C3P
Center for Pollution Prevention Program

Technical Workshop C3P & NASA 2007

Escola Superior de Tecnologia do Mar

Peniche, Portugal

Hexavalent Chrome Removal in Aircraft Painting Schemes

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iSQ TAP PORTUGAL OGMA

Scope

- Aeronautical community is responding to environmental, health and safety challenges;
- Hexavalent Chromium Cr_{VI} was identified as a problem; and some alternatives showed;
- Present project consists in the comparison of the performance of new Cr_{VI} free coating systems with conventional systems;
- The objective of this work is to examine the role of laboratory and flight testing in the performance of new corrosion protection schemes.

Partners

- C3P – Center for Pollution Prevention
- ISQ – Instituto de Soldadura e Qualidade
- TAP Portugal – Transportes Aéreos Portugueses
- OGMA – Indústria Aeronáutica de Portugal

Partners

- C3P is a non profit Association composed by:
  - ITB (International Trade Bridge)
  - ISQ (Instituto de Soldadura e Qualidade)
  - INEGI (Instituto de Engenharia Mecânica e Gestão Industrial)
- Develop partnerships between American, Portuguese and other European companies and institutions;
- Identify and validate pollution prevention technologies through joint activities that enhance environmental stewardship and reduce risk while minimizing duplication of effort and associated costs;
- C3P seeks the validation and demonstration of alternative solutions.

Background

- February 2003, EU implemented the legislation WEEE (Waste Electrical and Electronics Equipment) and RoHS (Restriction of the Use of Certain Hazardous Substances), in order to restrict the emissions of Cr_{VI}.

- The main objective in Portugal is to reduce or eliminate the use of Cr_{VI} in Aluminium finishing by demonstrating and validating the performance of alternatives.

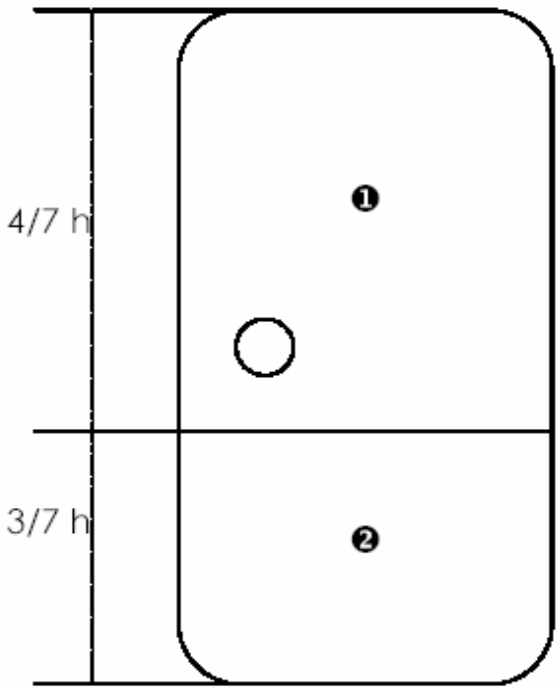
Project Objective

➔ Examine the performance of laboratory and field / flight testing of a non-chrome corrosion protection scheme.

➔ Project divided in 2 major group tests:
-Field Test - Follow up of an aircraft service door
-Laboratory tests according with AMS 3095

Aircraft Tests

- TAP painted one service door of an A319 Aircraft;
- The following systems were applied:



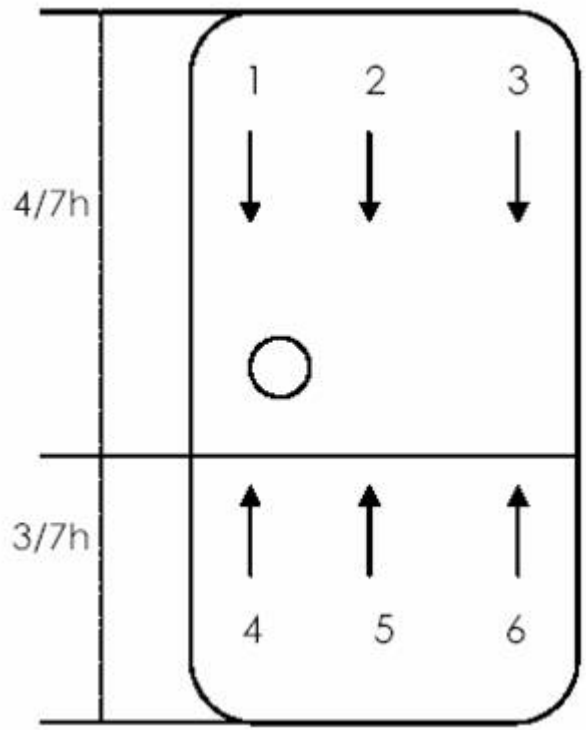
❶ **Upper part** (4/7th of the height)
-PreKote SP ⇨non chromated pre-treatment
-Aviox CF Primer
-Aviox Finish 77702

❷ **Lower part** (3/7th of the height)
-M790E ⇨ adhesion promoter product
-Aviox CF Primer
-Aviox Finish 77702

Aircraft Tests

- Thickness and Gloss measurements were taken after painting and then periodically during service period

Thickness and gloss measurement points



Aircraft Tests Results

The door was inspected periodically with final measurements after 2 years and 8 months in service

Table 1 - Upper and lower part average thickness measurements. (In µm)		
	Initial Test	**Final Test**
Upper Part (µm)	170	178.3
Lower Part (µm)	175	182.4

Table 2 - Upper and lower part average gloss measurements at 60º. In gloss units (GU).		
	Initial Test	**Final Test**
Upper Part (GU)	91	86.9
Lower Part (GU)	93	98.2

Aircraft Tests Results

- The follow-up reports of the Aircraft door show that both painting systems are in perfect conditions:
  - No peeling-off;
  - No defects were observed;
  - Present high gloss and DOI (Distinctness of Image)

Laboratory Tests

- Almost 170 coupons were prepared by OGMA
- Two painting schemes were tested:

P System	M System
PreKote SP Aviox CF Primer Aviox Finish 77702	M790E Aviox CF Primer Aviox Finish 77702

- Tests follow AMS 3095 standard which includes more than 30 different testing conditions.
- All tests conducted by the Project Partners

Laboratory Tests

Test	Test Method
1. Gloss	ISO 2813
2. Initial Color	ISO 7724; AMS 3095 5.3
3. Adhesion – Cross Hatch	ISO 2409
4. Impact (reverse)	ISO 6272
5. Flexibility – Conical Mandrel	ISO 6860
6. Flexibility – Cylindrical Mandrel	ISO 1519
7. Water *a)Blistering* *b)Grade* *c)Penetration*	 ISO 4628 ½ ISO 2409 ISO 1518

Laboratory Tests

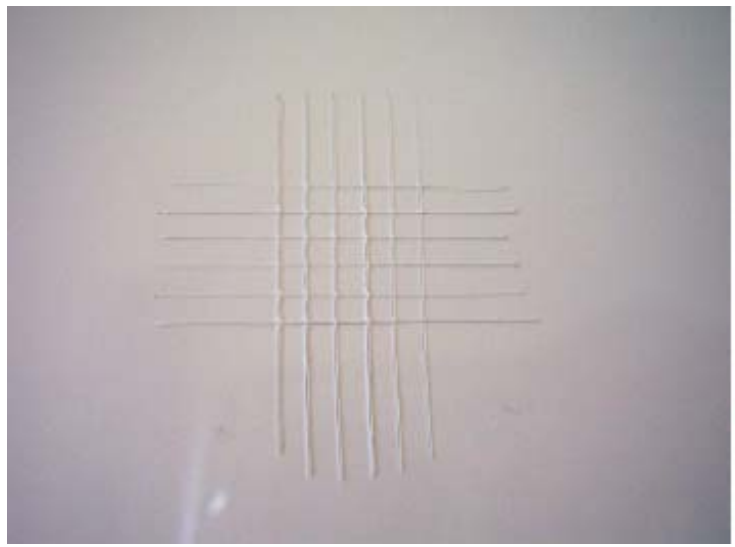
Test	Test Method
8. Fluid Resistance	ISO 1518
9. Corrosion Resistance – Filiform	EN 3665
10. Corrosion Resistance – Salt Spray	ISO 7253
11. Artificial weathering	ISO 2813; ISO 7724
12. Washability	ISO 2813
13. Strippability	AMS 3095 5.4
14. Restoration	AMS 3095 5.5
15. Heat Stability	ISO 1519; ISO 3270

Laboratory Tests Results

Adhesion – Cross Hatch

M Coupons

Classification “5” - All the squares have detached wholly

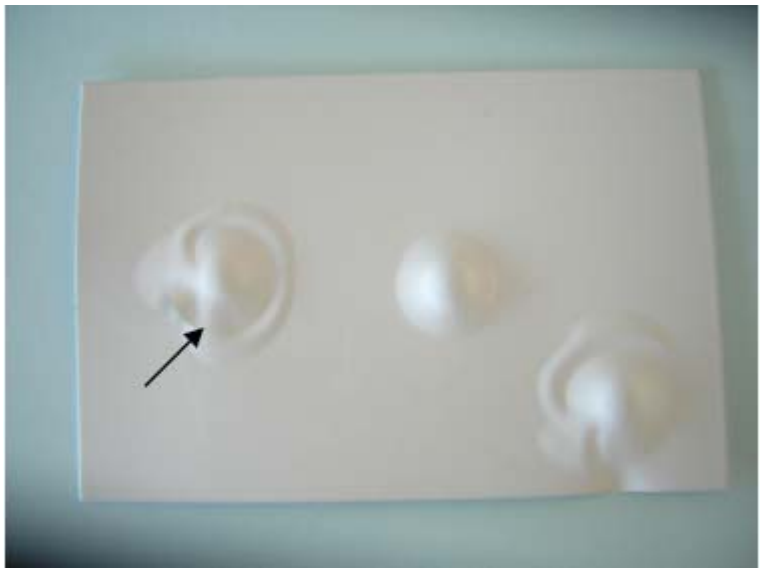


P Coupons

Classification “0” - The edges of the cuts are completely smooth; no visible detachment

Laboratory Tests Results

Impact (Reverse)



M Coupons

Coating has loss of adhesion in all impacts and as cracked in 1

The substrate has not cracked

P Coupons

The coating has not cracked or peeled

The substrate has not cracked

Laboratory Tests Results

Flexibility – Conical Mandrel

M Coupons → There is no cracking – some peeling was noted at the edges of the incisions after bending

P Coupons → There is no peel, no damage, no cracking

Laboratory Tests Results

Flexibility – Cylindrical Mandrel

- No evidence of cracking and/or detachment from the substrate was noted.

Water

- No blistering was found in the coatings;
- All the M coatings failed the adhesion test. The P coatings passed with grade 0 (the edges are completely smooth; no detachment visible);
- No penetration to the substrate occurred on all coupons.

Fluid Resistance

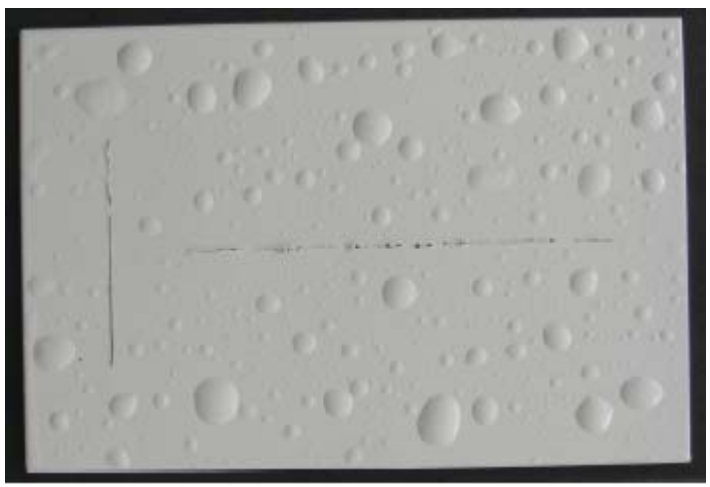
- No blistering was found in the coatings.

Laboratory Tests Results

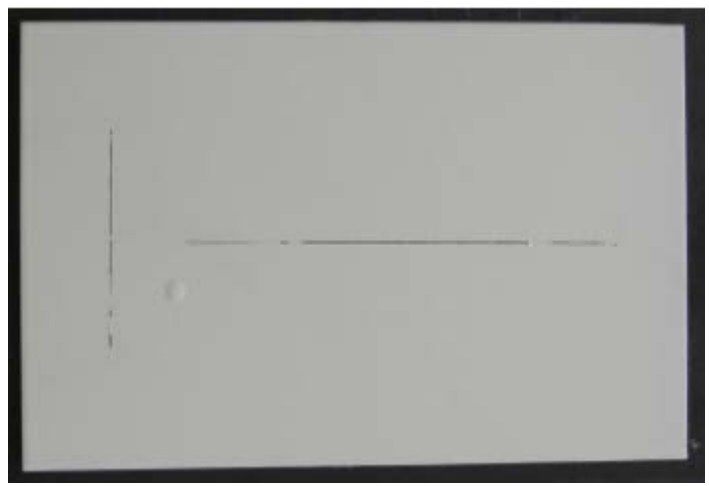
Corrosion Resistance - Filiform

Test Conditions: 1h of HCl exposure; humidity chamber with 40 ± 2 ºC of temperature and 82 ± 3 % of relative humidity for 1000h

M Coupons



P Coupons



No evidence of filiform corrosion ➔ Some blistering in the M coatings

Laboratory Tests Results

Corrosion Resistance – Salt Spray

Conditioning: 3000 hours at 35ºC; 50g/L NaCl Solution; pH 6.5-7.2.

- Evidence of corrosion was present in all the coatings.

M Restored Coupons after 3000 hours

Laboratory Tests Results

Artificial Weathering

- Gloss retention ➔ after testing all coupons showed good performance.

- Initial color and color retention ➔ all of the samples tested exceed the requirements, showing excellent performance.

Washability

- All coupons have passed the test equally with the minimum of 95% gloss retention after testing.

Laboratory Tests Results

Strippability

All coupons have passed the test (minimum requisite for the test was 95% removal in 7 hours); although, the P coatings took much longer to remove the paint than the M coatings.

M Coupon after scrubbing.

Heat Stability

No evidence of cracking, peeling or damage from the substrate were found after the bending test, except for the M coupons that did not passed the test.

Conclusions

- M coating system failed in some tests; P coating passed all the tests;

- The P coating system has performed better or equally than the M painting scheme.

- Non-chromate technologies have improved over the years and their performance is getting very close to the performance of the chromate ones.

Thank you!

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