LAB ANALYSIS REPORT

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UNITED KINGDOM

Date:	Our reference:	Your reference:
09/03/2004	**1588-0131-2004**	108070 dd. 14-08-2003

Type of intervention	**LAB ANALYSIS REPORT**
Subject	**Plascoat PPA-571ES - Laboratory Performance Tests**
Location/address	Coating-Lab, SGS Axa-Med, Brugge, Belgium
Date analysis	October 2003 – January 2004

Parties	Company	Report
Ordered by	Plascoat Systems Ltd Trading, Estate Farnham GU9 9NY – Surrey – United Kingdom	Original by mail + per e-mail
Executed by	SGS Axa-Med, div. SGS Belgium nv	Copy in file

Conclusions:

After this series of laboratory performance tests, the following can be concluded:

- Plascoat 571 ES is not affected by immersion nor by UV-exposure during the tests executed.
- Neither adhesion, nor appearance is affected by any of the tests performed.
- Resistance to corrosion and under creep corrosion is good to excellent during the tests that were performed.
- The tests executed did not show any significant difference in performance between phosphated steel panels and sandblasted steel panels. Some extra performance (especially adhesion-wise) could probably be achieved by providing for a higher anchor pattern than was the case on the blasted test panels.

Therefore, applications where Plascoat 571 ES is applied properly onto well prepared surfaces (as per the Technical Data Sheets), can be allotted at least the following feasible Insurance Backed Guarantee periods:

- 10 years in C1, C2, C3 and C4-environments (according to ISO 12944)
- 5 years in C5-I and C5-M environments (according to ISO 12944)

Report drawn by	Report verified by	Stamp
Name	Name	
Georges Van Cleemput	Gunnar Ackx	
Title	Title	
Inspector Consultant	Manager / NACE Certified Coating Inspector #5286	
Signature	Signature	

1. Introduction

1.1. Assignment

Ordered by	Plascoat Systems Ltd Trading, Estate Farnham GU9 9NY – Surrey – United Kingdom
Reference	Purchase order 108070
Date	14-08-2003

1.1.1. Subject – Description Of Tests

Nr.	Test	Method	Standard	Criteria
1.	Adhesion	Dolly Pull-off	ISO 4624	---
2.	Colour Measurements	Cielab	Cielab	---
3.	QUV-B test	500 hrs	---	---
4.	Immersion testing	500 hrs demin-water	---	---
5.	Adhesion after QUV (3)	Dolly Pull-off	ISO 4624	---
6.	Adhesion after immersion (4)	Dolly Pull-off	ISO 4624	---
7.	Colour Measurements after QUV (3)	Cielab	Cielab	$\Delta E < 3$
8.	Visual assessment of rusting, blistering, … after immersion (4)	Visual + standards	ISO 4628	< Ri 2 No blisters

1.1.2. Scope of Work

Goals of this series of tests were the following:

a) Compare the adhesion behaviour of Plascoat PPA-571 on blasted steel and on phosphated steel.
b) Verify the influence of immersion exposure on the adhesion of Plascoat PPA-571 (by re-testing adhesion and evaluating rusting, blistering, etc.).
c) Verify the influence of UV-exposure on the adhesion of Plascoat PPA-571 (by re-testing adhesion after 500 hrs of QUV-B exposure).
d) Verify the UV-resistance of Plascoat PPA-571 by measuring the ΔE colour difference after 500 hrs of QUV-B testing.
e) Predict estimated/expected Insurance Backed Guarantee Periods that would be achievable in various ISO 12944 climates.

2. Samples

Date reception of samples	25-08-2003
Total number of samples	32 samples (15 cm x 10 cm, 0,8 mm or 1,5 mm thick)
Remarks	Your identification: PPA 571 ES

2.1. *Known sample data*

From the test plates received, we drew up the following matrix of relevant & known coating data:

Our ID	Material Thickness	Surface Preparation	Colour code
01	0,8 mm	Phosphated	White 110
02	1,5 mm	Phosphated	White 110
03	1,5 mm	Phosphated	White 110
04	0,8 mm	Phosphated	White 110
05	0,8 mm	Sandblasted	White 110
06	0,8 mm	Sandblasted	White 110
07	1,5 mm	Sandblasted	White 110
08	1,5 mm	Sandblasted	White 110
09	0,8 mm	Phosphated	Green 475
10	1,5 mm	Phosphated	Green 475
11	1,5 mm	Phosphated	Green 475
12	0,8 mm	Phosphated	Green 475
13	0,8 mm	Sandblasted	Green 475
14	1,5 mm	Sandblasted	Green 475
15	0,8 mm	Sandblasted	Green 475
16	1,5 mm	Sandblasted	Green 475
17	0,8 mm	Phosphated	Grey 654
18	0,8 mm	Phosphated	Grey 654
19	1,5 mm	Phosphated	Grey 654
20	1,5 mm	Phosphated	Grey 654
21	0,8 mm	Sandblasted	Grey 654
22	1,5 mm	Sandblasted	Grey 654
23	1,5 mm	Sandblasted	Grey 654
24	0,8 mm	Sandblasted	Grey 654
25	0,8 mm	Phosphated	Black 700
26	0,8 mm	Phosphated	Black 700
27	1,5 mm	Phosphated	Black 700
28	1,5 mm	Phosphated	Black 700
29	1,5 mm	Sandblasted	Black 700
30	1,5 mm	Sandblasted	Black 700
31	0,8 mm	Sandblasted	Black 700
32	0,8 mm	Sandblasted	Black 700

All test plates were treated & coated equally at both sides.
For ease of reporting & interpretation, in the report all test plate ID-numbers are followed by one of the following suffixes:

- R = Recto-sides / V = Verso-side
- P = Phosphated / S = Sandblasted
- 08 = 0,8 mm plate-thickness / 15 = 1,5 mm plate-thickness
- 110 / 475 / 654 / 700 = colour codes

2.2. Application data

Execution application	
Coating applied by	Plascoat Systems Ltd Trading
Method of application	
Application date/period	Unknown
Present during application	---
Data received from	---

Coating systems	Description	DFT (µm)
Surface Preparation	Phosphating or Sandblasting	
Coating system	PPA 571 ES	See par. 3.1.

3. Lab analysis

Date/period execution tests	October 2003 – January 2004

3.1. Dry Film Thickness (ISO 2808)

In order to allow for optimal selection of the test plates for each type of test, coating thickness was first measured on both sides of ALL test plates received. This produced the following results:

Panel ID	DFT (µm)	Panel ID	DFT (µm)	Panel ID	DFT (µm)	Panel ID	DFT (µm)
01-R-P-08-110	**280**	09-R-P-08-475	**191**	17-R-P-08-654	**172**	25-R-P-08-700	**253**
01-V-P-08-110	**228**	09-V-P-08-475	**187**	17-V-P-08-654	**186**	25-V-P-08-700	**228**
02-R-P-15-110	**249**	10-R-P-15-475	**197**	18-R-P-08-654	**231**	26-R-P-08-700	**266**
02-V-P-15-110	**235**	10-V-P-15-475	**160**	18-V-P-08-654	**213**	26-V-P-08-700	**225**
03-R-P-15-110	**276**	11-R-P-15-475	**229**	19-R-P-15-654	**260**	27-R-P-15-700	**202**
03-V-P-15-110	**238**	11-V-P-15-475	**214**	19-V-P-15-654	**255**	27-V-P-15-700	**230**
04-R-P-08-110	**242**	12-R-P-08-475	**250**	20-R-P-15-654	**247**	28-R-P-15-700	**222**
04-V-P-08-110	**269**	12-V-P-08-475	**249**	20-V-P-15-654	**231**	28-V-P-15-700	**225**
05-R-S-08-110	**226**	13-R-S-08-475	**208**	21-R-S-08-654	**253**	29-R-S-15-700	**207**
05-V-S-08-110	**251**	13-V-S-08-475	**199**	21-V-S-08-654	**288**	29-V-S-15-700	**196**
06-R-S-08-110	**222**	14-R-S-15-475	**222**	22-R-S-15-654	**233**	30-R-S-15-700	**208**
06-V-S-08-110	**267**	14-V-S-15-475	**205**	22-V-S-15-654	**239**	30-V-S-15-700	**213**
07-R-S-15-110	**238**	15-R-S-08-475	**262**	23-R-S-15-654	**187**	31-R-S-08-700	**232**
07-V-S-15-110	**234**	15-V-S-08-475	**228**	23-V-S-15-654	**219**	31-V-S-08-700	**231**
08-R-S-15-110	**207**	16-R-S-15-475	**207**	24-R-S-08-654	**205**	32-R-S-08-700	**209**
08-V-S-15-110	**235**	16-V-S-15-475	**198**	24-V-S-08-654	**219**	32-V-S-08-700	**221**

3.2. Adhesion (Dolly Pull-off method acc. to ISO 4624)

3.2.1. Introduction

In the beginning, different types of glue (epoxy, polyurethane, cyano-acrylic, …) were tested to see which type of glue provides for the best adhesion of the test dollies onto the coated substrates.

Because of the slick nature of the Plascoat 571 ES-coating, NONE of the various types tested managed to provide for better adhesion properties to the coating than the coating had to the steel. In other words, initially no glue could be found with an adhesion to the coating high enough so that the coating could be pulled off from the steel.

Eventually, with Plascoat 571 ES being a thermoplastic coating, the test dollies were heated to ± 300 °C and glued onto the coating by re-melting it locally (underneath the heated dolly). With the dollies being blasted at a relatively high anchor profile (± 80 µm), the Plascoat 571 ES had now become located between 2 pieces of blasted steel (test plate + test dolly), which were then pulled from each other using a hydraulic PAT-tester (according to ISO 4624).

The following results were obtained:

3.2.1.1. Adhesion Test prior to exposure-testing

Panel ID	Adhesion (MPa)	Failure Description		
		Substrate / Coating	IN Coating (cohesion)	Coating / Dolly
03-R-**P**-15-110	4,8 MPa	---	25 %	75 %
03-R-**P**-15-110	5,0 MPa	20 %	40 %	40 %
07-R-**S**-15-110	3,8 MPa	---	50 %	50 %
07-R-**S**-15-110	4,2 MPa	---	75 %	25 %
10-R-**P**-15-475	5,3 MPa	30 %	60 %	10 %
10-R-**P**-15-475	5,5 MPa	20 %	60 %	20 %
16-R-**S**-15-475	4,9 MPa	---	70 %	30 %
16-R-**S**-15-475	5,0 MPa	---	70 %	30 %
19-R-**P**-15-654	6,8 MPa	---	30 %	70 %
19-R-**P**-15-654	4,3 MPa	---	40 %	60 %
23-R-**S**-15-654	4,9 MPa	---	65 %	35 %
23-R-**S**-15-654	5,0 MPa	---	65 %	35 %
28-R-**P**-15-700	4,5 MPa	---	80 %	20 %
28-R-**P**-15-700	4,0 MPa	---	60 %	40 %
30-R-**S**-15-700	3,2 MPa	---	100 %	---
30-R-**S**-15-700	3,2 MPa	---	50 %	50 %

Conclusions:

- The overall average adhesion before exposure testing is 4,65 MPa.
- The average adhesion on phosphated panels is 5,0 MPa.
- The average adhesion on sandblasted panels is 4,28 MPa.
- The fact that adhesion is better on phosphated panels indicates that the anchor profile achieved with the sandblasting probably wasn't optimal (or should be somewhat higher). It is more logical to achieve higher adhesion values on rough blasted panels as to flat phosphated panels.

3.2.1.2. *Adhesion Test after immersion*

Panel ID	Adhesion (MPa)	Failure Description		
		Substrate / Coating	IN Coating (cohesion)	Coating / Dolly
03-R-**P**-15-110	5,0 MPA	10 %	90 %	---
03-R-**P**-15-110	4,9 MPA	15 %	85 %	---
07-R-**S**-15-110	5,0 MPA	50 %	50 %	---
07-R-**S**-15-110	4,8 MPA	30 %	70 %	---
10-V-**P**-15-475	5,5 MPA	90 %	10 %	---
10-V-**P**-15-475	5,9 MPA	70 %	30 %	---
16-R-**S**-15-475	6,8 MPA	90 %	10 %	---
16-R-**S**-15-475	6,9 MPA	50 %	50 %	---
19-R-**P**-15-654	6,8 MPA	---	100 %	---
19-R-**P**-15-654	5,6 MPA	---	100 %	---
23-R-**S**-15-654	5,6 MPA	30 %	70 %	---
23-R-**S**-15-654	6,2 MPA	30 %	70 %	---
28-R-**P**-15-700	5,2 MPA	30 %	70 %	---
28-R-**P**-15-700	5,0 MPA	30 %	70 %	---
30-R-**S**-15-700	3,6 MPA	---	100 %	---
30-R-**S**-15-700	4,8 MPA	---	100 %	---

Conclusions:

- The overall average adhesion after the immersion test is 5,48 MPa.
- Adhesion does not seem to be influenced by immersion exposure, on the contrary.
- The average adhesion on phosphated panels is 5,49 MPa, more than before immersion exposure.
- The average adhesion on sandblasted panels is 5,46 MPa, more than before immersion exposure.

3.2.1.3. *Adhesion Test after QUV test*

Panel ID	Adhesion (MPa)	Failure Description		
		Substrate / Coating	IN Coating (cohesion)	Coating / Dolly
02-R-**P**-15-110	4,0 MPa	---	---	100 % (*)
02-R-**P**-15-110	4,0 MPa	---	---	100 % (*)
08-R-**S**-15-110	3,0 MPa	---	---	100 % (*)
08-R-**S**-15-110	4,5 MPa	---	---	100 % (*)
11-R-**P**-15-475	5,0 MPa	---	50 %	50 % (*)
11-R-**P**-15-475	5,0 MPa	---	50 %	50 % (*)
14-R-**S**-15-475	4,0 MPa	---	---	100 % (*)
14-R-**S**-15-475	3,8 MPa	---	---	100 % (*)
20-R-**P**-15-654	5,0 MPa	---	50 %	50 % (*)
20-R-**P**-15-654	6,0 MPa	---	50 %	50 % (*)
22-R-**S**-15-654	3,8 MPa	---	---	100 % (*)
22-R-**S**-15-654	4,0 MPa	---	---	100 % (*)
27-R-**P**-15-700	4,0 MPa	---	---	100 % (*)
27-R-**P**-15-700	4,0 MPa	---	---	100 % (*)
29-R-**S**-15-700	2,0 MPa	---	---	100 % (*)
29-R-**S**-15-700	2,2 MPa	---	---	100 % (*)

(*) Remark: Dolly was not blasted.

Conclusions:

- The overall average adhesion after the immersion test is 4,02 MPa.
- The average adhesion on phosphated panels is 4,62 MPa.
- The average adhesion on sandblasted panels is 3,41 MPa.
- Here, the adhesion test results come out somewhat lower than the other tests, but from the failure descriptions and the remark, one can clearly see that the main reason why lower values were achieved was because the dollies weren't blasted and adhesive failures between dolly and coating occurred, rather than adhesive or cohesive failures of the coating.
- Therefore, it can be concluded that adhesion is not affected (significantly) by UV-exposure.

3.2.1.4. *Overview table of Adhesion Test Results*

Sample ID	Adhesion before exposure	Adhesion after immersion	Adhesion after QUV-test
02-R-**P**-15-110	---	---	4,0 & 4,0
03-R-**P**-15-110	4,8 & 5,0	5,0 & 4,9	---
07-R-**S**-15-110	3,8 & 4,2	5,0 & 4,8	---
08-R-**S**-15-110	---	---	3,0 & 4,5
10-R/V-**P**-15-475	5,3 & 5,5	5,5 & 5,9	---
11-R-**P**-15-475	---	---	5,0 & 5,0
14-R-**S**-15-475	---	---	4,0 & 3,8
16-R-**S**-15-475	4,9 & 5,0	6,8 & 6,9	---
19-R-**P**-15-654	6,8 & 4,3	6,8 & 5,6	---
20-R-**P**-15-654	---	---	5,0 & 6,0
22-R-**S**-15-654	---	---	3,8 & 4,0
23-R-**S**-15-654	4,9 & 5,0	5,6 & 6,2	---
27-R-**P**-15-700	---	---	4,0 & 4,0
28-R-**P**-15-700	4,5 & 4,0	5,2 & 5,0	---
29-R-**S**-15-700	---	---	2,0 & 2,2
30-R-**S**-15-700	3,2 & 3,2	3,6 & 4,8	---

Conclusions:

- In general, it can be concluded that the adhesion of Plascoat 571 ES is not affected: neither by immersion exposure, nor by UV-exposure and that therefore Plascoat 571 ES is a product which can easily be used in humid outdoor environments for long-term exposure.

3.3. Immersion Test – 500 hours in demineralised water

3.3.1. Test set-up

In order to test the corrosion resistance of Plascoat 571 ES and its resistance to under creep corrosion, the test panels were partially (half) immerged in demineralised water at standard laboratory temperature of ± 23°C during the complete test duration of 500 hours.
The box where the panels were placed in was closed and sealed off, so that high humidity & condensation will prevail in the area above the waterline.

All test panels were scribed with a standardized scribing tool creating a 1 mm thick incision down to the steel. The other half of the X-cut consisted of an (fine) incision using a scalpel.

3.3.2. Evaluation

After the test period of 500 hours, the plates were removed from their environment and were visually observed and graded with respect to general corrosion, blistering, under creep corrosion, etc.

3.3.3. Test results

Panel ID	Visual appearance ISO 4628/1	Blistering ISO 4628/2	Corrosion ISO 4628/3	Under creep corrosion
01-R-P-08-110	1	No blisters	< Ri 1	0 mm
03-R-P-15-110	1	No blisters	< Ri 1	0 mm
05-R-S-08-110	1	No blisters	< Ri 1	0 mm
07-R-S-15-110	1	No blisters	< Ri 1	0 mm
09-R-P-08-475	1	No blisters	< Ri 1	0 mm
10-R-P-15-475	1	No blisters	< Ri 1	0 mm
13-R-S-08-475	1	No blisters	< Ri 1	0 mm
16-R-S-15-475	1	No blisters	< Ri 1	0 mm
17-R-P-08-654	1	No blisters	< Ri 1	0 mm
19-R-P-15-654	1	No blisters	< Ri 1	0 mm
21-R-S08-654	1	No blisters	< Ri 1	0 mm
23-R-S-15-654	1	No blisters	< Ri 1	0 mm
25-R-P-08-700	1	No blisters	< Ri 1	0 mm
28-V-P-15-700	1	No blisters	< Ri 1	0 mm
30-V-S-15-700	1	No blisters	< Ri 1	0 mm
32-R-S-08-700	1	No blisters	< Ri 1	0 mm

3.3.4. Conclusions

After 500 hours of immersion- and condensation exposure to demineralised water:

- Visual appearance: after the test all test plates show a slight (even hardly perceptible) bloom that can easily be wiped off again with a soft cloth.
- Blistering: Not a single blister could be observed.
- Rusting: Not a single spot of corrosion was observed outside of the scribed lines.
- Resistance against under creep corrosion seems to be good since no under creep could be detected on any of the test plates.

Based on the above, again it can be concluded that Plascoat 571 ES has good resistance against immersion and/or high humidity environments.
Also, from the test results as mentioned under par. 3.2.1.2. it can be concluded that adhesion is not affected by immersion- or high humidity exposure.

3.4. UV-Test – 500 hours of QUV-B exposure

3.4.1. Test set-up

In order to verify Plascoat 571 ES's resistance against UV-exposure, several test panels were exposed to the following alternating environment:

- 6 hours of QUV-B radiation
- 6 hours of condensation

3.4.2. Evaluation

After the test, the difference in colour and gloss was measured and the plates were also observed visually.
Colour was measured in Cie L*a*b*-units using D65 10 ° / A 10 ° / F11 10 ° -light sources.
Gloss was measured according to ISO 2813.

3.4.3. Test results

Panel ID	Gloss % @ 60°		Colour measurement			
	Before	After	ΔE* (D65-10°)	ΔE* (A-10°)	ΔE* (F11-10°)	CMC ΔE
02-R-P-15-110	80,00	86,40	1,33	1,45	1,51	**1,52**
04-R-P-08-110	76,60	88,20	0,55	0,58	0,63	**0,62**
06-R-S-08-110	78,70	86,10	0,99	1,09	1,16	**1,22**
08-R-S-15-110	81,00	85,30	1,11	1,28	1,32	**1,46**
11-R-P-15-475	80,80	87,50	1,22	1,08	1,07	**0,85**
12-R-P-08-475	87,40	87,70	0,77	0,62	0,64	**0,56**
14-R-S-15-475	86,40	87,40	1,23	1,00	1,04	**0,91**
15-R-S-08-475	86,70	88,70	0,92	0,75	0,76	**0,66**
18-R-P-08-654	79,30	88,00	0,26	0,24	0,27	**0,27**
20-R-P-15-654	80,10	85,50	0,17	0,13	0,17	**0,20**
22-R-S-15-654	80,90	80,80	0,14	0,08	0,11	**0,17**
24-R-S-08-654	82,20	86,80	0,25	0,21	0,25	**0,24**
26-R-P-08-700	76,00	81,30	0,47	0,47	0,47	**0,38**
27-R-P-15-700	80,30	80,10	0,51	0,52	0,51	**0,38**
29-R-S-15-700	79,90	80,20	0,16	0,16	0,16	**0,13**
31-R-S-08-700	80,70	83,00	0,59	0,59	0,59	**0,45**

3.4.4. Conclusions

- Right after UV-testing a (hardly perceptible) slight whitish bloom could be observed on the green, grey & black test plates. We are assuming this also occurred on the white test panels but this could not be observed because of identical colours.
- This bloom was easily removed by wiping with a soft cloth, which also led to the slightly higher measured gloss after immersion testing.
- The white test panels have discoloured most and showed (only very light) discolouration into the direction of light blue. However, the ΔE-value is certainly still acceptable.
- The other colours showed even less discolouration with the grey & black colours best resistant to discolouration from UV-exposure.
- The colour differences after 500 hours QUV are certainly acceptable for all 4 colours (normally, a ΔE of 3 is allowed).

4. Conclusions

After this series of laboratory performance tests, one can conclude the following:

- Plascoat 571 ES is not affected by immersion nor by UV-exposure during the tests executed.
- Neither adhesion, nor appearance is affected by any of the tests performed.
- Resistance to corrosion and under creep corrosion is also good to excellent during the tests that were performed.
- The tests executed did not show any significant difference in performance between phosphated steel panels and sandblasted steel panels. Some extra performance (especially adhesion-wise) could probably be achieved by providing for a higher anchor pattern than was the case on the blasted test panels.

Therefore, applications where Plascoat 571 ES is applied properly onto well prepared surfaces (as per the Technical Data Sheets), can be allotted at least the following feasible Insurance Backed Guarantee periods (1):

Environment (2)	Guarantee periods
C1	10 years (3) (4)
C2	10 years (3) (4)
C3	10 years (3) (4)
C4	10 years (3) (4)
C5-I	5 years (3)
C5-M	5 years (3)

Remarks:

(1) See ISO 12944 for the definition of expected durability, lifetime, guarantee time, …
(2) According to ISO 12944.
(3) 10 years is the normal maximum achievable Insurance Backed Guarantee period. This does not imply that expected life cycles would only be 10 years. Based on the test results, life cycles (until first maintenance) of higher than 10 years can certainly be expected.
(4) Note that some insurance companies may offer a maximum of 10 years of Insurance Backed Guarantee in 2 periods of 5 years (with a required intermediate follow-up inspection).
(5) The fact that, at present, only 5 years of Insurance Backed Guarantee is allotted to C5-I and C5-M environments does not imply that expected service life would not be longer. Extrapolation for longer-term guarantee periods in such environments would imply more severe testing (as per ISO 12944).
(6) We highly advise the use of ISO 12944 in all of its aspects (prediction of expected durability, design considerations, classification of environments, surface preparation, coating application, quality inspection, specification writing, etc.) for optimal corrosion protection results when using any kind of corrosion resistant coating.

5. Photos

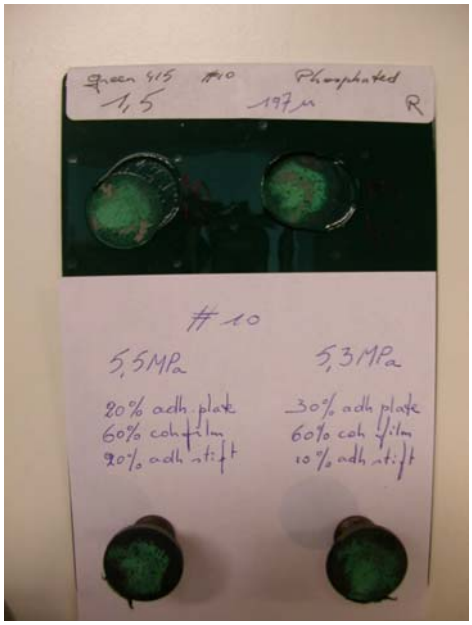

Photo 01

Sample plate # 10-R-P-15-475:
Dolly pull-off test before immersion.

Photo 02

Sample plate # 23-R-S-15-654:
Dolly pull-off test before immersion test.

Photo 03

Sample # 22-R-S-15-654:
Dolly pull-off test after QUV test.

Photo 04

Sample # 10-V-P-15-475:
Adhesion tests (scribing tool & dolly pull-off test) after immersion.

Photo 05

Sample # 07-V-S-15-110:
General evaluation after immersion exposure:

- No corrosion on coated surfaces (except in scribe and only very limited)
- No blisters
- No under creep corrosion at scribes

6. Annex

1) Elcometer batch numbers : F1 to F82 (in our file – available upon request)