F (°C)

	Booth No. 1	Booth No. 2
a.m.		
p.m.		

FIG. X2.1 Paint Shop Production Line, Quality Assurance Checklist Form

X2.2.2 *Appearance:*

X2.2.2.1 Runs.

X2.2.2.2 Blisters.

X2.2.2.3 Bumped or dented material requiring filling.

X3. PAINT SAMPLE QUALITY ASSURANCE SALT SPRAY TESTS

X3.1 *Samples*—One sample panel each of mild steel, aluminum, and galvanealed steel sheet that have been enameled shall be tested each production day.

X3.1.1 Panels must be checked for dry film thickness and scribed through the paint coat to expose the underlying metal before testing.

X3.2 *Testing*—Test panels shall be continuously tested in accordance with Practice B 117.

X3.2.1 Panels shall be tested for 250, 500, 750, and 1000 h, with results at each interval recorded on the Salt Spray Data Form (Fig. X1.2).

X3.3 *Records*—Copies of Salt Spray Data Form (Fig. X1.2) showing tests results must be forwarded to Quality Assurance and the plant manager for evaluation.

X3.3.1 Quality Assurance will maintain a reference file on all daily salt spray test results. (See 10.3.)

X3.3.2 After test results have been recorded and any failures evaluated by Quality Assurance, test panels may be discarded.

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