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

AAMA 605-98

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1.0 SCOPE

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.

2.0 PURPOSE

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

3.0 DEFINITIONS

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 indicated by architectural drawings which are visible when the coated product is installed. These may include both closed and open positions of operating sash, ventilators, doors or panels.

4.0 GENERAL

4.1 To quality 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 10 feet (120 inches) (305cm) from the metal surface and inspected at an angle of 90 degrees to the surface.

4.3 The total dry-film thickness utilizing the ASTM D 1400 method shall be calculated to be a minimum 1.2 mil (0.03mm) on significant exposed surfaces. Eighty percent of measurements shall meet or exceed 1.2 mil (0.03mm) total film thickness. In no case shall measurements be below 1.0 mil (0.025mm) or 85% of film thickness specified. On multiple coat applications involving a primer, the topcoat shall be 1.0 mil (0.025mm) minimum with a primer of 0.3 + 0.1 mil (0.003mm). Film thickness specified may be increased to be consistent with color selection and type of coating recommended by 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 requirements set forth in Section 6.

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 65°F to 80°F (18°C to 27°C) before conducting the film adhesion test.

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

4.6 Sealant shall be compatible with organic coatings and meet the performance requirements of AAMA 800 sealant specification. No deleterious effects such as organic coating separation, staining, lifting, discoloration or loss of adhesion shall be evident.

NOTE: *The fabricator of the finished products should consult his sea/ant supplier in selection of sealant which will exhibit adequate adhesion to the painted surface. Panel specimens of the specific coating to be used should be submitted to the sealant manufacturer for tests and recommendations. Peel adhesion tests as described in AAMA 800 is suggested.*

5.0 TEST SPECIMENS

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 six inches (150 mm) long and three inches (75 mm) 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.

6.0 METAL PREPARATION AND PRE-TREATMENT

NOTE: *A multi-stage cleaning and pre-treatment sys tem 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 products used to form the chemical conversion coating on aluminum extrusions and paneling shall conform with ASTM D 1730, Type B, Method 5 (Amorphous Chromium Phosphate Treatment) or Method 7 (Amorphous Chromate Treatment).

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
Coating weight should be a minimum of 30 mg/ft (323 mg/m^2)

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

7. TESTS

7.1 COLOR UNIFORMITY

7.1.1 Procedure
Check random samples visually under a uniform light source such as a MacBeth daylight lamp or the North daylight sky. Samples must meet minimum dry-film thickness requirements and should be viewed head-on.

7.1.2 Performance
Color uniformity shall be consistent with the color range as established between the approval source and the applicator.

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 limits be made with actual production line samples or mock-ups, not laboratory prepared color panels. Pearlescent, mica and metallic flake colors do present the need for more stringent control of the application, project design and installation processes such as flake orientation contributes to the color uniformity.*

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 Medium Low	80-Over 20-79 19 or less

7.3 DRY FILM HARDNESS

7.3.1 Procedure
Strip the wood from a Berol Eagle Turquoise pencil, grade F minimum hardness, leaving a full diameter of lead exposed to a length of 1/4 inch minimum to 3/8 inch maximum (6mm minimum to 10mm maximum). Flatten the end of the lead 90 degrees to the pencil axis using fine-grit sand or emery paper. Hold the pencil at 45 degrees to the film surface and push for ward about 1/4 inch (6mm) 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, 1/16 inch (1mm) apart through the film. Make 11 similar cuts at 90 degrees to and crossing the first 11 cuts. Apply tape (Permacel 99 or equivalent) 3/4 inch (20mm) 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 tothe plane of the surface being tested. Test pieces should be at ambient temperature (approximately 65°F to 80°F (18°C to 27°C)).

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 100°F (38°C) 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 (210°F to 21 2°F) (99°C to 100°C) 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 cross-hatched area or blistering anywhere on the wet test specimen. Report loss of adhesion as a percentage of squares affected, i.e., 10 squares lifted as 10% failure.

7.5 IMPACT RESISTANCE

7.5.1 Procedure
Using a 5/8 inch (16mm) diameter round-nosed impact tester (160 in.-lb. range (1BN-m)), 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 0.10 inch ± 0.01 inch (3mm ± 0.3mm). Apply tape (Permacel 99 or equivalent) 3/4 inch (20mm) wide over area of cuts 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 65°F to 80°F (18°C to 27°C).

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 0.001 inch (.03mm)

7.6.2 Performance
The Abrasion Coefficient Value of the coating shall be 40 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 65°F to 80°F (18°C to 27°C). After a 15 minute expo sure, wash off with running tap water. Conduct mini mum of four tests.

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 grams (0.01 oz) of building lime conforming to ASTM C 207 and 225 grams (0.03oz) of dry sand, both passing through a 10-mesh wire screen with sufficient water, approximately 100 grams (0.014oz), to make a soft paste. Immediately apply wet pats of mortar about two square inches (1300 sq. mm) in area and 1/2 inch (12mm) 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 100°F (38°C). Conduct minimum of four tests.

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[1]. 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.

7.7.3.2 Performance
Not more than 5 △ E 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.

[1] The assay of the nitic acid (HNO_3) should be Fisher A-200 or equivalent; minimum 69.0%, maximum 71.0%.

7.7.4 Detergent Resistance

7.7.4.1 Procedure

Prepare a 3% (by weight) solution of detergent and distilled water. Immerse at least two test specimens in the detergent solution at 100°F (38°C) for 72 hours. Remove and wipe the samples dry. Immediately apply tape (Permacel 99 or equivalent 3/4 inch) (20mm) 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. Detergent composition is as follows:

TECHNICAL GRADE REGENT	% BY WEIGHT
Tetrasodium Pyrophosphate	45
Sodium Sulphate Anydrous	23
Sodium Alkylarylsulfonate*	22
Sodium Metasilicate Hydrated	8
Sodium Carbonate Anhydrous	2
Total	100

* Allied Chemical Co. Nacconal 90F

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 65° to 80°F (18°C to 27°C).

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 100°F (38°C) 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) 3/4 inch (20mm) 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 7 on scribe or cut edges, and a minimum blister rating of 8 within the test specimen field, in accordance with the following Table I and Table 2 (Reference ASTM D 1654).

Table 1: Rating of Failure at Scribe (Procedure A)

Representative Mean Creepage from Scribe		
Millimeters	**Inches (Approximate)**	**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 6mm (1/4 inch) 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 pro duce a performance index number which very accurately indicates relative quality*

7.9 WEATHER EXPOSURE

7.9.1 The coating shall maintain its film integrity and as 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 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 five years.

7.9.1.2 Color Retention

7.9.1.2.1 Performance
Maximum of 5 △ E Units (Hunter) 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 exposure 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 may be qualified without the expo sure 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 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
Measure 60 degree gloss of exposed and unexposed areas of a test site exposure panel (per Section 7.9.1.1) as described in Section 7.9.1 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 50% after the exposure test per Section 7.9.1.1 expressed as:

$$\% \text{ Retention} = \left[\frac{60° \text{ gloss exposed}}{60° \text{ gloss unexposed}} \right] \text{ X } 100\%$$

7.9.1.5 Resistance to Erosion

7.9.1.5.1 Procedure
Measure dry film thickness of exposed and adjacent unexposed areas of exposure panels per Section 7.9.1.1, following procedures described in Section 7.9.1 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:

$$100 - \left[\frac{\text{Dry film thickness exposed}}{\text{Dry film thickness unexposed}} \right] \text{ X } 100\%$$

8.0 TEST REPORTS

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 and pretreatment 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 tailed 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.

9.0 REFERENCED STANDARDS

9.1 AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 800-92, Voluntary Specifications and Test Methods for Sealants

9.2 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117-94, Test Method of Salt Spray (FOG) Testing

ASTM B 244-79 (1993), Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and Other Nonconductive Coatings on Nonmagnetic Basis Metals With Eddy-Current Instruments

ASTM C 207-91 (1992), Specification for Hydrated Lime for Masonry Purposes

ASTM D 523-89, Test Method for Specular Gloss

ASTM D 714-87, Test Method for Evaluating Degree of Blistering of Paints

ASTM D 968-93, Test Method for Abrasion Resistance of Organic Coatings by Falling Abrasive

ASTM D 1400-94, Test Method for Nondestructive Measurement of Dry Film

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

ASTM D 1730-67 (1993), Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting

ASTM D 2244-89, Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates

ASTM D 2247-92, Practice for testing Water Resistance of Coatings in a 100% Relative Humidity

ASTM D 3359-92a, Standard Test Methods for Measuring Adhesion by Tape Test

ASTM D 3363-92, Test Method for Film Hardness by Pencil Test

ASTM D 4214-89, Test Methods for Evaluating Degree of Chalking of Exterior Paint Films

ASTM D 4585-92, Practice for Testing the Water Resistance of Coatings Using Controlled Condensation

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