

AEROSPACE MATERIAL SPECIFICATION

Coatings, Polyurethane, Rain Erosion Resistant for Exterior Aircraft and Missile Plastic Parts

1. SCOPE:

1.1 Scope:

This specification covers the requirements for two classes and two types of rain erosion resistant coatings.

1.2 Application:

These products have been used for protecting glass fabric reinforced plastic laminates and other plastic parts used for exterior surfaces of aircraft and missiles, but usage is not limited to such applications. (See 8.2)

1.3 Classification:

The coatings shall be of the following classes, types and compositions as specified. (See 8.2.)

Class A Polyurethane prepolymers which are not dependent on moisture or high relative humidity for curing (see 8.5).

Type I Rain erosion resistant coating.

Type II Antistatic rain erosion resistant coating.

Class B Polyurethane prepolymers which are dependent on moisture or high relative humidity for curing (see 8.5).

Type I Rain erosion resistant coating.

Type II Antistatic rain erosion resistant coating.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright 2001 Society of Automotive Engineers, Inc.
All rights reserved.

QUESTIONS REGARDING THIS DOCUMENT:
TO PLACE A DOCUMENT ORDER:
SAE WEB ADDRESS:

(724) 772-7161
(724) 776-4970
<http://www.sae.org>

FAX: (724) 776-0243
FAX: (724) 776-0790



Documents
Document Sharing Hub

1.4 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order form a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS5505	Requirements for Accreditation of Testing Laboratories for Organic Coatings
AS9100	Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing
PD2000	Procedures for an Industry Qualified Product Management Process

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 93	Flash Point by Pensky-Martin Closed Cup Tester
ASTM D 471	Rubber Property - Effect of Liquids
ASTM D 1014	Conducting Exterior Exposure Tests of Paints on Steel
ASTM D 1296	Odor of Volatile Solvents and Diluents
ASTM D 1475	Density of Liquid Coatings, Inks, and Related Products
ASTM D 1644	Non-Volatile Content of Varnishes (Discontinued 1998, no replacement)
ASTM D 2196	Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield type) Viscometer
ASTM D 2369	Volatile Content of Coatings
ASTM D 4420	Aromatics in Finished Gasoline by Gas Chromatography

2.3 U.S. Government Publications:

Available from DODSSP Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-PRF-5425	Plastic Sheet, Acrylic, Heat Resistant
MIL-A-8625	Anodic Coatings, For Aluminum and Aluminum Alloys
MIL-PRF-25134	Remover, Paint and Lacquer, Solvent Type
MIL-P-25421	Plastic Materials; Glass Fiber Based-Epoxy Resin, Low Pressure Laminated
MIL-R-7705	Radome, General Specification for (Canceled, no superseding document)
FED-STD-141	Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection. Sampling and Testing
U.S. Air Force Bulletin 535	U.S. Air Force 535 Free Diisocyanate Test Method
HUD	Free Diisocyanate Test Method
49CFR 171-178	Federal Hazardous Substances Labeling Act
	Department of Transportation (DOT) Regulations for the Transportation of Explosives and Other Dangerous Articles by Land and Water

3. TECHNICAL REQUIREMENTS:

3.1 Qualification:

- 3.1.1 All products sold to this specification shall be listed, or approved for listing on the qualified products list. PRI QPL AMS-C-83231. To qualify, the product shall meet the tests specified in section 4.4.
- 3.1.2 Qualification testing, review of test results, approved, reapproval and recertification of qualification for QPL listing shall be in accordance with PD2000.
- 3.1.3 Recertification of qualification is required every five years. Recertification consists of a letter certifying that there have been no changes in the material ingredients, manufacturing processes, or site of production since qualification and that the product meets all of the requirements of this specification. In addition a test report shall be provided from a lab of the manufacturer's choosing, showing compliance with all of the qualification tests.

3.2 Materials:

The coating material shall be of a polyurethane type formulated from a chemically curing composition of such ingredients as may be necessary to produce high quality materials. The coating materials shall cure completely at standard conditions. The Class A coatings shall contain only cycloaliphatic or aliphatic isocyanate (see 8.5).

3.2.1 Toxic Products and Formulations: The material shall have no adverse effect on the health of personnel when used for its intended purpose and applied in approved facilities with the use of approved safety equipment. Questions pertinent to this effect shall be referred by the procuring activity to the appropriate department medical service who will act as an advisor to the procuring agency.

3.3 Components:

3.3.1 Class A, Types I and II: The Class A coatings shall be a polyurethane prepolymer vehicle which can be polymerized with a curing agent at standard conditions without dependence on moisture or high relative humidity. Unless otherwise specified, class A, type I coating components shall be individually packaged and furnished as a kit. The kit shall consist of the following: a primer plus primer activator; polyurethane prepolymer vehicle plus the curing agent; and a thinning solvent. For class A, type II coatings, an anti-static film shall be applied to the surface of the type I coating. The class A, type II coating kit shall consist of all the components required for the class A, type I kit plus the antistatic polyurethane prepolymer vehicle and the curing agent. Class A coatings shall be applied by spray or brush techniques.

3.3.2 Class B, Types I and II: The class B coatings shall be moisture curing polyurethane prepolymers, of which the polymerization may be accelerated by a catalyst. The class B coatings can be polymerized at standard temperature conditions but are dependent on moisture or high relative humidity. The polymerization rate can be accelerated by the use of a catalyst. Unless otherwise specified, class B, type I coating components shall be individually packaged and furnished as a kit. The kit shall consist of the following: a primer plus primer activator; polyurethane prepolymer vehicle plus a catalyst when applicable; and a thinning solvent. For class B, type II coatings, an antistatic film shall be applied to the surface of type I coating. The class B, typed II coating kit shall consist of all the components required for the class B, type I kit plus the antistatic polyurethane vehicle and the catalyst when applicable. ClassB coatings shall be applied by brush or spray techniques.

3.4 Quantitative Requirements:

The quantitative requirements of the coatings shall be as specified in Table 1.

TABLE 1 - Quantitative Requirements - Classes A and B

Component	Nonvolatile (Solids Content) % by Weight, min	Density, kg/L (lb/gal)	Viscosity, Centipoises	Flash Point °C (°F), min
Primer (Mixed components, if applicable)	10.0	0.839 (7.0)	100-400	10 (50)
<u>CLASS A</u>				
Type I, Polyurethane Prepolymer	40	0.899 (7.5)	250-500	10 (50)
Type II, Polyurethane Prepolymer	40	0.899 (7.5)	250-500	10 (50)
Antistatic Polyurethane Prepolymer	50	0.899 (7.5)	900-1500	10 (50)
<u>CLASS B</u>				
Type I, Polyurethane Prepolymer	45	0.959 (8.0)	130-500	10 (50)
Type II, Polyurethane Prepolymer	45	0.959 (8.0)	130-400	10 (50)
Antistatic Polyurethane Prepolymer	35	0.899 (7.5)	900-1500	10 (50)

3.4.1 Polyurethane Prepolymers (Free Diisocyanate Content): The free diisocyanate content of the polyurethane prepolymers for classes A and B, types I and II coatings shall be not greater than 1percent when tested as specified in 4.9.2 and Appendix.

3.5 Qualitative Requirements:

3.5.1 Mixing: Components of classes A and B, types I and II coatings shall be individually mixed in accordance with the manufacturers instructions. The resulting individual mixtures shall be smooth, homogeneous materials free from lumps, gelling, seeding, separation or other objectional characteristics.

3.5.2 Odor: The odor of the wet coatings shall not be obnoxious when tested as specified in 4.9.

- 3.5.3 Color: Classes A and B coatings shall be tinted black. The color shall be sufficiently intense when the specified film thickness is applied that the sub-surface is completely hidden.
- 3.5.4 Accelerated Storage Stability: Classes A and B coatings shall be subjected to 4 days of accelerated storage. At the end of the 4 day storage period, the component materials shall be free of lumps, skins and gels and shall disperse readily to a smooth homogeneous mixture when tested in accordance with 4.9.6.
- 3.5.5 Shelf Storage Life: When stored as specified in 4.9.7, classes A and B coatings shall meet all the requirements of this specification except that the minimum viscosity in Table 1 shall not have decreased by more than 10 percent from the specified value and the maximum viscosity in Table 1 shall not have increased by more than 10 percent above the specified value.
- 3.5.6 Pot Life: Classes A and B coatings shall have a minimum pot life of 4 hours at standard conditions. At the end of the 4 hour period, the coatings shall show no signs of lumping, seeding, separation or an increase in viscosity of more than 20 percent from the initial viscosity.
- 3.5.7 Application and Drying Time: The class A and B coatings shall be applied in accordance with the manufacturer's instructions to a total dry film thickness of 0.31 to 0.36 mm (0.012 to 0.014 inch) (12 to 14 mils). The total application time, including priming and intervals between coatings shall not exceed 8 hours. The tack free drying time for class A coatings shall not exceed 4 hours after application of the final coating when tested in accordance with 4.9.9. The tack free drying time for class B coatings shall not exceed 10 hours after application of the final coat when tested in accordance with 4.9.9.
- 3.5.7.1 Rate-of-Cure: The rate-of-cure of the classes A and B coatings shall have a maximum set-to-touch or recoat time of one hour. For class B materials, the manufacturer shall furnish instructions for catalyzing or accelerating the polyurethane prepolymer materials for a temperature range from 18 to 35 °C (65 to 95 °F) and a relative humidity range from 40 percent to 75 percent.
- 3.5.8 Curing Time: Class A coatings shall be fully cured within 5 days and shall be free of pinholes, cracks, bubbles or other film irregularities. Class B coatings shall be fully cured within 10 days and shall be free of pinholes, cracks, bubbles, or other film irregularities.
- 3.5.9 Peel Strength: Class A coatings shall have a peel strength of not less than 1126 N/m (7 pounds per inch) and class B coating shall have a peel strength of not less than 1751 N/m (10 pounds per inch) when tested in accordance with 4.9.11.
- 3.5.10 Flexibility: Films of the coatings shall show no cracking or loss of adhesion in the bend area when tested in accordance with 4.9.14.
- 3.5.11 Water and Aromatic Fuel Resistance: After immersion in water and fuels, the coatings shall show no evidence of blistering, swelling, checking, or visible color change. After immersion, the peel strength shall not decrease to less than 7 pounds per inch when tested in accordance with 4.9.12 and 4.9.13.

- 3.5.12 Rain Erosion Resistance: Class A types I and II coatings, and class B types I and II coatings shall not erode through a 0.31 to 0.36 mm (0.012 to 0.014 inch) (12 to 14 mils) thick coating when tested as specified in 4.9.15 and Table 3.
- 3.5.13 Electrical Transmission: Class A types I and II coatings and class B types I and II coatings shall have a minimum electrical transmission of 85, 90 or 95 percent when tested as specified in 4.9.17 and Table 3.
- 3.5.14 Surface Resistivity: The surface resistivity of the class A, type II coating shall be not less than 0.5megohms nor more than 15 megohms per square when tested as specified in 4.9.18 and Table 3.
- 3.5.15 Weather Resistance: Class A, types I and II coatings and class B, types I and II coatings, when exposed to outdoor weathering for 6 months shall show no film deterioration such as chalking, checking, cracking, embrittlement, loss of adhesion, or loss of resiliency. After weathering, the coatings shall meet the surface resistivity requirements as specified in 3.5.14.
- 3.5.16 Strippability: Newly applied, fully cured and weathered Class A, types I and II and class B, types I and II coatings shall be easily strippable when tested as specified in 4.9.21.
- 3.5.17 Repairability: The cured coatings shall be repairable as specified by the manufacturer.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Quality System of Manufacturer:

Before submitting a product for qualification to this specification for the purpose of being listed on the PRI QPL, the manufacturer must have a quality system in place which holds a third party accreditation to AS9100.

4.2 Responsibility for Inspection:

The manufacturer of the coating compound shall supply all samples for manufacturer's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and perform any confirmatory testing deemed necessary to ensure that the coating compound conforms to the requirements of this specification.

4.3 Classification of Inspections:

The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.4).
- b. Quality conformance inspection (see 4.5).

4.4 Qualification Inspection:

Qualification tests shall consist of all tests specified in 4.9 except the test for inspection of filled containers. All qualification testing is to be done by a laboratory accredited to ISO 17025 and AS5505.

4.4.1 Qualification Samples: Unless otherwise specified, qualification test samples shall consist of the following materials and test panels:

a. Materials

Primer (for types I and II)	0.5 L or 1 pint (for each class and each type)
Primer activator	Quantity specified by manufacturer
Polyurethane prepolymer solutions	3.8 L or 1 gallon (for each class and each type)
Catalyst	Quantity specified by manufacturer
Antistatic coating (for type II)	1 L or 1 quart for each class
Antistatic catalyst (for type II)	Quantity specified by manufacturer
Diluent	3.8 L or 1 gallon (for each class and each type)

(b) Test panels

Uncoated airfoils (see 4.9.15)	18 (for each class and each type)
Coated void-free laminate panels (see 4.9.17)	5 (2 for type I, classes A and B) (3 for type II, classes A and B)
Uncoated void-free control panels (see 4.9.17)	1
Coated void-free panels (see 4.9.21)	1 (for each class and type)

Samples shall be identified as follows, and forwarded to the activity responsible for testing.

4.4.1 (Continued):

AMS-C-83231A Class (A or B) Type (I or II)

Manufacturer's Identification

Name of Manufacturer

Lot Number

Date of Manufacture

Submitted by (name) (date) for qualification tests in accordance with AMS-C-83231A under authorization (Reference Authorizing Letter)

Mixing Instructions

4.4.2 Test Report: Qualification samples shall be accompanied by a certified test report showing results of all tests required by this specification except the test for inspection of filled containers.

4.4.2.1 Instruction Sheet: The manufacturer shall forward 3 copies of the instruction sheet detailing mixing, thinning, application and curing procedures for his material with all qualification samples submitted for approval. Qualification approval of the manufacturer's coating system shall also constitute approval of the applicable instruction sheets. The instruction sheets shall not be changed in any way without specific approval of the qualifying activity.

4.5 Quality Conformance Inspection:

Quality conformance inspection for acceptance of individual lots shall consist of sampling and tests as specified herein.

4.5.1 Sampling:

4.5.1.1 Lot: A lot shall consist of all coating materials of the same type and class manufactured at one time and offered for delivery at one time.

4.5.1.2 Samples: 3.8 L or one gallon samples shall be selected from each lot and subjected to the following tests:

- a. Nonvolatile (solids) content (see 4.9)
- b. Viscosity (see 4.9)
- c. Condition in container (see 4.9.5)
- d. Accelerated storage (see 4.9.6)
- e. Peel strength (see 4.9.11)
- f. Surface resistivity (type II system only) (see 4.9.18).

4.6 Test Conditions:

Standard laboratory test: conditions shall be $24^{\circ}\text{C} \pm 1$ ($75^{\circ}\text{F} \pm 2$) with a relative humidity of 50 ± 2 percent. All component materials shall be conditioned for at least 24 hours at this temperature and relative humidity before being tested or used in the preparation of test panels. Except as otherwise specified herein, all physical tests on the coating material or test films thereof shall be made under these conditions in an atmosphere that is dust free.