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**Protective Film, High Performance, Polymeric
Pressure Sensitive Adhesive, for
Aircraft Exterior Applications**

1. SCOPE:

1.1 Form:

This specification covers adhesive-backed polymeric protective film, pigmented or clear, for aircraft exterior applications.

1.2 Application:

This film is used typically as a replacement for polyurethane paint topcoats on military and commercial exterior aircraft surfaces. The film has been designed to meet air pollution regulations with zero emission of volatile organic compounds (VOC)/organic hazardous air pollutants (HAP).

1.3 Classification:

Types: The polymeric protective film material shall be of the following types:

Type 1 - For commercial applications

Type 2 - For military applications

Unless otherwise specified, the requirements of this specification are applicable for Types 1 and 2.

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.

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Documents
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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 canceled 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 or www.sae.org.

AMS-QQ-A-250/4	Aluminum Alloy 2024, Plate and Sheet
AMS-QQ-A-250/5	Aluminum Alloy, Alclad 2024, Plate and Sheet
AMS 2629	Fluid, Jet Reference
AMS 2825	Material Safety Data Sheets

AS1241	Fire Resistant Hydraulic Fluid for Aircraft
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2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM B 117	Operating Salt Spray (Fog) Testing Apparatus
ASTM D 217	Test Method for Cone Penetration of Lubricating Grease
ASTM D 471	Rubber Property - Effect of Liquids
ASTM D 522	Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	Specular Gloss
ASTM D 1193	Reagent Water
ASTM D 2197	Adhesion of Organic Coatings by Scrape Adhesion
ASTM D 2244	Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2370	Tensile Properties of Organic Coatings
ASTM D 2805	Hiding Power of Paints by Reflectometry
ASTM D 3363	Film Hardness by Pencil Test
ASTM G 53	Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials
ASTM G 85	Modified Salt Spray (Fog) Testing

2.3 U.S. Government Publications:

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

FED-STD-141	Paints, Varnish, Lacquer and Related Materials, Methods of Inspection, Sampling and Testing
TT-P-2756	Polyurethane Coating: Self-priming Topcoat, Low Volatile Organic Compounds (VOC) Content
TT-P-2760	Primer Coating: Polyurethane, Elastomeric, High-Solids
MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-PRF-5606	Hydraulic Fluid, Petroleum Base, Aircraft Missile and Ordinance
MIL-P-25421	Plastic Materials, Glass Fiber Base Epoxy Resin, Low Pressure Laminated
MIL-PRF-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-PRF-23377	Primer Coatings: Epoxy, High Solids
MIL-PRF-23699	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number 0-156
MIL-PRF-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft, Metric, NATO Code Number H-537
MIL-PRF-85285	Coating: Polyurethane, High Solids
MIL-PRF-85582	Primer Coatings, Epoxy, Waterborne

3. TECHNICAL REQUIREMENTS:

3.1 General:

- 3.1.1 Material: The material shall consist of clear or pigmented polymeric film, with a pressure sensitive adhesive applied to one side. The adhesive backing shall have a suitable protective liner which shall be easily removed without the use of solvents or water and without distortion of the film. The film and adhesive system shall be free of constituents which may have corrosive effects on substrates under normal operating conditions.
- 3.1.2 Odor: The material odor shall not be obnoxious or cause discomfort to personnel during the application.
- 3.1.3 Toxicity: The manufacturer shall certify that the film material furnished under this specification will have no adverse effect on the health of personnel, when used for its intended purpose.

3.2 Properties:

The film when applied in accordance with the manufacturer's instructions shall conform to the following requirements, and in accordance with test methods in Table 1.

TABLE 1 - Material Requirements

PROPERTY	Type 1 Requirements	Type 2 Requirements	Test Requirements
Odor	3.1.2	3.1.2	***
Toxicity	3.1.3	3.1.3	***
Cleanability	3.2.1	3.2.1	4.5.2
Thickness	3.2.2	3.2.2	4.5.3
Color	3.2.3	3.2.3	4.5.4
Infrared Reflectance	***	3.2.3.1	4.5.4.1
Gloss	3.2.3.2	3.2.3.2	4.5.4.2
Hiding Power	3.2.4	3.2.4	4.5.5
Perforations	3.2.5	3.2.5	***
Hardness	3.2.6	3.2.6	4.5.6
Conformability	3.2.7	3.2.7	4.5.7
Shrinkage	3.2.8	3.2.8	4.5.8
Abrasion	3.2.9	3.2.9	4.5.9
Flexibility			
Impact Elongation	3.2.10.1	3.2.10.1	4.5.10.1
Low Temperature	3.2.10.2	3.2.10.2	4.5.10.2
Free Film Elongation	3.2.10.3	3.2.10.3	4.5.10.3
Adhesion			
Room Temperature	3.2.11.1	3.2.11.1	4.5.11.1
Low Temperature	3.2.11.2	3.2.11.2	4.5.11.2
High Temperature	3.2.11.3	3.2.11.3	4.5.11.3
Scrape Adhesion	3.2.11.4	3.2.11.4	4.5.11.4
Wet Tape Test	3.2.11.5	3.2.11.5	4.5.11.5
Adhesion After Aging	3.2.11.6	3.2.11.6	4.5.11.1
Compatibility			
With Primers	3.2.12.1a	3.2.12.1b	4.5.12.1
With Topcoats	3.2.12.2a	3.2.12.2b	4.5.12.2
Film Adhesion to Itself	3.2.12.3	3.2.12.3	4.5.12.3
Paint Adhesion on Film	3.2.12.4	3.2.12.4	4.5.12.4

TABLE 1 - Material Requirements (Continued)

PROPERTY	Type 1 Requirements	Type 2 Requirements	Test Requirements
Fluid resistance			
AS1241/MIL-PRF-83282	3.2.13a-1	***	4.5.13
Oil MIL-PRF-7808	3.2.13a-2	***	4.5.13
Hydraulic Fluid			
MIL-PRF-5606	3.2.13a-3	***	4.5.13
Reference Fuel B	3.2.13a-4	***	4.5.13
ASTM D 471			
Lubricating Oil	***	3.2.13b-1	4.5.13
MIL-PRF-23699			
Hydraulic Fluid	***	3.2.13b-2	4.5.13
Mil-PRF-83282			
Humidity Resistance	3.2.14	3.2.14	4.5.14
Heat Resistance	3.2.15	3.2.15	4.5.15
Weather resistance			
Xenon-Arc	3.2.16.1a	3.2.16.1a	4.5.16a
Atlas UVCON or equivalent	3.2.16.1b	***	4.5.16b
Corrosion Resistance			
Salt Spray	3.2.17.1a,b	3.2.17.1c	4.5.17
Filiform	3.2.17.2	3.2.17.2	4.5.18
Sulfur Dioxide/Salt			
Spray	***	3.2.17.3	4.5.19
Rain Erosion Resistance	3.2.18	3.2.18	4.5.20
Strippability	3.2.19	3.2.19	4.5.21
Shelf Life	3.2.20	3.2.20	***

- 3.2.1 Cleanability: The film shall have 90% minimum cleaning efficiency when tested in accordance with 4.5.2.
- 3.2.2 Thickness: The film thickness, including the adhesive, shall not exceed 0.13 mm (0.005 inch). The thickness shall be tested in accordance with 4.5.3.
- 3.2.3 Color: The protective film shall be furnished in the color specified by the procuring activity with good visual match to the specified color chip in daylight. The maximum deviation from the specified color chip shall be Delta E value of 1 when tested in accordance with paragraph 4.5.4.
- 3.2.3.1 Infrared Reflectance (for Type 2 only): The infrared reflectance of lusterless colors, when specified by the procuring activity, shall be tested per 4.5.4.1 and shall conform to the limits in Table 2:

TABLE 2 - Infrared Reflectance

Wavelength (nm)	Maximum Reflectance (%)
450-500	8
500-600	10
600-2700	8

- 3.2.3.2 Gloss: The specular gloss of the film at a 60° angle of incidence when tested per 4.5.4.2 shall be as follows in Table 3:

TABLE 3 - Specular Gloss

Specular Gloss	Requirement
Gloss Colors	Minimum of 90
Semi-Gloss	15-45
Lusterless (Flat)	Maximum of 3

- 3.2.4 Hiding Power: The applied film material shall have the following minimum contrast ratios in Table 4 at the required film thickness, less than 0.13 mm (0.005 inch), when tested in accordance with 4.5.5:

TABLE 4 - Hiding Power

Film Color	Contrast Ratio
Light Colors	0.96 minimum
Dark Colors	1.00 minimum

- 3.2.5 Perforations: When the film is perforated, the perforation shall not adversely affect the performance of the film as required by this specification. The perforated and non-perforated film material shall pass all qualification requirements of this specification.
- 3.2.6 Hardness: The minimum film hardness shall be HB when tested in accordance with 4.5.6.
- 3.2.7 Conformability: The film, when tested in accordance with 4.5.7, shall be smooth, free from wrinkles, air bubbles, tenting (forming a tent over a rivet head), and any other irregularities. The maximum non-conformability of the filmed area shall be no more than 1% of the total film area.
- 3.2.8 Shrinkage: The film material tested in accordance with 4.5.8 shall not exceed 0.40 mm (0.016 inch) shrinkage in any one direction.
- 3.2.9 Abrasion: The film when tested per 4.5.9 shall be capable of withstanding 750 revolutions without wearing through to the adhesive.

3.2.10 Flexibility:

3.2.10.1 Impact Elongation: The protective film shall exhibit a minimum impact elongation of 60% at room temperature, when tested in accordance with 4.5.10.1, without cracking, crazing, flaking or any adhesion failure when examined under 10X magnification.

3.2.10.2 Low Temperature Flexibility: The protective film shall not exhibit any cracking or delamination under 10X examination when bent over a mandrel in accordance with 4.5.10.2.

3.2.10.3 Free Film Elongation: The free film elongation shall be 50% minimum when tested in accordance with 4.5.10.3.

3.2.11 Adhesion:

3.2.11.1 Adhesion at Standard Room Conditions: The film shall have a minimum of 0.438 N/mm (40 oz/in) adhesion when tested in accordance with 4.5.11.1 at standard room temperature.

3.2.11.2 Adhesion at Low Temperature: The film shall have a minimum of 0.383 N/mm (35 oz/in) adhesion when tested in accordance with 4.5.11.2. The testing shall be performed in the cold chamber after conditioning the specimens for 24 hours at $-50\text{ }^{\circ}\text{C} \pm 3$ ($-60\text{ }^{\circ}\text{F} \pm 5$).

3.2.11.3 Adhesion at High Temperature: The film shall be capable of withstanding 8 hours at $149\text{ }^{\circ}\text{C} \pm 3$ ($300\text{ }^{\circ}\text{F} \pm 5$) with no separation of adhesive from the substrate when tested in accordance with 4.5.11.3.

3.2.11.4 Scrape Adhesion Test: The protective film shall resist removal from the substrate when tested with a 3 kg (6.62 lb) weight in accordance with 4.5.11.4.

3.2.11.5 Wet Tape Test: The protective film shall not peel away from the substrate when tested in accordance with 4.5.11.5.

3.2.11.6 Adhesion After Aging: There shall be no loss of adhesion after aging in accordance with 3.2.17.1 and tested in accordance with 4.5.11.1.

3.2.12 Compatibility:

3.2.12.1 Compatibility with Primers: The film shall pass the adhesion requirements of 3.2.11.1 and 3.2.11.5 when tested in accordance with 4.5.12.1. Unless otherwise specified by the purchaser (See 8.1), the following primers shall be tested:

- a. For Type 1 Film only - BMS 10-79, and DMS 2104
- b. For Type 2 Film only - MIL-PRF-23377, MIL-PRF-85582, TT-P-2760.