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Material Specification

TITLE:	**COATING, CORROSION PREVENTIVE FOR AIRCRAFT INTEGRAL FUEL TANKS**
SPECIFICATION NUMBER:	**DHMS C 4.06**
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COATING, CORROSION PREVENTIVE FOR AIRCRAFT INTEGRAL FUEL TANKS

REVISION RECORD

Iss.	Page	Description and Reason for Change	
A Amd.2	5	Para. 8.1 was added regarding MSDS. Para. 9 was revised regarding MSDS.	
B		This is a completely revised issue. Detail changes have not been noted.	
B Amd.1	13	Updated telephone number for Courtaulds Aerospace in QPL. Added Dexter-Crown Metro product 20P1-21 and PC-235 to QPL.	
B Amd.2	13	Updated company names.	
C	4	Para. 3.2.1	Revised to include viscosity value for high solids coatings.
	4	Para. 3.2.2	Revised to reflect fineness of grind for 20P1-21/PC-235 product.
	4	Para. 3.3.2	Revised to specify anodized panels in lieu of chemical conversion panels.
	4	Para. 3.3.3	Replaced test panel type B with type A.
	5	Para. 3.3.9	Revised and clarified impact resistance requirements.
	6	Para. 3.3.14	Editorial correction (is: "test panels B", was: "test panels C").
	6	Table 3	Revised table to include chromic acid anodized test panels.
	6	Para. 3.3.13	Deleted exfoliation corrosion requirement.
	9	Table 4	Deleted exfoliation corrosion requirement.
D	All	Updated format and PRC-Desoto's address in QPL	
E		Added Akzo Nobel products 20P1-10 and PC-108	
Amd.1	4	Revised viscosity requirement for grade B: Was: 20-45 sec., Now: 15-45 sec. Defined ambient temperature is $25^{o} \pm 2^{o}$C and 50% ± 5% relative humidity.	

COATING, CORROSION PREVENTIVE FOR AIRCRAFT INTEGRAL FUEL TANKS

REVISION RECORD

Iss.	Page	Description and Reason for Change
F	9	Table 4: Added column for "Acceptance Purchaser/User" and footnote 3

1 SCOPE

This specification covers the requirements for a coating to be used for corrosion protection of aircraft integral fuel tanks from fuel contaminants.

1.1 Classification

Corrosion preventive coatings to DHMS C4.06 shall be one of following types, classes and grades:

Types
Type I - polyurethane-based coating
Type II - epoxy-based coating (this type conforms to BMS 10-20 Type II Class A)

Classes
Class A - for application with conventional paint equipment
Class B - for application with electrostatic paint equipment

Grades
Grade A - high VOC (volatile organic coating, > 420 g/L), conventional coating
Grade B - low VOC (volatile organic coating, 420 g/L max.), high solids coating

2 APPLICABLE DOCUMENTS

The following documents shall form a part of this specification, to the extent defined herein. In the event of conflicting requirements between this and the specifications listed below, the requirements of this specification shall govern. Where a specific issue of a document is not stated, the current issue shall be used.

2.1 U.S. Government Specifications

QQ-A-250/4	-	Aluminum Alloy 2024, Plate and Sheet
QQ-A-250/5	-	Aluminum Alloy, Alclad 2024, Plate and Sheet
QQ-B-613	-	Brass, Leaded and Non-Leaded: Flat Products (Plate, Bar, Sheet, and Strip)
MIL-C-5541	-	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-A-8625	-	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-S-8802	-	Sealing Compound, Temperature Resistant, Integral Fuel Tanks and Fuel Cell Cavities, High Adhesion
MIL-PRF-23699	-	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, Nato Code Number 0-156
MIL-C-27725	-	Coating, Corrosion Preventive, for Aircraft Integral Fuel Tanks

2.2 Federal Specifications

Fed. Test Method Std. 141	-	Paint, Varnish, Lacquer and Related Materials and Methods of Inspection and Testing
Fed. Test Method Std. 791	-	Lubricants, Liquid Fuels, and Related Products, Methods and Testing
TT-S-735	-	Standard Test Fluid, Hydrocarbon

2.3 American Society for Testing & Materials

ASTM G34	-	Exfoliation Corrosion, Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)
ASTM B117	-	Salt Spray (Fog) Testing
ASTM D1200	-	Viscosity of Paints, Varnishes and Lacquers by Ford Viscosity Cup
ASTM D1210	-	Fineness of Dispersion of Pigment-Vehicle Systems
ASTM D1737	-	Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus
ASTM D2267	-	Method of Test for Aromatics, in Light Naphtha, Reformates and Gasoline by Gas Chromatography
ASTM D2369	-	Volatile Content of Paints
ASTM D2794	-	Resistance of Organic Coatings to Effect of Rapid Deformation (Impact Resistance)
ASTM D2803	-	Filiform Corrosion Resistance of Organic Coatings on Metal
ASTM D3359	-	Standard Test Methods for Measuring Adhesion by Tape Test
ASTM D3363	-	Standard Test Method for Film Hardness by Pencil Test

2.4 Bombardier Aerospace Toronto Specifications

DHMS S3.01	-	Sealing Compound, Temperature Resistant, Integral Fuel Tanks, High Adhesion
DHMS S5.01	-	Stripper Heavy Duty, Cleaning and Stripping Solvent (Slow Evaporating)

2.5 Boeing Specifications

BMS 3-11 Type IV Class 1 Grade A	-	Hydraulic Fluid, Fire Resistant

3 REQUIREMENTS

3.1 Component Requirements

3.1.1 Materials - Materials used in the manufacture of the product shall be of high quality and suitable for the purpose.

3.1.2 Components - The fuel tank coating shall consist of two components (base and catalyst), packaged separately and supplied in kit form. The components shall not be batch oriented.

3.1.3 Condition in Container - Freshly opened, full containers of the base component shall be free of lumps, skins, grit and coarse particles. Settled pigment shall be easily dispersed to a smooth, homogeneous condition. The catalyst component shall be clear and clean.

3.1.4 Storage Stability - The previously unopened, packaged product shall meet all the requirements specified herein for a period of at least one year, when stored at a temperature of 16^{o} to 30^{o}C.

3.1.5 Nonvolatile Content - The nonvolatile content of the base component shall not vary more than ± 2% from the value established by the supplier on the qualification report when tested per ASTM D2369.

3.2 Mixed Material Requirements

The base and catalyst shall be mixed according to the manufacturer's instructions.

3.2.1 Viscosity - The viscosity of the catalyzed fuel tank coating, when tested in accordance with ASTM D1200 in a #4 Ford Cup, shall be 10-20 seconds for Grade A and shall be 15 to 45 seconds for Grade B.

3.2.2 Fineness of Grind - The fineness of grind of the catalyzed fuel tank coating shall be not less than 4.5 when tested in accordance with ASTM D1210.

3.2.3 Pot Life - A sample of catalyzed fuel tank coating, shall show no lumping, seeding or separation after being stored in a closed container for 8 hours for Grade A and 4 hours for Grade B at $25^{o} \pm 2^{o}$C. The coating applied at the pot life shall meet all the requirements of this specification.

3.2.4 Spraying Properties - The catalyzed fuel tank coating shall spray satisfactorily with no sagging, running or streaking. The dried film shall be free from grit, seeds, craters, blisters or any other surface irregularities.

3.2.5 Colour - The coating shall be chromate yellow.

3.3 Physical Properties of Primer Film

3.3.1 Drying Time - When applied in accordance with the manufacturer's instructions, the fuel tank coating shall dry per **Table 1** under ambient conditions of $25^{o} \pm 2^{o}$C and 50% ± 5% relative humidity

Table 1: Drying Times for Integral Fuel Tank Coating

DRYING TIMES	GRADE A	GRADE B
dust-free	10 minutes	30 minutes
tack-free	45 minutes	4 hours
dry hard	2 hours	6 hours
full cure[1]	14 days	14 days

1. Full cure is achieved when no base material is exposed after the coating is rubbed with 50 double strokes (back and forth equals one double stroke) with a cloth soaked with MEK.

3.3.2 Flexibility - Cured fuel tank coating shall exhibit no cracking, crazing or loss of adhesion when bent over a 0.5 inch diameter mandrel. Three test panels C, per **Table 3** shall be tested in accordance with ASTM D1737.

3.3.3 Low Temperature Flexibility - Cured fuel tank coating shall exhibit no cracking, crazing or loss of adhesion. Three test panels A, per **Table 3** shall be tested in accordance with **Para.5.1**.

3.3.4 Hardness - Cured fuel tank coating shall have a pencil hardness of F minimum. Two test panels B, per **Table 3** shall be tested in accordance with ASTM D3363.

3.3.5 Dry Film Weight - The dry film weight of the cured fuel tank coating shall not exceed 0.0080 lb/ft^2/mil. Three test panels B, per **Table 3** shall be tested per **Para.5.2** .

3.3.6 Fluid Resistance - When immersed in the fluids per **Table 2**, the cured fuel tank coating shall show no blistering, loss of adhesion or other deleterious effects after the specified immersion time. Two test panels B per **Table 3** shall be tested for each fluid per ASTM D3359 Method B within 30 minutes from removal from the test fluid.

After a recovery period of 24 hours, the coating shall have regained its pre-test hardness.

Table 2: Fluid Resistance Test

TEST FLUID	IMMERSION TIME	FLUID TEST TEMPERATURE
distilled water	42 days	140 ± 2 °F
lubricating oil MIL-PRF-23699	14 days	250 ± 5 °F
hydraulic fluid[1]	42 days	140 ± 2 °F
TT-S-735 Type VII	42 days	140 ± 2 °F

1. Hydraulic Fluid to BMS 3-11 Type IV, Class 1, Grade A

3.3.7 Salt Spray Resistance - Three test panels A per **Table 3**, scratched diagonally corner to corner through the fuel tank coating to the substrate, shall exhibit no blistering, lifting of the primer or substrate corrosion, after exposure to 5% salt spray for 3000 hours in accordance with ASTM B117. (Test panels inclined at 6° from the vertical). Blistering, lifting of the primer or substrate corrosion within 0.125 inch of the scribes does not constitute cause for failure.

3.3.8 Filiform Corrosion Resistance - Three test panels A per **Table 3** shall exhibit no filiform corrosion under the coating after 3000 hours exposure in accordance with ASTM D2803.

3.3.9 Impact Resistance - Cured fuel tank coating shall not exhibit flaking or cracking when subjected to 50 in.lbs impact directly and 30 in.lbs on the reverse side, using a Gardner Impact Tester. Two test panels C per **Table 3** shall be tested in accordance with ASTM D2794.

3.3.10 Repairability - Cured fuel tank coating shall show no blistering, no adhesive nor cohesive failures, nor other deleterious effects when tested in accordance with **Para.5.3**.

3.3.11 Compatibility With DHMS C4.04 Type VI - Cured system (fuel tank coating and DHMS C4.04) shall show no blistering, no adhesive nor cohesive failures, nor other deleterious effect when tested in accordance with **Para.5.4**.

3.3.12 Fuel Contamination - The non-volatile extractable materials contributed by the cured coating in contact with jet reference fluid TT-S-735 Type VII shall be not more that 36 milligrams per 100 milliliters when tested per **Para.5.5**. Nothing more than slight discoloration or tarnish shall be present on a freshly polished copper strip.

3.3.13 Compatibility With Sealant - Sealing compound conforming to DHMS S3.01 Type II applied to the cured coating using three test panels B per **Table 3**, shall have a peel strength of not less than 20 lbs when tested per DHMS S3.01. There shall be no adhesive failure between the coating and the sealing compound.

3.3.14 Resistance to Simulated Microbial By-Products - The cured fuel tank coating shall show no loss of adhesion, softening nor other deleterious effects when tested in accordance with **Para.5.6**.

4 MATERIALS

Unless otherwise specified, tests shall be conducted at 18°C to 25°C and 30 to 60% relative humidity. Test panels shall be prepared as shown in **Table 3**.

The integral fuel tank coating shall be prepared by first thoroughly mixing each of the components separately. The components shall be thinned (if applicable) according to the manufacturer's specifications. Allow the coating to stand for 15 minutes before using. Spray the panels with one cross coat of the primer and air-dry at room temperature. The dry film thickness shall be 0.0008 to 0.0012 inch. Allow at least seven days air dry before testing.

Alternatively, cure coating for 24 hours at room temperature followed by 24 hours oven cure at 180 to 200°F at 40% relative humidity.

5 TEST METHODS

Table 3: Test Panels

Panel	LAB Dwg.	Material	Size	Pre-Treatment
A	062-11C	2024-T3 bare QQ-A-250/4	3" x 6" x 0.032"	Chemical Conversion Coat to MIL-C-5541 Class 1A
B	062-1C	2024-T3 clad QQ-A-250/5	3"x 6" x 0.032"	Chemical Conversion Coat to MIL-C-5541 Class 1A
C	062-11A	2024-T3 bare QQ-A-250/4	3" x 6" x 0.032"	Chromic Acid Anodize to MIL-A-8625 Type IB, Class 1

5.1 Low Temperature Flexibility - Three test panels B per **Table 3**, shall be conditioned at -65°F ± 5°F for 5 hours ± 0.5 hour. The panel shall than be rapidly bend over a 4 inch diameter mandrel that has been conditioned at the same temperature and time as the test panels.

5.2 Dry Film Weight -The length and width of three aluminum panels, shall be recorded. The panels shall be cleaned, dried and weighed to the nearest 10 mg. The fuel tank coating shall be applied to the panels and allowed to cure. The primed panels shall be weighed and the thickness of the primer film shall be measured in at least five positions on each panel, to within 0.0001 in. accuracy.

$$\text{Dry film weight} = \frac{(W_2 - W_1)}{L \times B \times T}$$

where W_1 = weight of bare panel,
W_2 = weight of coated panel
L = length of panel
B = breadth of panel
T = thickness of primer film

5.3 Repairability - The test panels used in **Para.3.3.6** shall be air dried for 24 hours, sanded using 220 grit aluminum oxide abrasive paper and solvent cleaned using DHMS S5.01 Class 2. Integral fuel tank coating shall be reapplied per para. 4.0 and air dried for 14 days.

The test panels shall be immersed for seven days in the test fluids specified **Table 2**. The test panels used in repairability test shall be immersed in the same fluid, which was used for fluid resistance test. Test per ASTM D3359 Method B within 30 minutes from removal from the test fluid.

5.4 Compatability With DHMS C4.04 - Three test panels B per **Table 3**, shall be coated with fuel tank coating and allowed to cure for 24 hours. The test panel shall be sanded using 220 grit aluminum oxide abrasive paper and solvent clean using DHMS S5.01 Class 2. DHMS C4.04 Type VI shall be applied and air dried for 14 days. The test panels shall be immersed in the distilled water and hydraulic fluid per **Table 2** for 7 days at ambient temperature. Test per ASTM D3359 Method B within 30 minutes from removal from the test fluid.

5.5 Fuel Contamination - One test panel B per **Table 3**, shall be coated on the both sides and immersed in 250 milliliters of jet reference fluid TT-S-735 Type VII for 48 hours at standard conditions. The contaminated fluid shall be decanted off and nonvolatile material determined by jet evaporation, method 3302 of Federal Test Method Standard No. 791, at 320^{o} to 329^{0} F, except that the total evaporation time shall be 45 minutes. A corrosion test for free sulfur shall be run in accordance with method 5313 of Federal Test Method Standard No. 791, except that a nonleaded copper strip conforming to QQ-B-613 shall be suspended in the contaminated fluid during the 48 hour extraxtion period prevoiously outlined.

5.6 Resistance to Simulated Microbial By-products - Three test panels B per **Table 3**, shall be immersed vertically for seven days at 140^{o}F ± 5^{o}F in the following solution:

Five parts of analytical grade glacial acetic acid dissolved in 100 parts by weight of 3% sodium chloride in distilled water. Jet reference fluid TT-S-735 Type VII shall be added to the solution.

The test panels shall be immersed in such a way that, one third of the panel shall be exposed to the acetic acid solution, one-third to the jet reference fluid, and one-third to the air-vapor mixture.

Upon removal, the test panels shall be rinsed in warm, running tap water and dried. Test per ASTM D3359 Method B and ASTM D3363

6 QUALITY ASSURANCE

6.1 Qualification

6.1.1 A supplier is responsible for the performance of all qualification testing as specified in Table 4.

6.1.2 A supplier desiring qualification shall submit one copy of a report, including the test specimens, showing actual qualification test data based on five different batches of the material. Although the requirements set in this specification indicate the minimum acceptable properties, all the tests shall be carried out until failure and the results shall be reported.

A sufficient quantity of product from two different batches shall be provided for Bombardier Aerospace Toronto's evaluation tests.

6.1.3 Upon review of supplier's data and Bombardier Aerospace Toronto tests, the supplier will be advised either of product qualification or of reasons for disqualification.

6.1.4 Products that are qualified will be listed in the Qualified Products List of this specification.

6.1.5 No changes in the method of manufacture and/or formulation shall be made without notification and prior written approval of Materials Technology.

6.1.6 Requalification of the product may be requested by the purchaser if there are any changes in the method of manufacture and/or formulation.

6.2 Qualification by Similarity

Where a product has been qualified to another similar specification, the supplier may submit this qualification test report in lieu of performing a separate qualification test required by Section 3. The similar specification may be a government, company, or other specification where the requirements are similar to this specification.

6.3 Acceptance Tests

6.3.1 Unless otherwise specified in the contract or purchase order, the supplier is responsible for all batch acceptance tests, as specified in Table 4.

6.3.2 The supplier performing batch acceptance tests shall furnish with each lot of product, one copy of a Batch Acceptance Test Report showing actual test data conforming to the acceptance tests specified in Table 4. The report shall include the supplier's batch identification.

6.3.3 Bombardier Aerospace Toronto reserves the right to perform any or all of the tests set forth in this specification to ensure that the product continues to meet specification requirements. Any product not meeting the requirements of this specification will be returned to the supplier at the supplier's expense.

6.4 Definitions

6.4.1 Batch is defined as the product produced in a single production run from the same lot of raw materials under the same final conditions and submitted for inspection at one time.

6.4.2 Lot is defined as the total quantity of product in a shipment taken from the same batch.

Table 4: Qualification And Batch Acceptance Tests[3]

Test	Qualification	Acceptance Manufacturer	Acceptance Purchaser/User
Condition in Container	x	x	x
Non-Volatile Content	x	x	
Viscosity	x	x	
Solids Content	x	x	
Fineness of Grind	x		
Pot Life	x	x	x
Spraying properties	x	x	
Colour	x	x	
Drying Time	x	x[1]	x
Flexibility	x	x	
Low Temperature Flexibility	x		
Hardness	x	x	
Dry Film Weight	x		
Resistance to Distilled Water	x		
Resistance to Lubricating Oil	x		
Resistance to Hydraulic Fluid	x	x[2]	
Resistance to TT-S-735 Type VII	x		
Salt Spray Resistance	x		
Filiform Corrosion Resistance	x		
Impact Resistance	x	x	x
Repairability	x		
Compatability With DHMS C4.04	x		
Fuel Contamination	x		
Compatibility With Sealant	x		
Resistance to Simulated Microbial By-Products	x		

1. For batch acceptance, full cure test is not required.
2. For batch acceptance, an abbreviated test (7 days immersion) is acceptable.
3. For Type II primer the tests should be carried out per BMS 10-20.

7 PROCUREMENT DOCUMENTS

Procurement documents shall specify the following:
- Title, Number, Issue and Amendment Number of this Specification
- Manufacturer's Name and Product Identification (Trade Name or Code Number)
- Type or Size of Containers
- Total Quantity

8 PREPARATION FOR DELIVERY

8.1 Packaging and Packing

The coating shall be packaged for shipment and storage in such a manner, that the product will be protected against damage. The coating shall be supplied in a kit, packaged as a unit, consisting of base and catalyst.

8.2 Marking

Each kit shall be legibly marked with the following information:
- DHMS C4.06 Type , Class , GradeX
- Manufacturer's Name and Product Identification
- Total Kit Content (Net)
- Date of Manufacture
- Certificate of Compliance Number

8.3 Documentation

The shipping document shall show:
- Bombardier Aerospace Toronto Purchase Order Numbers
- Specification Number
- Number of Containers
- Batch Number
- Total Quantity (Imperial or U.S. measure)
- Batch Acceptance Test Report

Each shipment shall contain a copy of the Material Safety Data Sheet.

9 HEALTH AND SAFETY DATA

When supplying samples for qualification **Para.6.1**, the supplier shall submit a Material Safety Data Sheet (MSDS) complying with the “Controlled Products Regulations” of the Hazardous Products Act (also known as W.H.M.I.S. Regulations). The document must state all hazardous ingredients, safe-handling procedures, first-aid measures, fire and explosion data, reactivity data, physical properties, preparation information and procedures for storage and disposal.

This MSDS must then be submitted with a completed DH 4339 form, “Application To Introduce A New Material”, to the Material Safety Committee.

Upon receipt of DH 4340 form, “Recommendation”, that approves the use of the material, it can then be included on the Qualified Products List.

Any change in the formulation of the material requires a resubmission of the MSDS.

QUALIFIED PRODUCTS LIST

Classification	Manufacturer	Manufacturer's Product Identification No.		Qualification No.	MSDS #	Product Approval
	PRC-De Soto Int., 11601 United Street, Mojave, CA93501 (661)824 4532	PR1563				Obsolete
Type I Class A Grade A	PRC - De Soto (same address as above)	Base Catalyst Reducer	823-707 910-702 020-707	PQS #3		Mar. 12, 1976
Type I Class A Grade B	PRC - De Soto (same address as above)	Base Catalyst	833K086 930K088	PQS #4		Sep. 13, 1996
	Akzo Nobel (formerly Dexter-Crown Metro) East Water Street Waukegan, Illinois 60085-5652 (847) 623-4200	Base HS IFT Activator	20P1-21 PC-235	PQS #5	2758 2757	Jan. 7, 1999
Type I Class A Grade A	Akzo Nobel (formerly Dexter-Crown Metro)	Base: Hardener Thinner	20P1-10 PC-108 TR-53	PQS #6	3719 3720 3721	Sept. 28, 2005