

**AAMA 2604-05**

**Voluntary Specification,  
Performance Requirements  
and Test Procedures for  
High Performance Organic  
Coatings on Aluminum  
Extrusions and Panels**





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## PREFACE

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For years, the architectural community has recognized AAMA 603 and AAMA 605 as the standards for testing and performance of organic coatings on architectural aluminum extrusions and panels. Significant advances have been made in technology which have created the need to revise these specifications.

**AAMA 2603**, "Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels;"

**AAMA 2604**, "Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels;"

**AAMA 2605**, "Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels."

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## SUPERCEED

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**AAMA 603**, "Voluntary Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum;" and

**AAMA 605**, "Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels;" as well as all revisions to these documents.

AAMA 2604 is a new five-year high performance specification similar in performance criteria to the original version of AAMA 605.2-92 (the original version does not include any subsequent Addenda) with the exception of the pre-treatment section, which allows for non-chrome pre-treatment.

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## 1.0 SCOPE

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**1.1** This specification describes test procedures and performance requirements for high performance organic coatings applied to aluminum extrusions and panels for architectural products.

**1.2** This specification covers factory-applied spray coatings only.

**1.3** The primary units of measure in this document are metric. The values stated in SI units are to be regarded as the standard. The values given in parentheses are for reference only.

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## 2.0 PURPOSE

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The specification will assist the architect, owner and contractor to specify and obtain factory-applied organic coatings which will provide and maintain a high level of performance in terms of film integrity, exterior weatherability and general appearance over a period of many years.

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## 3.0 DEFINITIONS

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**3.1** The terms "film" and "coating" are used interchangeably in this specification and are defined as meaning the layer of organic material applied to the surface of the aluminum.

**3.2** Exposed surfaces are those surfaces which are visible when the coated product is installed. These may include both closed and open positions of operating sash, ventilators, doors or panels.

**3.3** Spray Coating: The process of applying a resinous coating by atomizing it into a spray or mist, and curing it into a continuous film.

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## 4.0 GENERAL

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**4.1** To qualify as meeting this specification, products tested shall meet all requirements as specified herein.

**4.2** Coatings shall be visibly free from flow lines, streaks, blisters or other surface imperfections in the dry-film state on exposed surfaces when observed at a distance of 3 m (10 ft) from the metal surface and inspected at an angle of 90 degrees to the surface.

**4.3** The total dry-film thickness shall be assessed utilizing the ASTM D 1400 method. Eighty percent of measurements on primary exposed surfaces shall meet or exceed 30 microns (1.2 mil) total film thickness. Paint process capability may result in readings below 25 microns (1.0 mil). No more than 5% of the total readings, on primary exposed surfaces, shall be below 25 microns (1.0 mil) (or, 85% of film thickness specified), assuming appropriate color and hide. Film thickness specified may be increased to be consistent with color selection and type of coating as recommended by the coating manufacturer.

*NOTE: Due to the complexities of extrusion dies and limitations of application equipment, it may not be possible to achieve minimum recommended dry film thickness on all areas of an extrusion, such as inside corners and channels. For details of these affected areas, contact the coating applicator prior to painting.*

**4.4** Cleaning and metal preparation shall be to ensure compliance with the performance requirements.

**4.5** Minor scratches and blemishes shall be repairable with the coating manufacturer's recommended product or system. Such repairs shall match the original finish for color and gloss and shall adhere to the original finish when tested as outlined in Section 7.4.1.1, Dry Adhesion. After application, allow the repair coating to dry for at least 72 hours at 18°C to 27°C (65°F to 80°F) before conducting the film adhesion test.

*NOTE: The size and number of touch-up repairs should be kept to a minimum.*

**4.6** Sealant used in contact with an organic coating shall be compatible with the organic coating and meet the performance requirements of AAMA 800 sealant specification. There shall be no evidence of deleterious effects in the organic coating such as staining, coating separation, lifting, discoloration or loss of adhesion of the coating from the substrate.

*NOTE: It is strongly recommended that the fabricator of the finished products consult with the sealant manufacturer in the selection of the appropriate sealant. Pell adhesion testing as described in AAMA 800 is suggested. It is important to understand that the AAMA 800 sealant specification does not ensure adhesion to a specific coating. The best way to ensure adhesion is to submit panel specimens of the specific coating to the sealant manufacturer or an AAMA accredited independent laboratory for tests and recommendations.*

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## 5.0 TEST SPECIMENS

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**5.1** Test specimens shall consist of finished panels or extrusions representative of the production coated aluminum. A sufficient number of specimens on which to conduct instrument measurements with flat coated surfaces of at least 150 mm (6 in) long and 75 mm (3 in) wide, shall be submitted to the testing laboratory. The coating applicator or fabricator shall indicate exposed surfaces or submit drawings. Tests shall be performed on exposed areas as indicated on drawings or as marked on test specimens.

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## 6.0 METAL PREPARATION AND PRE-TREATMENT

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*NOTE: A multi-stage cleaning and pre-treatment system is required to remove organic and inorganic surface soils, remove residual oxides, and apply a chemical conversion coating to which organic coatings will firmly adhere.*

**6.1** The pre-treatment when used in conjunction with a baked organic coating shall produce a total finishing system capable of meeting impact, adhesion, detergent, humidity and salt spray performance as specified in the appropriate test method.

## 6.2 CHEMICAL CONVERSION COATING WEIGHT

### 6.2.1 Procedure

Measure in accordance with the latest issue of ASTM D 5723, using x-ray fluorescence or other standard methods for determining coating weights.

### 6.2.2 Performance

Chrome containing conversion coating weights should be a minimum of 323 mg/m<sup>2</sup> (30 mg/ft<sup>2</sup>).

Non-chrome conversion coating weights should be maintained according to supplier's recommendations.

*NOTE: Frequent in-plant testing and control of pre-treatment is required to insure satisfactory performance of the coating system.*

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## 7.0 TESTS

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### 7.1 COLOR UNIFORMITY

#### 7.1.1 Procedure

Check random samples visually under a uniform light source. Viewing should be done at multiple angles. In conjunction, instrumental methods are imperative.

#### 7.1.2 Performance

Color uniformity shall be consistent with the color range or numerical value established between the approval source and the applicator. Suggested range is 2ΔE per ASTM D 2244, Section 6.3, from agreed upon color standard.

*NOTE: Color and finish appearance may vary upon factory application due to differences in spray equipment, line conditions or day-to-day process variations. It is strongly recommended that final color approval be made with actual production line samples or mock-ups, not laboratory prepared panels.*

*Pearlescent mica and metallic flakes reflect and scatter light in random patterns; therefore, exact color uniformity should not be expected. Slight color shifting should also be expected when viewing from varying angles and distances. Equipment considerations affect color and are especially critical with multiple applicators.*

### 7.2 SPECULAR GLOSS

#### 7.2.1 Procedure

Measure in accordance with the latest issue of ASTM D 523 using a 60 degree gloss meter. Samples must meet minimum dry film thickness requirements.

#### 7.2.2 Performance

Gloss values shall be within ± 5 units of the manufacturer's specification.

*NOTE: Standard gloss range reference values are:*

Gloss Colors	Specular Gloss Value
High	80-Over
Medium	20-79
Low	19 or less

### 7.3 DRY FILM HARDNESS

#### 7.3.1 Procedure

Strip the wood from a Berol Eagle Turquoise pencil or equivalent, grade F minimum hardness, leaving a full diameter of lead exposed to a length of 6 mm minimum to 10 mm maximum (1/4 in minimum to 3/8 in maximum). Flatten the end of the lead 90 degrees to the pencil axis using fine-grit sand or emery paper. Hold the pencil at a 45 degree angle to the film surface and push forward about 6 mm (1/4 in) using as much downward pressure as can be applied without breaking the lead. Reference ASTM D 3363.

#### 7.3.2 Performance

No rupture of film per ASTM D 3363.

### 7.4 FILM ADHESION

#### 7.4.1 Procedure

##### 7.4.1.1 Dry Adhesion

Make 11 parallel cuts, 1 mm (1/16 in) apart through the film. Make 11 similar cuts at 90 degrees to and crossing the first 11 cuts. Apply tape (Permacel 99 or equivalent) 20 mm (3/4 in) wide over area of cuts by pressing down firmly against the coating to eliminate voids and air pockets. Sharply pull the tape off at a right angle to the plane of the surface being tested. Test pieces should be at ambient temperature [approximately 18°C to 27°C (65°F to 80°F)].

##### 7.4.1.2 Wet Adhesion

Make cuts as outlined in Section 7.4.1.1. Immerse the sample in distilled or deionized water at 38°C (100°F) for 24 hours. Remove and wipe the sample dry. Repeat the test specified in Section 7.4.1.1 within five minutes.

##### 7.4.1.3 Boiling Water Adhesion

Make cuts as outlined in Section 7.4.1.1. Immerse the sample in boiling distilled or deionized water 99°C to 100°C (210°F to 212°F) for 20 minutes. The water shall remain boiling throughout the test. Remove the sample and wipe it dry. Repeat the test specified in Section 7.4.1.1 within five minutes.

#### 7.4.2 Performance

No removal of film under the tape within or outside of the crosshatched area or blistering anywhere on the test specimen. Report loss of adhesion as a percentage of squares affected, (i.e., 10 squares lifted is 10% failure).

### 7.5 IMPACT RESISTANCE

#### 7.5.1 Procedure

Using a 16 mm (5/8 in) diameter round-nosed impact tester 18 N-m (160 in-lb) range, such as a Gardner impact tester, apply a load directly to the coated surface of sufficient force to deform the test sample a minimum of 3 mm ± 0.3 mm (0.10 in ± 0.01 in). Apply tape (Permacel 99 or equivalent) 20 mm (3/4 in) wide over area of deformation by pressing down firmly against coating to eliminate voids and air pockets. Sharply pull tape off at a right angle to the plane of the surface being tested. Test pieces should be at ambient temperature approximately 18°C to 27°C (65°F to 80°F).

#### 7.5.2 Performance

No removal of film from substrate.

*NOTE: Minute cracking at the perimeter of the concave area of the test panel is permissible but no coating pick-off should be apparent.*

### 7.6 ABRASION RESISTANCE

#### 7.6.1 Procedure

Using the falling sand test method, ASTM D 968, the Abrasion Coefficient shall be calculated according to the formula which follows.

ABRASION COEFFICIENT - LITERS PER MIL = V/T

where: V = volume of sand used in liters  
T = thickness of coating in mils

#### 7.6.2 Performance

The Abrasion Coefficient Value of the coating shall be 20 minimum.

### 7.7 CHEMICAL RESISTANCE

#### 7.7.1 Muriatic Acid Resistance (15-Minute Spot Test)

##### 7.7.1.1 Procedure

Apply 10 drops of 10% (by volume) solution of muriatic acid (37% commercial grade hydrochloric acid) in tap water and cover it with a watch glass, convex side up. The acid solution and test shall be conducted at 18°C to 27°C (65°F to 80°F). After a 15 minute exposure, wash off with running tap water.

##### 7.7.1.2 Performance

No blistering and no visual change in appearance when examined by the unaided eye.

#### 7.7.2 Mortar Resistance (24-Hour Pat Test)

### 7.7.2.1 Procedure

Prepare mortar by mixing 75 g (2.6 oz) of building lime (conforming to ASTM C 207) and 225 g (7.9 oz) of dry sand, both passing through a 10-mesh wire screen with sufficient water, approximately 100 g (3.5 oz), to make a soft paste. Immediately apply wet pats of mortar about 1300 mm<sup>2</sup> (2 in<sup>2</sup>) in area and 12 mm (1/2 in) in thickness to coated aluminum specimens, which have been aged at least 24 hours after coating. Immediately expose test sections for 24 hours to 100% relative humidity at 38°C (100°F).

### 7.7.2.2 Performance

Mortar shall dislodge easily from the painted surface, and any residue shall be removable with a damp cloth. Any lime residue should be easily removed with the 10% muriatic acid solution described in Section 7.7.1.1. There shall be no loss of film adhesion or visual change in appearance when examined by the unaided eye.

*NOTE: A slight staining or discoloration may be apparent on orange, yellow or metallic coatings. This should be discussed with the specifying source prior to selection of color.*

### 7.7.3 Nitric Acid Resistance

#### 7.7.3.1 Procedure

Fill an eight-ounce wide-mouth bottle one-half full of nitric acid, 70% ACS reagent grade<sup>(1)</sup>. Place the test panel completely over the mouth of the bottle painted side down, for 30 minutes. Rinse the sample with tap water, wipe it dry, and measure any color change after a one-hour recovery period.

<sup>(1)</sup>The assay of the nitric acid (HNO<sub>3</sub>) should be Fisher A-200 or equivalent; minimum 69.0%, maximum 71.0%.

#### 7.7.3.2 Performance

Not more than 5ΔE Units (Hunter) of color change, calculated in accordance with ASTM D 2244, when comparing measurements on the acid-exposed painted surface and the unexposed surface.

### 7.7.4 Detergent Resistance

#### 7.7.4.1 Procedure

Prepare a 3% (by weight) solution of detergent as prescribed in ASTM D 2248, and distilled water. Immerse at least two test specimens in the detergent solution at 38°C (100°F) for 72 hours. Remove and wipe the samples dry. Immediately apply tape (Permacel 99 or equivalent) 20 mm (3/4 in) wide by pressing down firmly against the coating to eliminate voids and air pockets. Place the tape longitudinally along the entire length of the test specimens. If blisters are visible, then the blistered area must be taped and rated. Sharply pull off at a right angle to the plane of the surface being tested, per ASTM D 3359. A typical solid detergent composition is as follows:

	Parts by Weight
Tetrasodium pyrophosphate (Na <sub>4</sub> P <sub>2</sub> O <sub>7</sub> ) anhydrous	53.0
Sodium sulfate (Na <sub>2</sub> SO <sub>4</sub> ), anhydrous	19.0
Sodium metasilicate (Na <sub>2</sub> SiO <sub>3</sub> ), anhydrous	7.0
Sodium carbonate (Na <sub>2</sub> CO <sub>3</sub> ), anhydrous	1.0
Sodium salt of a linear alkylarylsulfonate (90% flake grade)	20.0
Total	100.0

### 7.7.4.2 Performance

No loss of adhesion of the film to the metal. No blistering and no significant visual change in appearance when examined by the unaided eye.

### 7.7.5 Window Cleaner Resistance

#### 7.7.5.1 Procedure

Prepare a solution of glass cleaner. Apply 10 drops of the window cleaner to the painted surface and immediately cover it with a watch glass, convex side up. Let the test sit for 24 hours, then rinse the specimen with running tap water. Record visual appearance. Let the specimen sit for four hours before conducting the dry adhesion test outlined in Section 7.4.1.1

All purpose glass cleaner composition as follows:

Raw Materials	% By Weight
Dowanol PM*	5
Propylene glycol	5
Isopropanol	35
Water	55
*Dow Chemical, propylene glycol methyl ether	

The solution and test should be conducted at 18°C to 27°C (65°F to 80°F).

#### 7.7.5.2 Performance

There shall be no blistering or noticeable change in appearance when examined by the unaided eye and no removal of film under the tape within or outside of the cross-hatched area.

### 7.8 CORROSION RESISTANCE

#### 7.8.1 Humidity Resistance

##### 7.8.1.1 Procedure

Expose the sample in a controlled heat-and-humidity cabinet for 3,000 hours at 38°C (100°F) and 100% RH with the cabinet operated in accordance with ASTM D 2247 or ASTM D 4585.

### 7.8.1.2 Performance

No formation of blisters to extent greater than "Few" blisters Size No. 8, as shown in Figure No. 4, ASTM D 714.

### 7.8.2 Salt Spray Resistance

#### 7.8.2.1 Procedure

Score the film sufficiently deep to expose the base metal using a sharp knife or blade instrument. Expose the sample for 3,000 hours according to ASTM B 117 using a 5% salt solution. Remove and wipe sample dry.

Immediately apply tape (Permacel 99 or equivalent) 20 mm (3/4 in) wide over scored area by pressing down firmly against the coating to eliminate voids and air pockets. Sharply pull the tape off at a right angle to the plane of the surface being tested.

#### 7.8.2.2 Performance

Minimum rating of seven on scribe or cut edges, and a minimum blister rating of eight within the test specimen field, in accordance with the following Table 1 and Table 2 (Reference ASTM D 1654).

TABLE 1 – Rating of Failure at Scribe (Procedure A)		
Representative Mean Creepage From Scribe		
Millimeters	Inches (Approx.)	Rating Number
Zero	0	10
Over 0 to 0.5	0 to 1/64	9
Over 0.5 to 1.0	1/64 to 1/32	8
Over 1.0 to 2.0	1/32 to 1/16	7
Over 2.0 to 3.0	1/16 to 1/8	6
Over 3.0 to 5.0	1/8 to 3/16	5
Over 5.0 to 7.0	3/16 to 1/4	4
Over 7.0 to 10.0	1/4 to 3/8	3
Over 10.0 to 13.0	3/8 to 1/2	2
Over 13.0 to 16.0	1/2 to 5/8	1
Over 16.0	Over 5/8	0

TABLE 2 – Rating of Unscribed Areas (Procedure B)	
Area Failed, %	Rating Number
No Failure	10
0 to 1	9
2 to 3	8
4 to 6	7
7 to 10	6
11 to 20	5
21 to 30	4
31 to 40	3
41 to 55	2
56 to 75	1
Over 75	0

**NOTE:** The use of a ruled plastic grid is recommended as an aid in evaluating this type of failure. A 6 mm (1/4 in) grid is suggested as most practical for the usual specimen. In using the grid, the number of squares in which one or more points of failure are found is related to the total number of squares covering the significant area

of the specimen to get a percentage figure as used in the tabulation. In some instances, the rating numbers may be used as factors with exposure time intervals related thereto, to produce a performance index number which very accurately indicates relative quality.

## 7.9 WEATHERING

### 7.9.1 South Florida Exposure

The coating shall maintain its film integrity and at a minimum meet the following color retention, chalk resistance, gloss retention and erosion resistance properties. The architect, owner or contractor should request data relative to the long-term durability of the color(s) selected. Exposure panels must be made available to the architect and/or owner upon request.

#### 7.9.1.1 Test Site and Duration

Test sites for on-fence testing are acceptable as follows: Florida exposure South of latitude 27 degrees North at a 45 degree angle facing South for a minimum of five (5) years. Time elapsed when the coating is off the test fence for evaluation, or other purposes, shall not be counted as part of the 5 year exposure minimum.

#### 7.9.1.2 Color Retention

##### 7.9.1.2.1 Performance

Maximum of 5ΔE Units (Hunter) of color change as calculated in accordance with ASTM D 2244, Section 6.3 after the exposure test per Section 7.9.1.1. Color change shall be measured on the exposed painted surface which has been cleaned of external deposits with clear water and a soft cloth and corresponding values shall be measured on the original retained panel or the unexposed flap area of the panel. A portion of the exposed panel may be washed lightly to remove surface dirt only. Heavy scrubbing or any polishing to remove chalk formation or restore the surface is not permitted where color measurements are made. New colors, whether formulated by a paint manufacturer or blended by an applicator according to a paint manufacturer's specifications, may be qualified without the exposure test per Section 7.9.1.1 provided that they are produced with the same pigments in the same coating resin system as a color on which acceptable five (5) year test data is available and which is within ± 10 Hunter Units in lightness (L).

#### 7.9.1.3 Chalk Resistance

##### 7.9.1.3.1 Performance

Chalking shall be no more than that represented by a No. 8 rating based on ASTM D 4214, Test Method A (Method D 659) after test site (weathering) exposure (per Section 7.9.1.1). Chalking shall be measured on an exposed, unwashed painted surface.

### 7.9.1.4 Gloss Retention

#### 7.9.1.4.1 Procedure

After weathering exposure (per Section 7.9.1.1), measure 60 degree gloss of exposed and unexposed areas of a test site exposure panel following ASTM D 523. The exposure panel may be washed lightly with clear water and a soft cloth to remove loose surface dirt. Heavy scrubbing or any polishing to restore the surface is not permitted where gloss measurements are made.

#### 7.9.1.4.2 Performance

Gloss retention shall be a minimum of 30% after the exposure test per Section 7.9.1.1 expressed as:

$$\% \text{ Retention} = \left( \frac{60^\circ \text{ gloss exposed}}{60^\circ \text{ gloss unexposed}} \right) \times 100\%$$

### 7.9.1.5 Resistance to Erosion

#### 7.9.1.5.1 Procedure

After weathering exposure (per Section 7.9.1.1), measure dry film thickness of exposed and adjacent unexposed areas of exposure panels using an Eddy Current Meter as defined in ASTM B 244 or other instrumental methods of equal precision.

#### 7.9.1.5.2 Performance

Less than 10 percent film loss after the exposure test per Section 7.9.1.1 expressed as a percent loss of total film:

$$\text{Loss} = 100\% \left( \left( \frac{\text{Dry film thickness exposed}}{\text{Dry film thickness unexposed}} \right) \right) \times 100\%$$

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## 8.0 TEST REPORTS

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**8.1** Test reports on file with the applicator shall include the following information:

**8.1.1** Date when tests were performed and date of issue of report.

**8.1.2** Identification of organic coating and/or coating system tested, including production date, batch or lot number, cure conditions, pre-treatment data, manufacturer's name and name of company submitting coated samples used in test.

**8.1.3** Copy of drawings submitted showing exposed surfaces.

**8.1.4** Test results.

**8.1.5** A statement indicating that the organic coating and/or coating system tested passed all tests or failed one or more.

**8.1.6** In the case of a failure, which test(s) and a description of the failure(s).

**8.1.7** Statement that all tests were conducted in accordance with this standard.

**8.1.8** Name and address of the laboratory which conducted tests and issued the report.



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## 9.0 REFERENCED STANDARDS

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References to the standards listed below shall be to the edition indicated. Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as to referring to the latest edition of that code or standard.

### AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

**AAMA 800-05**, Voluntary Specifications and Test Methods for Sealants

### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

**ASTM B 117-03**, Standard Practice for Operating Salt Spray (Fog) Apparatus

**ASTM B 244-97(2002)**, Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments

**ASTM C 207-05**, Standard Specification for Hydrated Lime for Masonry Purposes

**ASTM D 523-89(1999)**, Standard Test Method for Specular Gloss

**ASTM D 714-02**, Standard Test Method for Evaluating Degree of Blistering of Paints

**ASTM D 968-93(2001)**, Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive

**ASTM D 1400-00**, Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base

**ASTM D 1654-05**, Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

**ASTM D 2244-02e1**, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

**ASTM D 2247-02**, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity

**ASTM D 2248-01a**, Standard Practice for Detergent Resistance of Organic Finishes

**ASTM D 3359-02**, Standard Test Methods for Measuring Adhesion by Tape Test

**ASTM D 3363-05**, Standard Test Method for Film Hardness by Pencil Test

**ASTM D 4214-98**, Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

**ASTM D 4585-99**, Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation

**ASTM D 5723-95(2002)**, Standard Practice for Determination of Chromium Treatment Weight on Metal Substrates by X-Ray Fluorescence



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