MINISTRY OF DEFENCE

Secretariat General of Defence and National Armaments Directorate
Directorate of Air Armaments

ADVANCED PAINT SYSTEMS FOR AEROSPACE APPLICATIONS

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FOR ANY DOUBT PLEASE REFER TO ORIGINAL ITALIAN VERSION

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LIST OF VALID PAGES

ATTENTION: This standard shall be valid only if composed of the pages listed below, duly updated.
A copy of this standard shall be available on request to the following email address: spt@dgaa.it.

The dates of issue of the original and amended pages are given hereafter:

Original…….0…….of 24th April 2012

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1 PART 1 - GENERAL INFORMATION

1.1 Introduction

The Legislative Decree no. 81 of 9th April 2008 (relating to health and safety at work), and the EU directives it refers to (EC Regulation no. 1907/2006 - REACH – Registration, Evaluation, Authorisation of Chemicals, amended by EC Regulation no. 1272/2008 - CLP, Classification, Labelling and Packaging of Substances and Mixtures), applying to any chemicals, be they manufactured, imported, commercialized or used, alone or in combination with other, provide an accurate guideline to the use of those chemicals which can pose significant risks to both human health and the environment.

The paint process in the aeronautics currently provides for chrome-based products (VI) both for the pre-treatment and the high solid epoxy coating.

The above mentioned EC Regulation no. 1272/2008 classifies any chrome-based products (VI) as category 1 carcinogens.

Following several studies, the CSV – Chemical Department has finally identified a paint process in compliance with the requirements of the aeronautical military standards, providing for chrome-free products (VI) both for surface pre-treatment and coating (VI).

Further reductions in the impacts on the environment and on the health and safety of people employed in maintenance activities have then been achieved through the adoption of finishing paints with reduced organic solvent content (VOC) as waterborne paints, that is water-based, featuring CARC (Chemical Agent Resistant Coating) in compliance with military requirements.

1.2 Task and Scope

Scope of this PT shall be to define the requirements of long duration paint systems for aircraft external surfaces, including any military specific requirements of specular gloss (brightness/camouflage) and IR low observability.

Further specific tests might be required to use the paint systems defined in this PT in applications other than the aerospace military field.

All components of this paint systems work in synergy to provide long duration chemical resistance and protection from corrosion.

These paint systems include surface treatment (or pre-treatment), coating (or primer) and finishing paint (or topcoat).

1.3 Reference Standards

- CSV Report no. 11/253 Technical Specifications of Peculiar Aeronautical Consumables-Chrome-Free Advanced Paint Systems for Aerospace Applications. Drawing Up of a New Standard AER.M-P-XXX.

1.4 Correlated Armaereo PP.TT

- AER(EP).P-6 — Instructions for Drawing Up of Technical Standards for Military Aircraft.
- AER.Q-2010 — Definition of the Initials, Terms and Phrases Commonly Used in D.G.A.A. Technical Publications.

1.5 Applicable Standards

The following specifications, standards and manuals shall be considered integral parts of this document.

Unless otherwise specified, the following documents shall be referred to, inside the procurement administrative procedures.

The following specifications, standards and manuals shall be intended in the latest editions.

1.5.1 Federal Standards

- FED-STD-141 — Paint, Varnish, Lacquer And Related Materials: Methods Of Inspection, Sampling And Testing
- FED-STD-313 — Material Safety Data, Transportation Data And Disposal Data For Hazardous Materials Furnished To Government Activities
- FED-STD-595 — Colours Used In Government Procurement

1.5.2 Military Standards

- MIL-C-8507 — Coating, Wash Primer (Pre-treatment) for Metals, Applications of (for Aeronautical Use) - Inactive for New Design
- MIL-C-8514 — Coating Compound, Metal Pre-treatment, Resin-Acid
- MIL-PRF-23699 — Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, Nato Code Number O-156
- MIL-DTL-53072 — Chemical Agent Resistant Coating (Carc) System Application Procedures And Quality Control Inspection
- MIL-PRF-83282 — Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Nato Code Number H-537
- MIL-PRF-5606 — Hydraulic Fluid, Petroleum Base; Aircraft, missile, and ordnance
- MIL-PRF-85285 — Coating: Polyurethane, Aircraft And Support Equipment.
- MIL-PRF-85570 — Cleaning Compounds, Aircraft, Exterior
- MIL-PRF-87937 — Cleaning Compound, Aerospace Equipment

- MIL PRF-32239 — Coating System, Advanced Performance, For Aerospace Applications
- MIL-DTL-64159 — Camouflage coating, water dispersible aliphatic polyurethane, chemical agent resistant
- MIL-STD-129 — Department Of Defense Standard Practice: Military Marking For Shipment And Storage

1.5.3 NATO Standardization Agreement

- STANAG 4360 — Specification for paints and paint systems, resistant to chemical agents and decontaminants, for the protection of land military equipment

1.5.4 SAE Specification

- AMS-QQ-A-250/5 — Aluminium Alloy Alclad 2024, Plate And Sheet
- AMS-QQ-A-250/12 — Aluminium Alloy 7075, Plate And Sheet
- AMS-QQ-A-250/13 — Aluminium Alloy Alclad 7075, Plate And Sheet
- AMS3819 — Cloths, Cleaning, For Aircraft Primary and Secondary Structural Surfaces
- AMS 4911 — Titanium Alloy, Sheet, Strip, and Plate, 6Al - 4V, Annealed
- AS 5505 — Requirements for Accreditation of Testing Laboratories for Organic Coatings
- AS 9100 — Quality Management Systems - Requirements for Aviation, Space and Defense Organizations

1.5.5 ASTM Standards

- ASTM B117 — Standard Practice for Operating Salt Spray (Fog) Apparatus
- ASTM G154 — Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Non-metallic Materials
- ASTM G155 — Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
- ASTM D522 — Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
- ASTM D523 — Standard Test Method for Specular Gloss
- ASTM D1200 — Standard Test Method for Viscosity by Ford Viscosity Cup
- ASTM D2243 — Standard Test Method for Freeze-Thaw Resistance of Water-Borne Coatings

- ASTM D2244 — Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
- ASTM D2247 — Testing Coated Metal Specimens at 100 Percent Relative Humidity.
- ASTM D2794 — Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
- ASTM D2803 — Standard Guide for Testing Filiform Corrosion Resistance of Organic Coatings on Metal
- ASTM D2805 — Hiding Power of Paints
- ASTM D3335 — Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
- ASTM D3359 — Standard Test Methods for Measuring Adhesion by Tape Test
- ASTM D3363 — Standard Test Method for Film Hardness by Pencil Test
- ASTM D3718 — Standard Test Method for Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
- ASTM D3960 — Volatile Organic Content (VOC) of Paints and Related Coatings

1.5.6 ISO Standards

- ISO 1513 — Paints and Varnishes - Examination and Preparation of Samples for Testing
- ISO 4617 — Paints and Varnishes - List of Equivalent Terms
- ISO 4618 — Paints and Varnishes - Terms and Definitions for Coating Materials
- ISO 15528 — Paints, Varnishes and Raw Materials for Paints and Varnishes - Sampling

1.6 Applicability

The paint systems defined in this PT are qualified for military aircraft external surfaces, but they shall not be limited to this application.

Further specific tests might be required to use these paint systems on aircraft surfaces other than the external ones.

In case, under maintenance operations, the original substrate should not be reached, it shall be possible to apply any process components selectively, starting from the first surface reached.

1.7 Validity

This PT shall enter into effect on the date it is approved.

1.8 Definition of the Terms Used

Pursuant to this standard, any initials, terms and phrases included in the PT AER.Q-2010 shall apply, in addition to the following:

- **Beaker:** a container used in chemistry laboratories, usually made of glass or plastics.
- **Paint Process:** the whole set of activities, from the preparation of the surface up to the finishing. It generally includes the application of more paint layers, each one performing a specific function.
- **Primer:** a paint product used to fill any small irregularities of the surface and improve the adhesion of next layers. Furthermore, it can also work as anti-rust, when it contains pigments performing a protection action.
  It features a low reticulation grade and polar groups to guarantee the adhesion to the surface and to the next layers.
  It is usually applied with thickness of 10-20 micron.
- **Topcoat:** further to its aesthetic function, it must comply with the surface requirements of mechanical or chemical resistance; it generally features a higher reticulation grade and a lower presence of polar groups to guarantee a higher ageing resistance.
- **Pre-treatment:** it includes all processes aimed at modifying metal or alloy surfaces.
  Surfaces need to be modified when some specific characteristic (such as the corrosion resistance) must be improved.
  The most common pre-treatment applications include substances with no chemical alteration of the surface (painting, electrolytic metalizing, etc) or with chemical reactions between the reagents and the surface (anodizing, phosphation, passivation).
  The anodizing processes form oxide layers featuring properties different from those of aluminium natural oxides, improving the corrosion resistance.
- **Pot-Life:** it is the length of time a mixture is useful after its package is open.
- **CLP** Classification, Labelling and Packaging of Substances and Mixtures.
- **COTS** Commercial Off The Shelf.
- **MEK** Metil Etil Chetone.
- **QPL** Qualified Product Listing.
- **REACH** Registration, Evaluation, Authorisation and Restriction of Chemical substances
- **VOC** Volatile Organic Content

2 PART 2 - PAINT SYSTEMS

2.1 Classification

The anticorrosive paint systems defined in this PT regard the following types, classes and grades:

- **TYPE 1:** chrome-free paint systems
  - ► Class 1: standard flexibility
  - ► Class 2: high flexibility
  - ► Class 3: CARC (Chemical Agent Resistant Coating)
    - ■ Grade 1: IR low observability

2.2 Pre-treatment

The pre-treatment, chrome-free, shall be the same in any paint systems defined in this PT.

2.3 Primer

The primer, chrome-free, shall be the same in any paint systems defined in this PT.

2.4 Topcoat

Each class shall have a specific and appropriate topcoat, as detailed hereafter:

- Class 1: high solids polyurethane topcoat in compliance with military standard PRF-85285 Type I Class H, VOC content < 420 g/l;
- Class 2: high solids polyurethane topcoat in compliance with military standard PRF-85285 Type IV Class H, VOC content < 420 g/l;
- Class 3: waterborne polyurethane CARC topcoat certified Stanag 4360 ed.2 by the authorized laboratories listed in Annex D of Stanag 4360 ed.1 for the chemical and decontamination agent resistance; in compliance with MIL-DTL-64159 for optical, chemical and technological performance requirements. VOC content **<** 250 g/l.

2.4.1 Colours

The topcoat shall be available in any colours and any gloss grades in compliance with specification FED-STD-595.

Colours not included in FED-STD-595 shall be provided against further standards and in compliance with requirements to be defined in the procurement phase.

3 PART 3 - PAINT SYSTEM REQUIREMENTS

3.1 Qualification

The paint systems defined in this PT shall be subject to any necessary qualification tests and shall be included in the Qualified Product List (QPL), at Attachment A, in support to any relating procurement procedures.
Modifications in the formulation of a qualified product shall not be allowed unless following a written approval by the Directorate of Air Armaments.

NOTE

This PT does not qualify chemical cleaners or paint removers.
The qualified cleaning products shall be those included in the QPL of standards MIL-PRF-87937 type IV and MIL-PRF-85570 Type II.
The chemical paint removers shall be those listed in the Technical Order 1-1-8 (U.S. Air Force).

3.2 Materials

A paint system includes pre-treatment, primer and topcoat.
Any paint systems shall further include, as COTS (Commercial Off The Shelf) products, chemical paint removers and topcoat cleaning products.
The above set of materials shall be the minimum products needed to achieve the performance requirements set forth in this PT.

3.3 Chemical Composition Limits

In accordance with standard ASTM D3335, the cadmium (or cadmium products) and lead (or lead products) content in the components of the paint systems defined in this PT shall not exceed 0.005% and 0.01%, respectively.
In accordance with standard ASTM D3718, the hexavalent and trivalent total chrome (or hexavalent and trivalent chrome products) content in the components of the paint systems defined in this PT shall not exceed 0.005%.

3.4 Toxicity

Pursuant to the Legislative Decree 106/2009 and all relevant Italian and European standards, the manufacturers of paint system components shall have to certify that the products supplied in compliance with this PT do not entail any adverse effects on health, when used properly and in compliance with the warnings reported on the product labels and safety charts.

3.5 Physical Requirements of Paint System Components

Table 1 reports all physical requirements of paint system components.

Properties	Requirement	Condition	Method
Quality	3.6 3.6.1 3.6.2	In original sealed containers	ISO 1513
Storage Stability	3.7	In original sealed containers	4.2.1
Accelerated Storage Stability	3.8	In original sealed containers	4.2.2
VOC Content	3.9.1 Primer <340 g/l Topcoat <420 g/l	Mixed, ready for the application	4.2.3
Odour	3.9.2	Mixed, ready for the application	4.2.4
Viscosity and Pot-Life	3.9.3	Mixed, ready for the application	4.2.5
Drying Time	3.9.4	Applied on test panels	4.2.6
Wettability	3.9.5	Applied on test panels	4.2.7

Table 1: Physical Requirements

3.6 Quality

The paint system components, considered in their original sealed containers, shall not feature any floating elements nor flocculation nor any substances gelled, agglomerated or which could compromise the product correct and homogeneous application, thus generating defects on the coating film.

3.6.1 Materials and Components

The materials and components of the paint systems shall be homogeneous and easy to dispense and mix.

Furthermore, they shall not feature any sediments nor floating elements nor flocculation, lumps, external contaminating agents and agglomerated parts.

3.6.2 Mixing

All components shall be easy to mix, in accordance with the manufacturer instructions.

3.7 Storage Stability

The content of any paint system component or of a pre-mixed liquid surface pre-treatment, in its original sealed container, shall comply with the requirements of this PT in accordance with para 4.2.1.

The paint systems compliant with the requirements set forth in this para, shall be subject to a further set of tests in accordance with para 3.9.3, 3.10.1, 3.10.2, 3.10.4, 3.10.5, 3.10.6 (MIL-PRF-83282 only H537).

As for the retouching and repairing sets, the content of any paint system material or pre-mixed liquid surface pre-treatment, in its original sealed container, shall fully comply with this PT for at least 1 year from the date of its packaging, stored at a room temperature between 2 and 35 °C.

3.8 Accelerated Storage Stability

Any paint system components, except pre-treatment systems, cleaners and chemical paint removers, shall fully comply with this PT, tested in accordance with para 4.2.2.

The accelerated storage condition shall be 7days at 60 ± 3 °C.

A set of tests shall be performed on paint samples compliant with this para.

The set of requirements and corresponding tests shall be 3.9.3, 3.10.1, 3.10.2, 3.10.4, 3.10.5, 3.10.6 (MIL-PRF-83282 only H537).

3.9 Propriety of the Mixed Product

3.9.1 VOC Content

The VOC content at the primer application shall not exceed 600 g/l.

The VOC content at the topcoat application shall not exceed 420 g/l.

Tests shall be performed in accordance with para 4.2.3.

3.9.2 Odour

The dried paint systems shall not feature any residual odour after 48 hours from the application, tested in accordance with para 4.2.4.

3.9.3 Viscosity and Pot-Life

The viscosity/consistence of the pre-treatment materials shall be appropriate for spray or roll applications on the aircraft surfaces. The primer and topcoat viscosity/consistence shall be appropriate for the conventional applications, HVLP (High Volume Low Pressure), airless and electrostatic spray (in case of waterborne materials). The paint manufacturer shall define the recommended viscosity interval, in accordance with para 4.2.5.

The mixture pot-life requirements shall be the following: 4 hours after the initial mixture, the primer and the topcoat shall fully comply with the performance and application requirements of this specification.

A set of tests shall be performed on paint samples which shall have to comply with the requirements of this para. The set of requirements and corresponding tests shall be 3.10.1, 3.10.2, 3.10.4, 3.10.5, 3.10.6 (MIL-PRF-83282 only H537).

The test panels shall be realized applying the primer, 4 hours after mixing it, and subsequently the topcoat, again 4 hours after mixing it.

3.9.4 Drying Time

The paint system components for the surface pre-treatment shall dry in 4 hours for the primer application. The paint systems components for the primer shall dry in 5 hours for the topcoat application. The paint system components for the topcoat dry to tape shall not exceed 8 hours, without any loss of adhesion or damages, tested in accordance with para 4.2.6. Alternatively, the dry to tape total time for the application of pre-treatment, primer and topcoat shall not exceed 17 hours.

3.9.5 Wettability

The test panels shall not feature any scratches, grazes or other visible irregularities, tested in accordance with para 4.2.7

3.10 Requirements of the Paint Systems Applied

Table 2 reports all requirements of the paint systems applied

Properties	Requirements	Conditions	Method
Surface Aspect	3.10.1	Air-dried for min. 24 hours	Visual observation
Colour	3.10.2 - $\Delta E \leq 1$		4.2.8
IR Reflectance	3.10.3 Max 7% only for FS34031 Max 8% only for FS36118		4.2.9
Brightness	3.10.4 Camouflage: 9 max. at 85° 5 max. at 60° Gunship: 3 max. at 85° 3 max. at 60° Semi-Lucid: 15 to 45 max. at 60° Lucid: 90 min. at 60°		4.2.10
Opacity	3.10.5 All Colours: Contrast Ratio = 0.95 Yellow (13538), Orange (12197), Red (11136): Contrast Ratio > 0.90		4.2.11
Adhesion	3.10.6		
Wet Tape	3.10.6.1 No delamination or		4.2.12

Properties	Requirements	Conditions	Method
	grazes at a ratio ≥ 4A		
Chequering	3.10.6.2 No delamination or grazes at a ratio ≥ 4B		4.2.13
Flexibility	3.10.7		
Room Temperature	3.10.7.1 **Class 1:** ≥60% Brightness 40% Camouflage; Exposed to the elements: ≥40% Brightness 20% Camouflage **Class 2:** ≥60% Brightness and Camouflage before and after exposure to the elements	Standard Polymerization 4.2.17.1 Xenon Arc 4.2.17.2 QUV-B	4.2.14
Low Temperature	3.10.7.2 **Class 1** Lucid, 2 camouflaged **Class 1** Lucid and camouflaged, no cracking	Standard Polymerization 4.2.17.1 Xenon Arc 4.2.17.2 QUV-B	4.2.15
Fluid Resistance	3.10.8 **Class 1** No delamination due to blistering or lack of adhesion. $\Delta E \leq 3$. Test with Skydrol only for Class 3.		4.2.16
MIL-PRF-23699		24 hours at 121° C	
MIL-PRF-83282		7 days at 65° C	
Skydrol LD-4		30 days at 25° C	
JP-8		30 days at 25° C	
DI Water		30 days at 40° C	

Properties	Requirements	Conditions	Method
Ageing Resistance	3.10.9 ∆E ≤1. Camouflage Colours: 60° max 5. Gunship: 60° max 3. Semi-Lucid Colours: 60° min 15 max 45. Lucid Colours : 60° min 90.		4.2.17
Xenon Arc			4.2.17.1
QUV-B			4.2.17.2
Humidity Resistance	3.10.10 Paint system: lack of blistering, softening, loss of adhesion or other defects of the layer	30 days at 120 °F	4.2.18
Spidery Corrosion	3.10.11 Lack of spiderly corrosion or bubbles bigger than 1/8 inches with respect to the incision	Exposition to HCl, 2000 hours at 39 °C and 80% RH	4.2.19
Neutral Salt Fog	3.10.12 Type 1**:** any bubbles or delamination from the incision. Type 1**:** in the incision, limited decolourization and corrosion is tolered, but no pitting	Type 1: 2000 hours	4.2.20
Heat Resistance	3.10.13 Lack of cracks, smattering or loss of adhesion. ΔE ≤ 1	4 days at 177 ± 15°C	4.2.21
Solvent Resitance	3.10.14 Complete erasure to primer layer show the failure of test		4.2.22
Paint Stripping	3.10.15 90% of paint stripping		4.2.23

Table 2 - Requirements of the paint systems applied

3.10.1 Surface Aspect

On test panels prepared in accordance with para 4.1.3, the finishing shall produce a homogeneous and smooth surface, without dripping, bubbles, grazes, pounces, burn marks, ripples, spots or other defects.

3.10.2 Colour

The paint system shall refer to standard FED-STD-595 with a tolerated colour difference (ΔE) ≤ 1.0, tested in accordance with para 4.2.8.

3.10.3 IR Reflectance (FED-STD-595, Only Colours Code 34031 and Code 36118)

The paint system total IR reflectance (specular and diffused) shall not exceed the 7% for the FED-STD-595 colour code 34031 and the 8% for the FED-STD-595 colour code 36118, with respect to the standard calibration of NIST Spectralon white, tested in accordance with para 4.2.9.

3.10.4 Gloss

The system specular gloss, tested in accordance with para 4.2.10, shall be the following:

- Camouflage colours:
  9 max. at incidence angle of 85°, 5 max. at 60°.
- Gunship:
  3 max. at incidence angle of 85°, 3 max. at 60°.
- Semi-lucid colour:
  45 max. at incidence angle of 60°.
- Lucid colour:
  90 min. at incidence angle of 60°.

3.10.5 Opacity

The paint system, tested in accordance with paragraph 4.2.11, shall feature a contrast ratio ≥ 0.95 for all colours except yellow (FED-STD-595 colour code 13538), orange (FED-STD-595 colour code 12197), and red (FED-STD-595 colour code 11136), which shall feature a contrast ratio ≥ 0,90.

3.10.6 Adhesion

3.10.6.1 Wet Tape

The paint system shall be ≥ 4A and no component shall craze or delaminate from the substrate or from any other system component, tested in accordance with para 4.2.12.

3.10.6.2 Chequering

The paint system shall be ≥ 4B and no component shall craze or delaminate from the substrate or from any other system component, tested in accordance with para 4.2.13.

3.10.7 Flexibility

3.10.7.1 Flexibility at Room Temperature

- Paint schemes Class 1:
  Tested in accordance with para 4.2.14, the paint system shall feature a 60% minimum elongation at impact for lucid systems and 40% for camouflage systems.
  In case of ageing in accordance with para 4.2.17.1 and 4.2.17.2., the paint system shall feature a 40% minimum elongation at impact for lucid systems and 20% for camouflage systems.
  The flexibility tests listed in para 3.7, 3.8 and 3.9.3 shall not apply after the ageing.

- Paint schemes Class 2 and 3:
  Tested in accordance with para 4.2.14, the paint system shall feature a 60% minimum elongation at impact both for lucid and camouflage topcoats.
  The requirements shall be the same in case of exposure to ageing in accordance with para 4.2.17.1 and 4.2.17.2.
  The flexibility tests listed in para 3.7, 3.8 and 3.9.3 shall not apply after the ageing.

3.10.7.2 Flexibility at Low Temperature

- Paint schemes Class 1:
  The paint systems shall not feature any cracking, tested in accordance with para 4.2.15.

- Paint schemes Class 2 and 3:
  The paint systems shall not feature any cracking, tested in accordance with para 4.2.15.

3.10.8 Fluid Resistance

The paint systems, tested in accordance with para 4.2.16, shall feature the following requirements:

- no blistering, delamination or lack of adhesion, tested in accordance with para 4.2.13.
- Skydrol resistance shall not be required for the paint systems Class 1 and 2.
- the colour variation (ΔE) shall be ≤ 3, tested in accordance with para 4.2.8.

3.10.9 Ageing Resistance

The paint systems, tested on a set of test panels (see Table IV) in accordance with para 4.2.17.1 or 4.2.17.2, shall:

- feature a colour variation (∆E) ≤ 1.0, tested in accordance with para 4.2.8.
- the 60° gloss, tested in accordance with para 4.2.10, shall be:
  - camouflage colour: max. 5 at incidence angle of 60°;
  - gunship colour: max. 3 at incidence angle of 60°;
  - semi-lucid colour: 15-45 at incidence angle of 60°;
  - lucid colour: min. 90 at incidence angle of 60°.

3.10.10 Humidity Resistance

The paint systems shall not feature:

- bubbles;
- loss of adhesion, tested in accordance with para 4.2.13;
- other defects of the film, tested in accordance with para 4.2.18

3.10.11 Spidery Corrosion Resistance

For the test validation, the control panel shall have a minimum spidery corrosion of 0,7 mm (1/4 of inch) from the incision.

The test panel shall not feature spidery corrosions or paint detachments exceeding 0,3 mm (1/8 of inch) from the incision by the end of the exposure period, in accordance with para 4.2.19.

3.10.12 Neutral Salt Fog – Corrosion Resistance

The test panels shall not feature any bubbles, pitting or decolourizations, tested in accordance with para 4.2.20.

3.10.13 Heat Resistance

The paint system shall not feature any smattering, loss of adhesion, tested in accordance with para 4.2.21.

The colour variation shall be (ΔE) ≤ 1, tested in accordance with para 4.2.8.

3.10.14 Solvent Resistance (Cure)

The paint systems shall resist to 50 MEK (metil etil chetone) passages on the surface, tested in accordance with para 4.2.22.

Any kind of primer solution shall be intended as a damage.

3.10.15 Paint Stripping

A minimum of 90% of the paint system shall have to be removed from the test panel in 24 hours and with no more than 4 applications of chemical paint remover, tested in accordance with para 4.2.23.

It is recommended to specify the chemical paint remover used for the topcoat.

Furthermore, another chemical paint remover can be identified to remove the primer. Do not apply more than 4 hands in total to satisfy the specific requirement.

4 PART 4 - TEST CONDITIONS AND PROCEDURES

4.1 Test conditions

4.1.1 Test Standard Conditions

The standard laboratory conditions shall be 25±3 °C temperature and 50±10 % RH humidity.

Unless otherwise specified in next paragraphs, all tests shall be performed in accordance with this paragraph.

The “room temperature” conditions considered shall be 25±3 °C.

4.1.2 Test Standard Tolerances

Unless otherwise specified in next paragraphs, Table 3 reports the standard tolerances applied

Measure	Tolerance
Temperature	±1 °C
Days	±2 hours
Hours	±5 minutes
Minutes	±10 seconds
Inches (mm)	±0.25 mm

Table 3 – Standard Tolerances

4.1.3 Preparation of Test Panels

4.1.3.1 Description of Test Panels

All test panels shall be Alclad 2024-T3 and 7075-T6 aluminum alloy panels sized 0.81X76.2X152.4 mm (0.032X3X6 inches).

Paragraph of Requirements	Proprieties	Substrate	Quantity of Panels
3.7 Storage Stability	Viscosity and Pot-Life	N/A	N/A
	Surface Aspect	Alclad 2024-T3	3
	Brightness	Alclad 2024-T3	3
	Wet Tape	Alclad 2024-T3	3
	Flexibility at Room T	Alclad 2024-T3	3
	Fluid Resistance MIL-PRF-83282	Alclad 2024-T3	3
3.8Accelerated Storage Stability	Viscosity and Pot-Life	N/A	N/A
	Surface Aspect	Alclad 2024-T3	3
	Brightness	Alclad 2024-T3	3
	Wet Tape	Alclad 2024-T3	3
	Flexibility at Room T	Alclad 2024-T3	3

Paragraph of Requirements	Proprieties	Substrate	Quantity of Panels
	Fluid Resistance MIL-PRF-83282	Alclad 2024-T3	3
3.9.2 Odour	Residual Odour from Dried Paint after 48 Hours	Alclad 2024-T3	Use Test Panels of Para 3.10.1
3.9.3 Viscosity and Pot-life	Surface Aspect	Alclad 2024-T3	3
	Brightness	Alclad 2024-T3	3
	Wet Tape	Alclad 2024-T3	3
	Flexibility at Room T	Alclad 2024-T3	3
	Fluid Resistance MIL-PRF-83282	Alclad 2024-T3	3
3.9.4 Drying Time	Dry to Tape Time	Alclad 2024-T3 (0,813X304,8X304,8)	1
3.9.5 Wettability	Wettability	Alclad 2024-T3 (0,813X304,8X304,8)	1
3.10.1 Surface Aspect	Surface Aspect	Alclad 2024-T3	3
3.10.2 Colour	Colour	Alclad 2024-T3	3
3.10.3 IR Reflectance	UV Reflectance, IR Observability and Distance	Alclad 2024-T3	3
3.10.4 Brightness	Brightness	Alclad 2024-T3	Use Test Panels of Para 3.10.2
3.10.5 Covering Power	Covering Power	LENETA 3B Opacity Charts	
3.10.6.1 Wet Tape	Adhesion (Wet Tape)	Alclad 2024-T3	3
		Ti6Al-4V	3
3.10.6.2 Chequering	Adhesion (Chequering)	Alclad 2024-T3	3
		Ti6Al-4V	3
3.10.7.1 Flexibility at Room T (forming at 25±3°C)	Impact Resistance	Alclad 2024-T3 (Thickness 0,51 mm)	3
3.10.7.2 Flexibility at Low T (-51±3 °C)	Cylindrical Mandrel Bending Resistance	Alclad 2024-T3 (Thickness 0,51 mm)	3
3.10.8 Fluid Resistance	MIL-PRF23699	Alclad 2024-T3	3
	MIL-PRF83282	Alclad 2024-T3	3
3.10.9 Ageing Resistance (Xenon Arc)	Colour	Alclad 2024-T3	3
	Brightness	Alclad 2024-T3	Use Colour Test Panels

Paragraph of Requirements	Proprieties	Substrate	Quantity of Panels
	Forming (Room T)	Alclad 2024-T3 (Thickness 0,51 mm)	3
	Cylindrical Mandrels (Low T)	Alclad 2024-T3 (Thickness 0,51 mm)	3
3.10.9 Ageing Resistance (QUV-B)	Colour	Alclad 2024-T3	3
	Brightness	Alclad 2024-T3	Use Colour Test Panels
	Forming (Room T)	Alclad 2024-T3 (0,51 mm thickness)	3
	Cylindrical Mandrels (Low T)	Alclad 2024-T3 (0,51 mm thickness)	3
3.10.10 Humidity Resistance	Blistering / Defects of the Applied Film	Alclad 2024-T3	3
	Chequering	Alclad 2024-T3	Use Blistering Test Panels
3.10.11 Spidery Corrosion	Onset of Spidery Corrosion	Alclad 2024-T3	3
		Alclad 7075-T6	3
3.10.12 Neutral Salt Fog	Corrosion Calculation	Alclad 2024-T3	3
		Alclad 7075-T6	3
3.10.13 Heat Resistance (177±2 °C)	Colour	Alclad 2024-T3	3
	Chequering	Alclad 2024-T3	Use Colour Test Panels
	Flexibility with Cylindrical Mandrels	Alclad 2024-T3	3
3.10.14 Solvent Resistance	MEK Resistance	Alclad 2024-T3	3
3.10.15 Paint Stripping	Paint Stripping	Alclad 2024-T3	3

4.1.3.2 Preparation of Test Panels – Procedure:

Test panels shall be prepared as follows:

- remove the grease from the metal surface (use MEK - metil etil chetone);
- apply the pre-treatment in accordance with manufacturer technical chart;
- apply the primer in accordance with manufacturer technical chart;
- apply the topcoat in accordance with manufacturer technical chart.

4.1.4 Incision of Test Panels

Incisions on test panels shall be performed up to the metal substrate.

On the Fluid-Skydrol Resistance test panels, incise a diagonal line at 102 ± 3.2 mm (4 ± 0.125 inches).

On the Spidery Corrosion and Salt Fog test panels, incise 2 diagonal lines at 102 ± 3.2 mm (4 ± 0.125 inches) forming a central "X".

The diagonal lines shall be equally spaced and in line with the panel opposed corners.

4.2 Test Procedures

4.2.1 Storage Stability

The primer and topcoat original sealed containers shall be kept locked for a year from their production date, at a room temperature between 2 and 46°C.

The pre-treatments shall be stored at the same conditions for 6 months.

4.2.2 Accelerated Storage Stability

All paint system components, which shall comply with the provisions of para 3.8, shall be stored in their original manufacturer sealing packaging, at 60 ± 3 °C, for 7 days, and then cooled down at room temperature.

4.2.3 VOC Content

The test shall be performed in accordance with standard ASTM D3960.

4.2.4 Odour

After 48 hours of drying time at laboratory conditions, the panel shall be positioned in a 1000 ml beaker covered by a clock glass, and left there for balancing for 20 minutes at laboratory conditions. After that, the clock glass shall be removed to check the presence of odour.

4.2.5 Viscosity and Pot-Life

The test shall be performed in accordance with standard ASTM D1200, using a Ford #4 Cup.

For the pot-life test, the paint system components shall be left in a closed container and, 4 hours after their mixing, their viscosity shall be tested in accordance with standard ASTM D1200 using a Ford #4 Cup.

4.2.6 Drying Time

After removing two circles of tape from a roll, a stripe of adhesive tape (length: 5 inches (3M#250), height: 1 inch (25.4 mm), shall be applied on any test panel and pressed with 4 double passages of a 2 kg roll.

The adhesive tape shall remain on the panels for at least 1 hour. The adhesive tape shall be removed by constantly and moderately pulling its free extremity, forming a 180° corner.

4.2.7 Wettability

The test shall be performed in a paint booth with an airflow of 0.381 -0.635 meters per second.

Use a panel of 305 x 305 mm (12x12 inches).

Apply a layer of mixed topcoat on one half of the panel.

After 15 minutes in the paint booth, apply a layer of mixed topcoat on the second half of the panel and overlap one inch of the first application.

Check the panel after at least 24 hours of cure.

4.2.8 Colour

The test shall be performed in accordance with standard ASTM D2244 using CIE 1976 (L*, a*, b*).

The spectrophotometer parameters shall be:

a. CIE Lab colour system
b. 10° observer
c. D65 brightener
d. Specular reflectance included

4.2.9 IR Reflectance

The paint total IR reflectance (specular and diffused) shall be defined in the wavelength spectrum of between 700-2600 nanometres (nm) using a Perkin-Elmer LAMBDA 750 spectrophotometer with integrating sphere.

4.2.10 Brightness

The test shall be performed in accordance with standard ASTM D523.

4.2.11 Opacity

The test shall be performed in accordance with standard ASTM D2805.

The thickness of the dried film shall range from 0.051 to 0.061 mm on 3 charts LENETA Form 3B, or equivalent.

Define the average opacity for compliance.

4.2.12 Wet Tape

The loss of adhesion as a consequence to the exposure tests shall be defined in accordance with FED-STD-141 Method 6301.3, with the following exceptions:

a. the test panels shall be accurately dried with a cloth in accordance with standard AMS 3819B, Grade A;
b. the test shall be performed within 10 minutes from the cleaning, at 25±3 °C temperature;
c. use a blade to incise 2 parallel lines spaced 25.4 mm (1 inch) from each other and a X intersecting them.
d. The X size shall be 12.7 mm (0,5 inches), as showed in Figure 1.

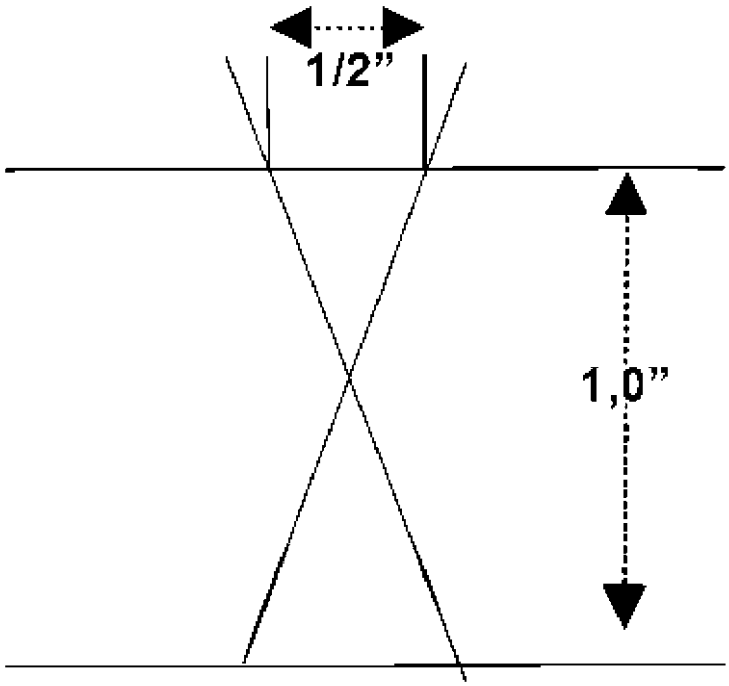

Figure 1. Wet Tape Test.

NOTE

The parallel lines and the X shall be incised up to the metal surface

e. Press a piece of adhesive tape 3M #250 (length: 25.4 mm (1 inch) perpendicularly to the parallel incisions, covering the X. The adhesive tape shall be pressed with 8 passages of a roll featuring 2.04 -2.27 kg, and a Shore D hardness 70-80 rubber cover (diameter: 90 mm (3,5 inches), length: 45 mm (1,75 inch).

f. Within 90 ± 30 sec.

g. After the roll passages, remove the tape with a sharp movement, forming a 180° corner with the panel surface.

h. Define the adhesion visually using the scale defined in standard ASTM D3359, Method A.

4.2.13 Chequering

The test shall be performed in accordance with standard ASTM D3359, Method B, with 6 incisions spaced 2 mm from each other.

4.2.14 Flexibility at Room Temperature

The test shall be performed in accordance with standard ASTM D2794, using a device for dynamic forming. A covering cracking shall mean a crack up to the substrate.

4.2.15 Flexibility at Low Temperature

- Paint systems Class 1:
  The test shall be performed in accordance with standard ASTM D522 Method B at -51 ± 3 °C. Use a 25.4 mm (1 inch) mandrel for lucid and semi-lucid topcoats and a 50.8 mm (2 inches) mandrel for camouflage topcoats.
- Paint systems Class 2 and 3:
  The test shall be performed in accordance with standard ASTM D522 Method B at -51 ± 3 °C. Use a 25.4 mm (1 inch) mandrel for lucid, semi-lucid and camouflage topcoats.

4.2.16 Fluid Resistance

Expose distinct sets of three test panels at any of the following conditions:

a. MIL-PRF-23699 – before the exposure, measure the colours of the 3 panels in accordance with para 4.2.8, then immerge them completely for 24 hours at121 ± 3 °C.

b. MIL-PRF-83282 - before the exposure, measure the colours of the 3 panels in accordance with para 4.2.8, then immerge them completely for 7 days at 65 ± 3 °C.

c. Jet Fuel JP-8 - before the exposure, measure the colours of the 3 panels in accordance with para 4.2.8, then immerge them completely for 30 days at 25 ± 3 °C.

d. Water (ASTM D1193 Type IV) - before the exposure, measure the colours of the 3 panels in accordance with para 4.2.8, then immerge them completely for 30 days at 49 ± 3 °C.

e. Skydrol LD-4 - before the exposure, measure the colours of the 3 panels in accordance with para 4.2.9. After that, incise 3 further panels in accordance with para 4.1.4 and position all 6 panels horizontally with their painted side turned up, at 25 ± 3 °C.

   Use Skydrol LD-4 at 25 ± 3 °C, wet the 6 panels separately, once a day in 30 days (never immerge them).

   After each exposure, remove the panels and immediately check the presence of film blistering or delamination.

   After that, properly clean the test panels according with MIL-PRF-23699, MIL-PRF-83282, Jet Fuel, and Skydrol LD-4 for panels without incisions, and rinse with water.

   Dry the panels and leave them in the open air for 1 hour, then measure colours in accordance with para 4.2.8.

4.2.17 Ageing Resistance

4.2.17.1 Xenon Arc

The test panels shall be exposed for 3000 hours in a Xenon Arc radiation chamber, with cycles of 102 minutes of light and 18s of light + spray deionized water.

After the exposure, check the compliance with para 3.10.7.

To perform the test in accordance with standard ASTM G 155, Type BH, the following conditions shall apply:

- black body temperature in the chamber: 63±3 °C;
- Xenon Arc intensity: 0.35 ± 0.05 watt/meter2 at wavelength of 340 nm.

4.2.17.2 QUV-B

The test shall be performed in accordance with standard ASTM G154 with an exposure of 1500 hours in a UV-CON chamber (chamber at UV/Condensa irradiating) with cycles of 8 hours of UVB irradiation (lamp 313) at 60 °C, followed by 4 hours of darkness and condensed water at 45°C.

The UV-CON chamber shall be set with a wavelength of 310 nm and a radiation intensity of 0.63 watts/m2.

4.2.18 Humidity Resistance

The test panels shall be exposed for at least 30 days in a humidostatic chamber with temperature of 49 ± 2 °C and 100 % of relative humidity, in accordance with standard ASTM D2247.

4.2.19 Spidery Corrosion Resistance

The test panels, prepared and incised in accordance with para 4.1.3 and para 4.1.4, respectively, shall be laid on a rack positioned 5 centimetre far from the liquid level in a closed container with a hydrocloric acid solution concentrated enough to completely cover the container bottom for 65±5 minutes. Do not rinse nor dry.

After that, immediately move the panels into a humidostatic chamber with temperature of 39±3 °C and 80±5% of relative humidity.

Expose the panels with their longer side inclined of nearly 6°.

The test shall take at least 2000 hours.

At the end of the test, pursuant to the evaluation, remove the paint with a chemical agent on one half of the shorter side of the panels.

4.2.20 Neutral Salt Spray (Fog) Test – Corrosion Resistance

The test panels, prepared and incised in accordance with para 4.1.3 and para 4.1.4,respectively, shall be exposed for at least 2000 hours to 5% NaCi salt fog as per ASTM B117.

4.2.21 Heat Resistance

The test panels shall be positioned into a stove at 177±15 °C.

After 4 hours, remove the panels and let them cool down at standard conditions.

Test the panels in accordance with para 4.2.13.

4.2.22 Solvent Resistance

The test panels shall be prepared in accordance with para 4.1.3. Go over the paint for 25 times (50 passages) with a cotton cloth imbued with methyl ethyl chetone, exercising a constant pressure.

4.2.23 Paint Stripping

The test panels shall be cured for 7 days in standard conditions and exposed to high temperature (100 °C) accelerated ageing for 96 continuative hours.

Cover all the edges of the test panels with a 3M aluminium tape and position them on a rack (60° inclination).

Pour the paint remover from the upper edge of any panel, covering the whole surface.

After 6 hours, brush away the slushy paint remover and rinse the panels with cold water. Do not exceed 4 applications of paint remover for a maximum amount of 24 hours of operation.

The quantity of the paint system removed shall result from the percentage of the substrate surface exposed.

5 PART 5 - PACKAGING

Pursuant to the procurement process, the packaging requirements shall be specified in the contract or order, and shall comply with the (EC) Regulation no. 1907/2006 of the European Parliament and Council, 18th December 2006, for the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), and the (EC) Regulation no. 1272/2008 (CLP) for the Classification, Labelling and Packaging of Substances and Mixtures.

6 PART 6 - QUALIFIED PRODUCT LIST (QPL)

The Qualified Product List (QPL) , (Attachment A), reporting all paint systems qualified by the Logistics Command – 1st Division – Flight Testing Centre, shall support the procurement procedures.

After the qualification, the Logistics Command - 1st Division – Flight Testing Centre, shall indicate to the DAA the paint system qualified for the insertion in the QPL.

QUALIFIED PRODUCT LIST
QPL - AER(EP).M-P-001

Paint System Type 1, Class 1:

Component		Commercial Name	Manufacturer
pre-treatment	a)	PreKote™ Surface Pretreatme nt	Pantheon Chemical 225 West Deer Valley Road Suite #4 Phoenix, Arizona 85027-2108
	a1)	Metaflex® SP 1050 Pretreatmen t	Akzo Nobel Aerospace Coatings Rijksstraatweg 31 2171 AJ Sassenheim P.O. Box 3 2170 BA Sassenheim The Netherlands
primer	b)	Aerodur® 2100 MgRP Corrosion Inhibiting Chrome Free Epoxy Primer	AkzoNobel Aerospace Coatings, a division of International Paint LLC 1 East Water Street Waukegan, IL 60085 USA
	b1)	-	-
topcoat	c)	58 Series Polyurethane Topcoat	AkzoNobel Aerospace Coatings, a division of International Paint LLC 1 East Water Street Waukegan, IL 60085 USA The Netherlands: P.O. Box 3, 2170 BA Sassenheim
	c1)	-	-

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Paint System Type 1, Class 2:

Component		Commercial Name	Manufacturer
pre-treatment	a)	PreKote™ Surface Pretreatment	Pantheon Chemical 225 West Deer Valley Road Suite #4 Phoenix, Arizona 85027-2108
	a1)	Metaflex® SP 1050 Pretreatment	Akzo Nobel Aerospace Coatings Rijksstraatweg 31 2171 AJ Sassenheim P.O. Box 3 2170 BA Sassenheim The Netherlands
primer	b)	Aerodur® 2100 MgRP Corrosion Inhibiting Chrome Free Epoxy Primer	AkzoNobel Aerospace Coatings, a division of International Paint LLC 1 East Water Street Waukegan, IL 60085 USA
	b1)	-	-
topcoat	c)	Aerodur® 5000 Military Aircraft Camouflage Topcoat	Akzo Nobel Aerospace Coatings Rijksstraatweg 31 2171 AJ Sassenheim P.O. Box 3 2170 BA Sassenheim The Netherlands
	c1)	-	-

Paint System Type 1, Class 3: Grade 1

Component		Commercial Name	Manufacturer
pre-treatment	a)	PreKote™ Surface Pretreatment	Pantheon Chemical 225 West Deer Valley Road Suite #4 Phoenix, Arizona 85027-2108
	a1)	Metaflex® SP 1050 Pretreatment	Akzo Nobel Aerospace Coatings Rijksstraatweg 31 2171 AJ Sassenheimù P.O. Box 3 2170 BA Sassenheim The Netherlands
primer	b)	Aerodur® 2100 MgRP Corrosion Inhibiting Chrome Free Epoxy Primer	AkzoNobel Aerospace Coatings, a division of International Paint LLC 1 East Water Street Waukegan, IL 60085 USA
	b1)	-	-
topcoat	c)	Aerowave® 5001	Akzo Nobel Aerospace Coatings Rijksstraatweg 31 2171 AJ Sassenheim P.O. Box 3 2170 BA Sassenheim The Netherlands

Reference Technical Report: Chemical Dept. - Rep. no. 11/103 of 15/07/2011