



Standard Specification for Aluminum Particle-Filled Basecoat/Organic or Inorganic Topcoat, Corrosion Protective Coatings for Fasteners¹

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1. Scope

1.1 This specification covers the basic requirements for a corrosion-resistant coating consisting of an inorganic aluminum particle-filled basecoat and an organic or inorganic topcoat, depending on the specific requirements.

1.2 The coating may be specified with basecoat only, or with the top coated with compatible organic polymer or inorganic topcoats, depending on the specific requirements.

1.3 The basecoat is a water-dilutable slurry containing aluminum particles dispersed in a liquid binder of chromate/phosphate compounds.

1.4 The organic topcoats consist of polymer resins and dispersed pigments and are for service where temperatures do not exceed 230°C (450°F).

1.5 The inorganic topcoats consist of ceramic oxide pigments dispersed in a liquid binder of chromate/phosphate compounds and are for service where temperatures do not exceed 645°C (1200°F).

1.6 These coatings are applied by conventional dip/spin, dip/drain, or spray methods.

1.7 The coating process does not normally induce hydrogen embrittlement, provided that the parts to be coated have not been subjected to an acid cleaner or pretreatment (see **Note 1**).

NOTE 1—Although this coating material contains water, it has a relatively low susceptibility to inducing hydrogen embrittlement in steel parts of tensile strengths equal to or greater than 1000 MPa (approximately RC31). Normal precautions for preparing, descaling, and cleaning steels of these tensile strengths must be observed. An initial stress relief treatment should be considered prior to any chemical treatment or cleaning operation. Acids or other treatments that evolve hydrogen should be avoided. Mechanical cleaning methods may be considered. Some steels are more susceptible to hydrogen embrittlement than others and may also require hydrogen embrittlement relief baking after cleaning but before coating. Since no process can completely guarantee freedom from embrittlement, careful consideration must be given to the entire coating process and the specific steel alloy employed.

¹ This specification is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.03 on Coatings on Fasteners.

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1.8 The coating systems defined by this specification can be applied to ferrous alloy steels, aluminum, and ferritic and austenitic stainless steels.

1.9 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.10 The following safety hazards caveat pertains only to the test methods portion, Section 6, of this specification: *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*:²

- B117 Practice for Operating Salt Spray (Fog) Apparatus
- B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section
- B568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry
- D1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base (Withdrawn 2006)³
- D2247 Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity
- D3359 Test Methods for Measuring Adhesion by Tape Test
- E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process
- E376 Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods

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 The last approved version of this historical standard is referenced on www.astm.org.

3. Classification

3.1 The inorganic aluminum particle-filled basecoat and the subsequent topcoats are classified into three groups, with subsequent subgroups formed according to the requirements given in **Table 1**. The coating bath requirements and cure temperatures recommended by the chemical manufacturer should be followed.

3.2 Regardless of the processes or materials used, the inorganic and organic coatings shall conform to all of the applicable requirements of this specification.

4. Ordering Information

4.1 Orders for material in accordance with this specification shall include the following information:

- 4.1.1 Quantity of parts,
- 4.1.2 Grade of coating (see **Table 1**),
- 4.1.3 Color of coating,
- 4.1.4 Any additions to specifications as agreed upon by the purchaser and the supplier, and
- 4.1.5 Certification and test report requirements.

5. Requirements

5.1 *Appearance*—The coatings shall have a smooth, uniform appearance and shall be free of lacerations and other discontinuities that may affect the appearance or performance of the coatings. All topcoat colors shall be agreed upon by both the purchaser and the supplier.

5.2 *Adhesion*—The coating shall show no evidence of blistering or other appearance changes after exposure to humidity testing for 96 h, it shall show no more than 3.0-mm peel-back from the intersection of scribed lines that are tape-tested immediately after a 10-min recovery period from the humidity test, and there shall be no other peeling under the tape.

TABLE 1 Classification of Coatings

NOTE 1—Grades 4A, 4B, and 2C require basecoat burnishing.

NOTE 2—The torque tension relationship of coated fasteners may be different from those of uncoated fasteners. A wax lubricant may be specified to improve the torque-tension characteristics of coated fasteners.

NOTE 3—When spray application methods are employed, the thickness requirements of the two individual coats may be achieved in one single spray application.

Grade No.	Coats of Basecoat	Coats of Topcoats	Average Thickness, μm	Salt Spray Life Hours
1A ^A	1	1	10–15	168
2A	2	1	15–25	240
3A	2	2	20–30	720
4A	2	2	20–30	1000
1B ^B	1	1	10–15	168
2B	2	1	15–25	240
3B	2	2	20–30	500
4B	2	2	20–30	1000
1C ^C	2	0	10–20	168
2C	2	0	10–20	400

^A Grades with Suffix A are organic topcoated for a maximum service temperature of 230°C (450°F).

^B Grades with Suffix B are inorganic topcoated for a maximum service temperature of 645°C (1200°F).

^C Grades with Suffix C are basecoated only for a maximum service temperature of 645°C (1200°F).

5.3 *Corrosion*—These coatings shall be capable of withstanding neutral salt spray testing for the minimum time specified in **Table 1**. Unless otherwise defined, acceptable corrosion resistance shall be considered to be met where there is no base metal corrosion on significant surfaces.

5.3.1 Significant surfaces on threaded fasteners are defined as the surfaces exposed when the fasteners are installed in a normal manner (bolt head, nut drive, face, and so forth). On other surfaces on which coating control cannot be obtained under normal processing, such as holes, recesses, threads, and so forth, the above requirements do not apply.

5.4 *Thread-Fit*—The coating shall not have an adverse effect on normal installation and removal practices, as determined by the proper “GO” thread gage or the fit and function inspection method (see **8.2**).

5.4.1 *Sizing*—The thickness of the coating is limited by the basic thread size. Where greater thickness is necessary, threads may be produced undersize or oversize (before coating) to accommodate the coating thickness, providing that the finished fastener (after coating) meets all specified mechanical properties, as agreed upon by the supplier and the purchaser.

5.5 *Weathering*—The coatings shall show no blistering, peeling, cracking, loss of adhesion, discoloration, or red rust on significant surfaces after exposure to the weathering test for at least as many hours as specified for salt spray resistance for the various codes.

6. Test Methods

6.1 *Corrosion*—Corrosion resistance shall be tested in accordance with Practice **B117**.

6.2 *Coating Thickness*—Coating thickness shall be tested in accordance with Test Methods **D1186**, magnetic-permeability; Practice **E376**, eddy-current; or Test Method **B568**, X-ray spectrometry. For referee purposes, micro-examination in accordance with Test Method **B487** shall be used.

6.3 *Humidity Test*—The humidity test shall be conducted in accordance with Practice **D2247**.

6.4 *Adhesion*—After exposure to the humidity test, adhesion shall be tested in accordance with Test Methods **D3359**.

7. Application

7.1 Any conventional cleaning procedure that does not induce hydrogen embrittlement or intergranular attack of the basis metal can be used, followed by grit blasting or micro-zinc phosphating (see **Note 2**).

NOTE 2—If not properly controlled, zinc phosphate coatings and certain acid descaling processes may produce hydrogen embrittlement or severe etching of the basis metal.

7.2 The coatings are applied by conventional dip/spin, dip/drain, or spray methods.

7.3 The coatings shall be applied under suitable control conditions and in the stages necessary to meet the requirements of the specification. Unless otherwise specified, these coatings shall be applied after all machining, forming, and heat treatments have been completed, but prior to final inspection.

7.4 The contractor (applicator) shall maintain control over factors that affect the quality of the treatment, including, but not limited to, dip/spin parameters, coating viscosities, and temperature. Chemical analyses, coating replenishment, visual inspection, and other process control devices shall be conducted with the frequency required to maintain good quality of the treatment and to meet the requirements of this specification. Visual inspection is intended to include appearance factors such as (1) streaking, (2) dulling, (3) uncoated areas, and (4) loss of color where color is specified.

8. Inspection

8.1 Samples may be taken in accordance with Practice E122 or as agreed upon by the purchaser and the supplier.

8.1.1 A lot shall consist of all items having the same coating specification and processed at the same time.

8.2 *Fit and Function Inspection*—The following fit and function thread inspection procedure may be used if the specified “GO” gage binds on the threads.

8.2.1 *Bolt or Screw*—Assemble a phosphate-plated test nut with a 2B or 6H class thread fit down the full length of the thread.

8.2.2 *Nut*—Assemble a phosphate-plated test screw with a 2A or 6g class thread for a minimum of one diameter through the nut.

8.2.3 The test nut or screw must run freely for the total length without binding.

9. Rejection and Rehearing

9.1 Unless otherwise specified, any rejection based on the tests specified herein and made by the purchaser shall be reported to the manufacturer as soon as practical after receipt of the fasteners by the purchaser.

10. Certification Requirement

10.1 Product designations used in the coating system are to be reported to the purchasing organization, along with certification that the parts meet the requirements of this specification.

10.2 When applicable, test reports affirming acceptance are to be attached to the certification.

11. Keywords

11.1 aluminum; coating; corrosion; dip spin; fasteners; protection; resistance; rust; sealer

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