IAEG® WG2 - Integral Fuel Tank Coating Product Requirements Document

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Version **01**

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Version History

Date	v#	Modified By	Section, Page(s) and Text Revised
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Table of Contents

Version History 2
1 Purpose 3
2 Applicable Documents 3
2.1 Test Methods 3
2.2 Materials 3
2.3 Other 3
3 Definitions and Acronyms 4
3.1 Mixed Material Performance Requirements 4
3.1.1 Hardness 4
3.1.2 Impact Resistance 4
3.1.3 Adhesion 4
3.1.4 Corrosion Resistance 5
3.1.5 Flexibility – Low Temperature 5
3.1.6 Fluid Resistance 6
3.1.7 Microbiological Performance 7
3.1.8 Sealant Compatibility 8
3.1.9 Repair, with Conversion Coating Touch-up 8
3.2 Test Panels 9
3.2.1 Pretreatment 9
3.2.2 Application of Integral Fuel Tank Coating 9
3.2.3 Cure of Integral Fuel Tank Coating 9
3.2.4 Preparation of Repair, with Conversion Coating Touch-up, Panels 9

1 Purpose

The purpose of this Requirements Document is to capture the requirements of an aerospace Integral Fuel Tank Coating. This is an output of IAEG Working Group 2's Integral Fuel Tank Coating project and has been collated with input from the project's member companies.

2 Applicable Documents

2.1 Test Methods

AS5127/1	Test Methods for Aerospace Sealants Two-Component Synthetic Rubber Compounds
ASTM D2794	Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3359	Standard Test Methods for Rating Adhesion by Tape Test
ASTM D3363	Standard Test Method for Film Hardness by Pencil Test
EN 3665	Filiform Corrosion Resistance Test on Aluminum Alloys
ISO 9227	Corrosion Tests in Artificial Atmospheres — Salt Spray Tests
ISO 846B	Plastics — Evaluation of The Action of Microorganisms

2.2 Materials

AMS2629	Jet Reference Fluid
AMS-C-27725	Coating, Corrosion Preventative, for Aircraft Integral Fuel Tanks for Use to 250°F (121°C)
AMS-QQ-A-250/4	Aluminium Alloy 2024, Plate and Sheet
AMS-QQ-A-250/5	Aluminium Alloy Alclad 2024, Plate and Sheet
AMS-QQ-A-250/12	Aluminium Alloy 7075, Plate and Sheet

2.3 Other

MIL-PRF-8625	Anodic Coatings for Aluminum and Aluminum Alloys

3 Definitions and Acronyms

CCC	Chemical Conversion Coating
DiEGME	Diethylene Glycol Monomethyl Ether
TSAA	Tartaric Sulfuric Acid Anodizing
TFSAA	Thin Film Sulfuric Acid Anodizing

3.1 Mixed Material Performance Requirements

3.1.1 Hardness

Prepare test panels according to 3.2, Table 1 and Table 2.

Conduct pencil hardness test per ASTM D3363 using an appropriate set of drawing pencils.

The cured coating shall have a minimum pencil hardness of F.

3.1.2 Impact Resistance

Prepare test panels according to 3.2, Table 1 and Table 2.

Subject the forward side (coated) of the test panel to 50-inch pounds, and the reverse side (uncoated) of the test panel to 30-inch pounds, using a Gardner Impact Tester per ASTM D2794.

Examine the impact areas, the cured coating shall not show any flaking, cracking or other adhesion failures when impacted.

3.1.3 Adhesion

3.1.3.1 Dry Tape

Prepare test panels according to 3.2, Table 1 and Table 2.

Conduct test per ASTM D3359 Method B.

The cured coating shall have an adhesion rating of 5B.

3.1.3.2 Wet Tape

Prepare test panels according to 3.2, Table 1 and Table 2.

Immerse test panels in distilled water at 60 ± 2°C for 30 days.

Remove panels from distilled water and dry with a clean cloth. Conduct adhesion test per ASTM D3359 Method B within 5 minutes of removal from the distilled water.

The panels shall exhibit no blistering or other film defects, and the area evaluated shall have an adhesion rating of 5B.

3.1.4 Corrosion Resistance

3.1.4.1 Neutral Salt Spray

Prepare test panels according to 3.2, Table 1 and Table 2.

Scribe 2 intersecting lines, 1.5 mm to 3 mm wide, extending from corner to corner of the panel, through coating and treatments and down to the base alloy.

Expose the test panels to neutral salt spray per ISO 9227 for 3000 hours, inspecting every 500 hours. At each 500-hour inspection interval, photograph each test panel and record any observations made such as corrosion in the scribe, extending from the scribe (and distance of extension), and corrosion or blistering of the coating away from the scribe.

After completion of 3000 hours in the neutral salt spray chamber and final inspection has been completed, strip the coating from the test panels using mechanical (e.g., using MIL-DTL-85891 20-30 grit size media) or chemical means (e.g., MIL-R-81294; TT-R-2918), and carry out a further inspection for corrosion of the test panel material, recording any observations.

There shall be no extension of corrosion beyond 2 mm for the scribe lines, and no blisters in the coating.

3.1.4.2 Filiform

Prepare test panels according to 3.2, Table 1 and Table 2.

Scribe 2 intersecting lines, 1.5 mm to 3 mm wide, extending from corner to corner of the panel, through coating and treatments and down to the base alloy.

Carry out filiform corrosion test per EN 3665, for 3000 hours, inspecting every 500 hours. At each 500-hour inspection interval, photograph each test panel and record any observations made such as corrosion in the scribe, extending from the scribe (and distance of extension), and corrosion or blistering of the coating away from the scribe.

After completion of 3000 hours in the neutral salt spray chamber and final inspection has been completed, strip the coating from the test panels using mechanical (e.g., using MIL-DTL-85891 20-30 grit size media) or chemical means (e.g., MIL-R-81294; TT-R-2918), and carry out a further inspection for corrosion of the test panel material, recording any observations.

There shall be no extension of corrosion beyond 2 mm for the scribe lines, and no blisters in the coating.

3.1.5 Flexibility – Low Temperature

Prepare test panels according to 3.2, Table 1 and Table 2.

Condition the test panels and a 4-inch diameter mandrel for 5 hours at -57 ± 3°C.

At the end of the 5-hour low temperature exposure period, bend the test panels over the mandrel per ASTM D522 Method B.

After the test panels come up to room temperature, inspect the coating for any cracking or adhesion failures, prior to conducting a tape adhesion test per ASTM D3359 Method B.

There shall be no adhesion failures after bending over a 4-inch mandrel, and tape adhesion rating shall be 5B.

3.1.6 Fluid Resistance

3.1.6.1 Fuel(s)

Prepare test panels according to 3.2, Table 1 and Table 2.

Immerse 1 set of test panels in AMS2629 Jet Reference Fluid at 23°C for 30 days, and 1 set of test panels in AMS2629 Jet Reference Fluid at 60°C for 30 days.

Remove panels from the fuel and dry with a clean cloth. Conduct adhesion test per ASTM D3359 Method B within 5 minutes of removal from the fuel (it is permissible to manually solvent clean the panels to remove any fuel residue and enable the tape to adhere to the panels).

After a 24-hour period, conduct a pencil hardness test per ASTM D3363 using an approved set of drawing pencils.

The panels shall exhibit no blistering or other film defects, and the area evaluated shall have an adhesion rating of 5B.

The coating shall not have softened by any more than 2 levels on the pencil hardness scale from the hardness established in 3.1.1.

3.1.6.2 Hydraulic Fluid – Skydrol LD4

Prepare test panels according to 3.2, Table 1 and Table 2.

Immerse test panels in Skydrol LD4 Hydraulic Fluid at 23°C for 30 days.

Remove panels from the fluid and dry with a clean cloth. Conduct adhesion test per ASTM D3359 Method B within 5 minutes of removal from the fluid (it is permissible to manually solvent clean the panels to remove any fluid residue and enable the tape to adhere to the panels).

After a 24-hour period, conduct a pencil hardness test per ASTM D3363 using an appropriate set of drawing pencils.

The panels shall exhibit no blistering or other film defects, and the area evaluated shall have an adhesion rating of 5B.

The coating shall not have softened by any more than 2 levels on the pencil hardness scale from the hardness established in 3.1.1.

3.1.6.3 DiEGME

Prepare test panels according to 3.2, Table 1 and Table 2.

Testing to be carried out per the procedure defined in AMS-C-27725 Section 4.7.5.18.2

Remove panels from the test environment and dry with a clean cloth. Conduct adhesion test per ASTM D3359 Method B within 5 minutes of removal from the fluid (it is permissible to manually solvent clean the panels to remove any fluid residue and enable the tape to adhere to the panels).

After a 24-hour period, conduct a pencil hardness test per ASTM D3363 using an appropriate set of drawing pencils.

The panels shall exhibit no blistering or other film defects, and the area evaluated shall have an adhesion rating of 5B.

The coating shall not have softened by any more than 2 levels on the pencil hardness scale from the hardness established in 3.1.1.

3.1.7 Microbiological Performance

3.1.7.1 Simulated Resistance

Prepare test panels according to 3.2, Table 1 and Table 2.

To make up the immersion fluid for this test:

- Dissolve 5 parts of analytical grade acetic acid in 100 parts by weight of 3% NaCl in distilled water
- An equal volume of AMS 2629 Reference Fuel shall then be added to the mixture

The test panels shall be immersed for 5 days at 60 ± 3 °C in such a way that one third of the panel is exposed to the acetic acid/salt solution, one third to the Reference Fuel, and one third to the air vapour mix.

At the end of the specified immersion period, remove the test panels and rinse in running water before examining for blisters or other irregularities in the coating.

Conduct adhesion test per ASTM D3359 Method B within 5 minutes of removal from immersion fluid (it is permissible to manually solvent clean the panels to remove any fluid residue and enable the tape to adhere to the panels).

After a 24-hour period, conduct a pencil hardness test per ASTM D3363 using an appropriate set of drawing pencils.

The panels shall exhibit no blistering or other film defects, and the area evaluated shall have an adhesion rating of 5B.

The coating shall not have softened by any more than 2 levels on the pencil hardness scale from the hardness established in 3.1.1.

3.1.7.2 Live Resistance

Prepare test panels according to 3.2, Table 1 and Table 2.

Two tests according to ISO 846 shall be applied:

- Method A is a "Fungal-growth test" that determines the nutritive property of the coating (no other organic matter). Resistance of the material to fungal attack can also be evaluated through this test.
- Method B is a "Determination of fungistatic effects" test that determines how well the material can inhibit microbial growth in a nutrient rich medium. Resistance of the material to fungal attack can also be evaluated trough this test.

Composition of the spore suspension:

- Aspergillus niger van Tieghem – ATCC 6275
- Penicillium funiculosum Thom – CMI 114933
- Paecilomyces variotii Bainier – ATCC 18502
- Gliocladium virens Miller et al. – ATCC 9645
- Hormoconis Resinae – ATCC 20495 (replace Chaetomium globosum - ATCC 6205)

Put separated samples in the defined matter, inoculate test samples, and incubate inoculated and reference samples for a minimum of 4 weeks @ 24 ± 1°C.

After 4 weeks:

- Measure the extent of growth (with Method A no growth means coating is not nutritive, with Method B no growth indicates inhibition efficiency). Pass requirement: 0
- Deterioration of coating by visual examination: cracking, blistering, softening, shrinking and evaluation of adhesion per 3.1.3.1.

3.1.8 Sealant Compatibility

Prepare test panels according to 3.2, Table 1 and Table 2, and AS5127/1.

Immerse in the following fluids for 42 days at 60 ± 3°C:

- AMS2629 Jet Reference Fluid
- 50%/50% ± 10% by volume AMS2629 Type 1 + 3% aqueous sodium chloride
- DI Water

The peel strength shall be a minimum of 20 lbs / inch, with 100% cohesive failure.

3.1.9 Repair, with Conversion Coating Touch-up

Prepare test panels according to 3.2, Table 1 and Table 2

Ensuring that tests are carried out on the repair area, conduct wet tape adhesion test per the test method prescribed by 3.1.3.2, corrosion resistance – neutral salt spray test per the test method described in 3.1.4.1, and fuel resistance test detailed in 3.1.6.1.

The repair shall meet the requirement of each of the individual tests.

3.2 Test Panels

Test panels shall be prepared as outlined in Table 1 and Table 2, following the procedures outlined in 3.2.1, 3.2.2 and 3.2.3.

For Panel Types VII to XII, follow the procedure outlined in 3.2.4

3.2.1 Pretreatment

When Thin Film Sulfuric Acid Anodising (TFSAA) is required, anodise per MIL-PRF-8625 Type IIB.

When Tartaric Sulfuric Acid Anodising (TSAA) is required, anodise per MIL-PRF-8625 Type IC.

3.2.2 Application of Integral Fuel Tank Coating

Unless otherwise specified, the test panels shall be spray coated on one side to produce a dry film thickness of 20 to 30 µm.

3.2.3 Cure of Integral Fuel Tank Coating

Unless otherwise specified, the test panels shall be cured per manufacturer's recommendation.

3.2.4 Preparation of Repair, with Conversion Coating Touch-up, Panels

Take the necessary Test Panel Type as defined in Table 1, and using a ScotchBrite pad (or equivalent), abrade through the coating and pretreatment in the grey area indicated in Figure 1 until a water break free surface is achieved. Solvent clean the panel using an appropriate solvent.

Repair the area of the panel with the removed coating and pretreatment through the application of a conversion coating touch-up solution qualified to MIL-DTL-81706 Type 1 Class 1A. Apply the touch-up conversion coating per the instructions provided by the manufacturer of the conversion coating selected.

Apply and cure the Integral Fuel Tank Coating on the entire panel again per 3.2.2 and 3.2.3.

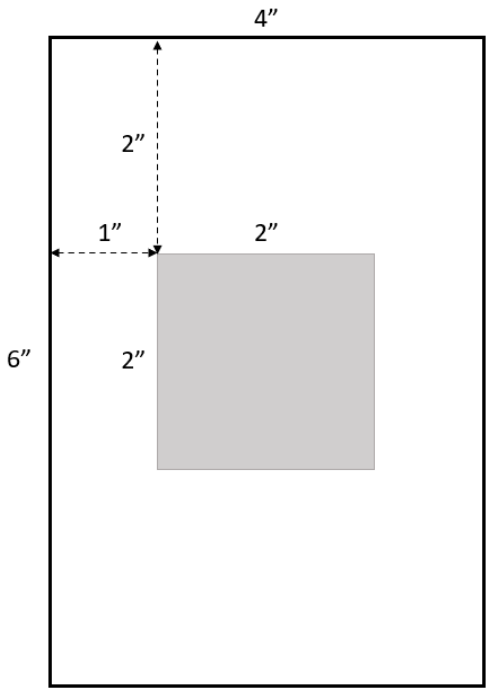

Figure 1 Area and location of area to be repaired (grey) on Repair, with Conversion Coating Touch-up, Panels

Table 1 Test Panel Types

Panel Type	Material	Dimensions	Pretreatment
I	2024-T3 Aluminium Bare (AMS-QQ-A-250/4)	4" x 6" x 0.032"	TSAA
II			TFSAA
III	2024-T3 Aluminum Alclad (AMS-QQ-A-250/5)		TSAA
IV			TFSAA
V	7075-T6 Aluminium Bare (AMS-QQ-A-250/12)		TSAA
VI			TFSAA
VII	Panel Type I + Section 3.2.4		CCC Touch-up per 3.2.4
VIII	Panel Type II + Section 3.2.4		
IX	Panel Type III + Section 3.2.4		
X	Panel Type IV+ Section 3.2.4		
XI	Panel Type V + Section 3.2.4		
XII	Panel Type VI+ Section 3.2.4		

Table 2 Summary of Test Procedures and Test Panel Requirements

Requirement	No. of Panels	Requirement & Test Procedure
Hardness	3x Type I 3x Type II 3x Type III 3x Type IV 3x Type V 3x Type VI	3.1.1
Impact Resistance		3.1.2
Adhesion – Dry		3.1.3.1
Adhesion – Wet		3.1.3.2
Corrosion Resistance – NSS		3.1.4.1
Corrosion Resistance – Filiform		3.1.4.2
Flexibility – Low Temperature		3.1.5
Fluid Resistance – Fuels		3.1.6.1
Fluid Resistance – Skydrol LD4		3.1.6.2
Fluid Resistance – DiEGME*		0
Microbiological Performance – Simulated Resistance		3.1.7.1
Microbiological Performance – Live Resistance		0
Sealant Compatibility		3.1.8
Repair, with Conversion Coating Touch-up	3x Type VII 3x Type VIII 3x Type IX 3x Type X 3x Type XI 3x Type XII	3.1.9

* Test panels to be assembled per process defined in AMS-C-27725 Section 4.7.5.18.1.1 including panel size, although using the alloys for each panel type required per this Requirements Document