SUPERIOR PRODUCTS INTERNATIONAL II, INC.

10835 W. 78th St. Shawnee, KS 66214

LABORATORY TESTING OF RUST GRIP® ULVOC COATING SYSTEM AS PER ISO 12944-6 IN COMPLIANCE WITH PDO SP-1246 FOR PCS-1A AND CORROSIVITY CATEGORY C5H

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EXECUTIVE SUMMARY

This report details the findings of a study conducted by Charter Coating Service (2000) Ltd. for Superior Products International II, Inc. The objective of this study was to qualify the performance of Rust Grip® ULVOC coating product according to PDO's external coating system PCS-1A for uninsulated carbon/low alloy steel structure at ≤ 120℃ and harsh atmospheric environment. The test was performed as per PDO SP-1246 "Specification for Painting and Coating of Oil and Gas Production Facilities" in compliance with ISO 12944-6 "Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 6: Laboratory performance test methods" for corrosivity category C5H. The submitted Rust Grip® ULVOC is a tough, one-part, moisture-cure polyurethane coating that absorbs atmospheric moisture to cure. Results obtained are summarized below and given in Tables 1 and 2.

Ageing Resistance as per ISO 12944-6:2018 Annex B

No blistering, rusting, cracking, or flaking was observed on any test panel. The average corrosion creep from the scribe line was 2.4 mm, meeting the requirement of corrosion at scribe less than 3.0 mm as average value. The pull-off adhesion strength after 7 days of post-test conditioning was 1366 psi/9.4 MPa to 2505 psi/17.3 MPa with mainly cohesive failure and it met the requirement of minimum pull-off value of 2.5 MPa for each measurement.

Non-volatile Matter Content by Mass as per ISO 3251

The non-volatile matter content of the Rust Grip® ULVOC coating (Batch No.: 071817MT) was 47.5 % by mass.

Density as per ISO 2811

The density of the Rust Grip® ULVOC coating (Batch No.: 071817MT) was 1.34 g/cm^3.

Ash Content as per ASTM D817

The ash content of the Rust Grip® ULVOC coating (Batch No.: 071817MT) was 23.8 %.

FTIR Analysis as per ASTM E1252

The FTIR spectrum of the Rust Grip ® ULVOC coating (Batch No.: 071817MT) showed characteristic absorption bands of naphtha, parachlorobenzotrifluoride and diphenylmethane.

SUMMARY OF RESULTS

Table 1. Ageing Resistance of Rust Grip® ULVOC Coating System as per ISO 12944-6:2018 Annex B

Test Method	Test Conditions	Acceptance Criteria	Test Results
Ageing Resistance ISO 12944-6:2018 Annex B	➢ **Total Test Duration**: 10 Cycles (1680 hours) ➢ **Artificial Damage:** A horizontal scribe (50 mm × 2 mm) as per ISO 12944-6:2018, Annex A ➢ **Step 1** - UV and Condensation as per ISO 16474-3:2013 • 4 hrs exposure to UV at 60 °C and 4hrs condensation at 50 °C • Duration: 72 Hours ➢ **Step 2** - Neutral Salt Spray as per ISO 9227:2017 • Temperature: 35 ± 2 °C • pH (Collected Solution): 6.5 to 7.2 • Atomization Rate: 1.5 ± 0.5 ml/hr • Duration: 72 Hours • **Note**: Between the salt spray and low temperature exposure, rinse the panels with DI water, but do not dry them. ➢ **Step 3** - Exposure to Low Temperature • Temperature: -20 ± 2 °C • Duration: 24 Hours	**ISO 12944-6:2018 Table 4** *Immediately after the test* ➢ Blistering (ISO 4628-2): 0 (S0) ➢ Rusting (ISO 4628-3): Ri 0 ➢ Cracking (ISO 4628-4): 0 (S0) ➢ Flaking (ISO 4628-5): 0 (S0) ➢ Corrosion at Scribe: M ≤ 3.0 mm as average value *After 7 days conditioning at 23 ± 2 °C and 50 ± 5 % RH* ➢ Pull-off Adhesion (ISO 4624) • Minimum pull-off value of 2.5 MPa for each measurement. • 0 % adhesive failure between carbon steel/metalized steel respectively and the first coat (unless pull-off values are at least 5 MPa).	• No blistering, rusting, cracking, or flaking was observed on any test panel. • Corrosion creep (M) from the scribe line: ➢ AR-4: 2.5 mm ➢ AR-5: 2.7 mm ➢ AR-6: 2.1 mm ➢ Average of 2.4 mm • Pull-off adhesion after 7 days conditioning: ➢ AR-4: 1751 psi/12.1 MPa to 2063 psi/14.2 MPa, averaged 1906 psi/13.1 MPa, mainly cohesive failure mode ➢ AR-5: 1526 psi/10.5 MPa to 1698 psi/11.7 MPa, averaged 1612 psi/11.1 MPa, mainly cohesive failure mode ➢ AR-6: 1366 psi/9.4 MPa to 2505 psi/17.3 MPa, averaged 1919 psi/13.2 MPa, mainly cohesive failure mode

Pre-test pull-off adhesion: 1216 psi/8.4 MPa to 1379 psi/9.5 MPa, averaged 1308 psi/9.0 MPa, mainly cohesive failure mode.
Note: Blisters which were observed only along the scribe line are due to corrosion undercreep.

Table 2. Fingerprint of Rust Grip ® ULVOC Coating System as per ISO 12944-9:2018 Annex C

Test Method	Test Conditions	Acceptance Criteria	Coating Name	Test Results	
FTIR Analysis ASTM E1252	N/A	Report the results	Rust Grip® ULVOC (Batch No.: 071817MT)	Fingerprint Spectra Reported in Figure 4	
Non-volatile Matter (by Mass) ISO 3251	➢ **Temperature**: 125 ºC ➢ **Duration**: 60 mins	Meets manufacturer's specification within ±2 %		47.2 % 47.8 %	Average of 47.5 %
Density ISO 2811	N/A	Meets manufacturer's specification within ± 0.05 g/cm^3		1.34 g/cm^3 1.33 g/cm^3 1.34 g/cm^3	Average of 1.34 g/cm^3
Ash Content ASTM D817	➢ **Temperature**: 600 ºC ➢ **Duration**: 3 hours	Meets manufacturer's specification within ± 3 %		23.9 % 23.7 % 23.7 %	Average of 23.8 %

INTRODUCTION

At the request of Superior Products International II, Inc, Charter Coating Service (2000) Ltd. conducted laboratory testing to evaluate the performance of the Rust Grip® ULVOC coating product according to PDO's external coating system PCS-1A for uninsulated carbon/low alloy steel structure at ≤ 120 °C and harsh atmospheric environment. The test was performed as per PDO SP-1246 "Specification for Painting and Coating of Oil and Gas Production Facilities" in compliance with ISO 12944-6 "Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 6: Laboratory performance test methods" for corrosivity category C5H.

Rust Grip® ULVOC is a single component polyurethane and moisture cure coating, which is loaded with aluminum pigment for strength and is also resistant to chemical solvents and acid splash. It can be used as a primer or as a one-coating system. The report is divided into sections, with each test constituting a different section.

OBJECTIVE

The objective of the study was to evaluate the performance of the Rust Grip® ULVOC coating product when tested in accordance with the requirements of PDO SP-1246 "Specification for Painting and Coating of Oil and Gas Production Facilities" for coating system PCS-1A and corrosivity category C5H.

SCOPE

The scope of this study was as follows:

- Superior Products International II, Inc provided the Rust Grip® ULVOC coating product (Batch No.: 071817MT) and submitted the coated panels.
- The client specified the tests as per PDO SP-1246 in compliance with ISO 12944-6 for C5H.
- Charter Coating Service (2000) Ltd. performed the laboratory testing according to PDO SP-1246 "Specification for Painting and Coating of Oil and Gas Production Facilities" for coating system PCS-1A .

AGEING RESISTANCE

The outdoor corrosion of painted metals is influenced by many factors, including corrosive atmospheres, rain, condensed dew, UV light, wet/dry cycling, and temperature cycling. These factors frequently have a synergistic effect on one another. The aging resistance test is an accelerated laboratory test to provide a practice to simulate more realistically weathering environments for the interactions of these factors and has been used to produce relative corrosion resistance information for coated metals. In this test, the coating is exposed to alternating conditions of UV/condensation, salt spray, and low temperature. The changes in performance of the specimens is used to evaluate how well the coating can mitigate undercreep corrosion, and maintain its initial physical and mechanical properties, under the test conditions. The objective of this test was to evaluate the ageing resistance of Rust Grip® ULVOC coating system under the test conditions.

METHODOLOGY

The ageing resistance test was conducted according to ISO 12944-6:2018, Annex B. The samples were exposed to cyclic weathering, with one cycle consisting of 72 hours exposure to UV/condensation, 72 hours exposure to salt spray, and 24 hours exposure to low temperature as shown below. Sample size was (3" × 6").

Note that the UV/condensation exposure was conducted in accordance with ISO 16474-3:2013, Table 4, Method A, Cycle No. 1, which is the active standard that has replaced the withdrawn standard ISO 11507:2007, Method A, that is referenced in ISO 20340:2009 Annex A. Samples were placed in a UV/condensation tester equipped with UVA-340 lamps, and rearranged at periodic intervals during the test, to mitigate any potential variation in exposure conditions within the test chamber. The 72 hours exposure consists of alternating periods of 4 hours exposure to UV radiation and 4 hours exposure to condensation, according to the following test parameters:

1) UV and Condensation as per ISO 16474-3:2013

- 4 hours UV at 60 °C/140 °F and 4 hours condensation at 50 °C/122 °F
- Duration: 72 hours

Following the UV/condensation exposure, the samples were transferred to a salt spray test chamber, and salt spray testing was conducted in accordance with the ISO 9227:2017. The samples were set at a 25° angle from the vertical position parallel to the principal direction of flow of spray through the chamber and were rearranged at periodic intervals during the test to mitigate any potential variation in exposure conditions within the test chamber.

2) Salt Spray in accordance with ISO 9227:2017

- Temperature: (35 ± 2) °C / (95 ± 3) °F
- Salt Solution Composition: 5 % NaCl in deionized water, pH 6.5 – 7.2 after collection
- Atomization Rate: (1.5 ± 0.5) ml of solution per hour
- Duration: 72 hours

Following the salt spray exposure, the panels were rinsed with deionized water to remove any salt deposits, and were transferred, without drying, into a freezer for the low temperature exposure, according to the following test parameters:

3) Exposure to Low Temperature

- Temperature: (-20 ± 2) °C / (-4 ± 3) °F
- Duration: 24 hours

At the completion of the low temperature exposure, the samples were returned to the UV/condensation test chamber to begin the second cycle. The panels were exposed to the artificial weathering for a total of 10 cycles (1680 hours).

After test completion, the samples were examined as per ISO 12944-6:2018, Table 4. The panels were visually examined for blistering as per ISO 4628-2:2016, rusting as per ISO 4628-3:2016, cracking as per ISO 4628-4:2016, flaking as per ISO 4628-5:2016, and corrosion along the scratch as per ISO 4628-8:2016. The samples were then conditioned in an Environmental Chamber for 7 days at 23 °C/73 °F and 50 % RH before conducting the pull-off adhesion test.

After conditioning, the pull-off adhesion test was conducted as per ISO 4624:2016 Method B. A portable pull-off adhesion tester (PATTI Quantum Gold with F-20 piston) was used. The test was performed by first cleaning the surface of the test area using a fine abrasive (400 grit) and Scotch tape to remove loose

or weakly adhered surface contaminants. Then a loading fixture (dolly) normal (perpendicular) to the surface of the coating was secured with an adhesive (3M™ Scotch-Weld™ Epoxy Adhesive DP460NS). The size of pull-stub dolly was 0.5″ in diameter. After the adhesive was cured, the testing apparatus was then attached to the loading fixture and aligned to apply tension normal (perpendicular) to the test surface. The force applied to the loading fixture was then gradually increased at a rate of ≤ 1 MPa/s such that failure of the test assembly occurred within 90 s. The process was monitored until either a plug of coating material was detached, or there was failure of the glue on the dolly. The maximum pressure attained was automatically recorded. When a plug of material was detached, the exposed surface represented the plane of limiting strength within the system. The nature of the failure was qualified in accordance with the percent of adhesive and cohesive failures, and the actual interfaces and layers involved.

RESULTS

No blistering, rusting, cracking, or flaking was observed on any test panel. The average corrosion creep from the scribe line was 2.4 mm. The pull-off adhesion strength after 7 days of post-test conditioning was 1366 psi/9.4 MPa to 2505 psi/17.3 MPa with mainly cohesive failure. The results are shown in Figures 1 to 3 and given in the data sheet at the end of this section.

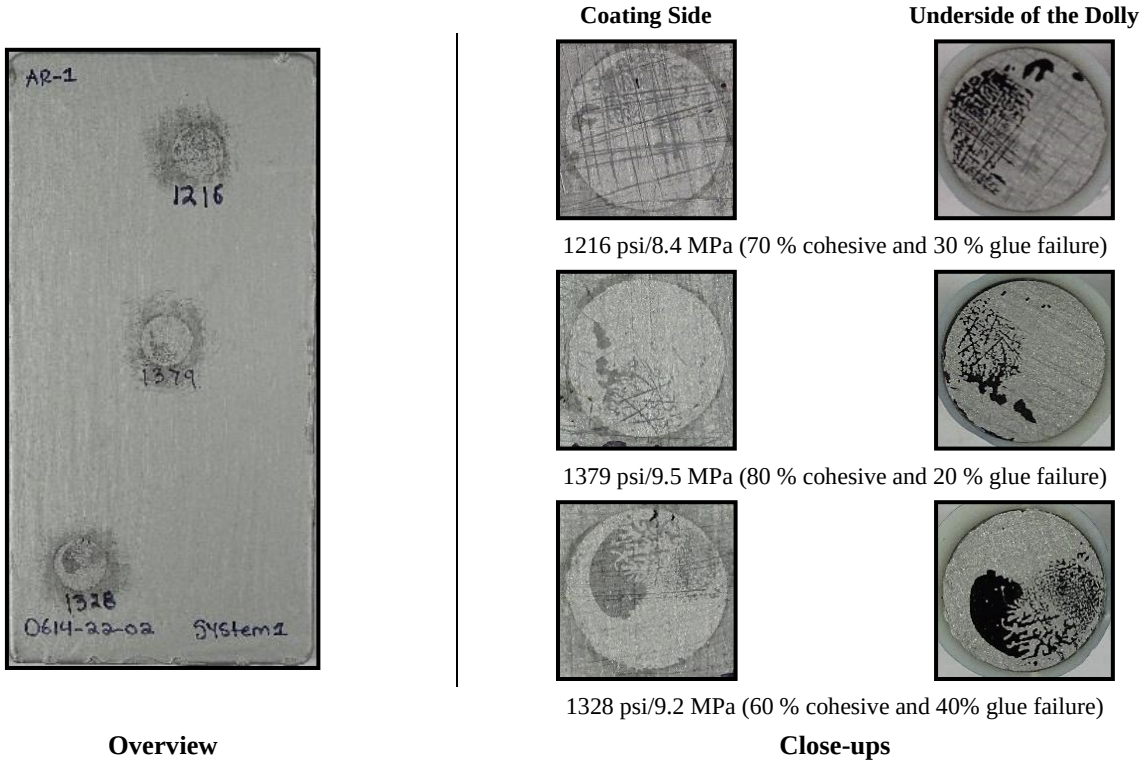

Figure 1. Pull-off Adhesion Pre-test Photos of *Rust Grip® ULVOC* Coating System

The pre-test pull-off adhesion strength of the coating system was 1216 psi/8.4 MPa to 1379 psi/9.5 MPa (average 1308 psi/9.0 MPa) with the fracture mode of mainly cohesive failure.

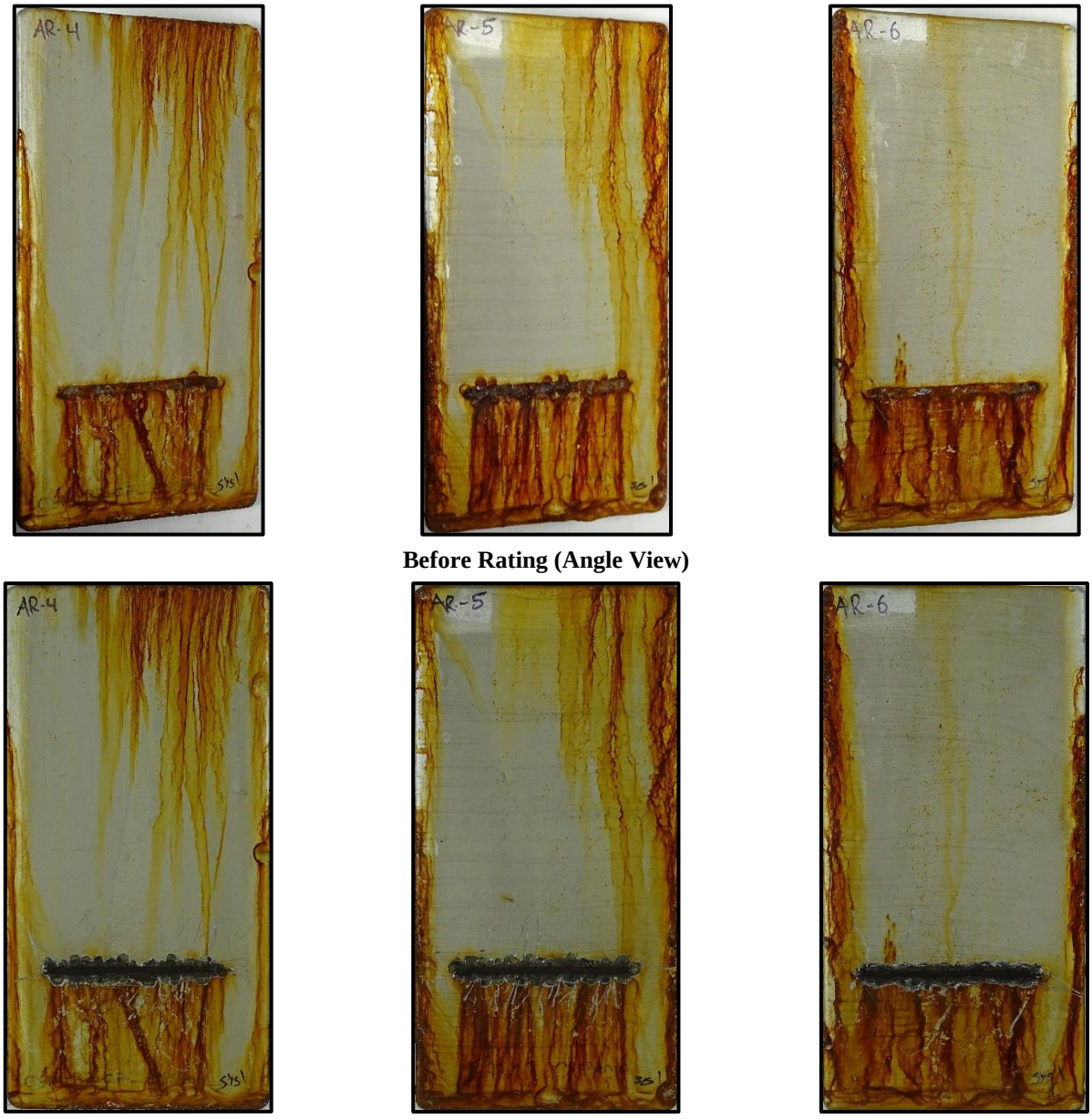

Figure 2. Post-test Photographs of *Rust Grip® ULVOC* Coating System after 1680 Hours (10 Cycles) of Ageing Resistance as per ISO 12944-6:2018 Annex B

Figure 2 shows the post-test photographs of Rust Grip® ULVOC coating system after 1680 hours of ageing resistance as per ISO 12944-6:2018 Annex B. The coating system showed no blistering, rusting, cracking or flaking on any test panel. The corrosion creep (M) from the scribe lines were 2.5 mm, 2.7 mm and 2.1 mm for panels AR-4, AR-5 and AR-6 respectively.

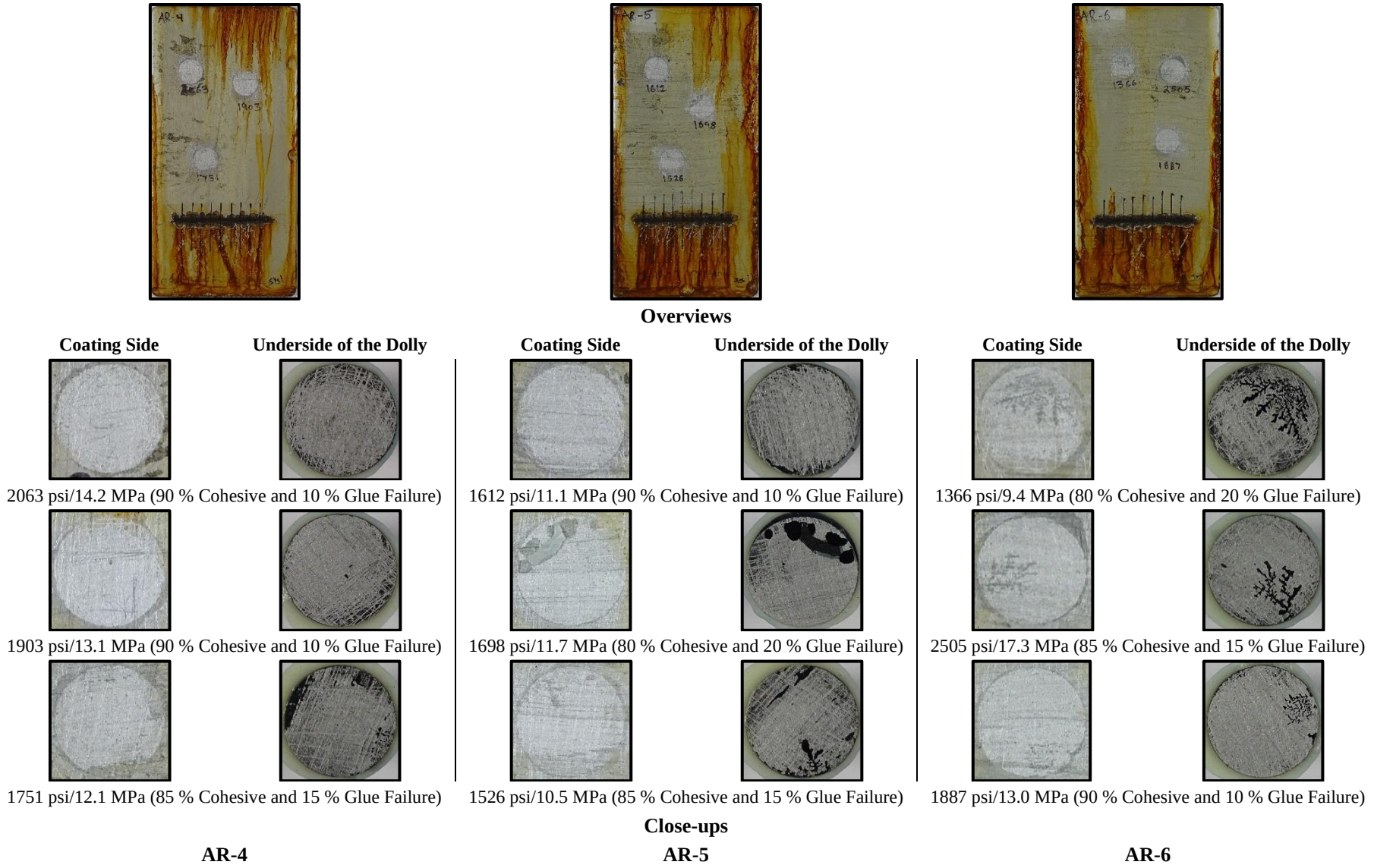

Figure 3. Pull-off Adhesion Post-test Photos of *Rust Grip® ULVOC* Coating System after 1680 Hours (10 Cycles) of Ageing Resistance Test and Rating Followed by 7 Days of Conditioning at 23 °C/73 °F and 50 % RH as per ISO 4624:2016

The post-test pull-off adhesion strengths for panels AR-4, AR-5 and AR-6 were 1751 psi/12.1 MPa to 2063 psi/14.2 MPa (average 1906 psi/13.1 MPa), 1526 psi/10.5 MPa to 1698 psi/11.7 MPa (average 1612 psi/11.1 MPa) and 1366 psi/9.4 MPa to 2505 psi/17.3 MPa (average 1919 psi/13.2 MPa) respectively, with the fracture mode of mainly cohesive failure.

CHARTER COATING SERVICE (2000) LTD.
AGING RESISTANCE DATA SHEET
(ISO 12944-6:2018 Annex B)

Project Number:	0614-22-02-1	**Visual Evaluation Date:**	October 28th, 2022
Coating Name:	Rust Grip® ULVOC	**Pull-off Evaluation Date:**	November 4th, 2022
Test Performed By:	I. Stevens	**Total Hours of Exposure:**	1680

Sample #	Pre-Test	Post-Test						
	Film Thickness (mils) Min-Max/Avg	Film Thickness (mils) Min-Max/Avg	Blistering	Rusting	Cracking	Flaking	Corrosion creep (mm)[1]	Pull-off Adhesion[2,3]
AR-4	11.6 – 14.8 / 12.6	4.8 – 6.9 / 6.1	None*	Ri 0	None	None	2.5	2063 psi/14.2 MPa**
								1903 psi/13.1 MPa**
								1751 psi/12.1 MPa**
AR-5	5.6 – 11.0 / 8.0	6.3 – 8.5 / 7.5	None*	Ri 0	None	None	2.7	1612 psi/11.1 MPa**
								1698 psi/11.7 MPa**
								1526 psi/10.5 MPa**
AR-6	4.9 – 8.8 / 7.2	5.9 – 8.2 / 6.9	None*	Ri 0	None	None	2.1	1366 psi/9.4 MPa**
								2505 psi/17.3 MPa**
								1887 psi/13.0 MPa**

[1] The uncertainty of the creep measurement is ± 0.033 mm; [2] Post-test panels conditioned for 7 days at (23 ± 2) °C and (50 ± 5) % RH; [3] Pull-off adhesion as per ISO 4624;
* Blisters which were observed only along the scribe line are due to corrosion undercreep; ** The fracture mode was mainly cohesive failure.

Post Test Evaluation Acceptance Criteria Rating Keys:

Blistering as per ISO 4628-2					
Size				Density	
S2	S3	S4	S5	Few	2
Small → Large					3
				Dense	4
					5

Rusting as per ISO 4628-3	
Degree of rusting	Rusted Area, %
Ri 0	0
Ri 1	0.05
Ri 2	0.5
Ri 3	1
Ri 4	8
Ri 5	40 to 50

Cracking as per ISO 4628-4	
Rating	Quantity of Cracks
0	None
1	Very Few
2	Few
3	Moderate number of cracks
4	Considerable number of cracks
5	Dense pattern of cracks

Flaking as per ISO 4628-5	
Rating	Flaked Area, %
0	0
1	0.1
2	0.3
3	1
4	3
5	15

NON-VOLATILE MATTER CONTENT BY MASS

Non-volatile-matter content by mass is one of physical properties of a coating. The method is primarily intended for testing different batches of the same type of product as quality control. The results can also be used to compare the non-volatile-matter content for different coatings used for the same application, that is, to coat the same area to the same dry film thickness (assuming the same application efficiency). This information is useful to the coating producer and user and to environmental and health and safety interests in comparing the coverage of competing products and in estimating the volatile matter content.

The objective of this test was to assess the non-volatile matter content of the Rust Grip® ULVOC coating material.

METHODOLOGY

The non-volatile matter by mass test was conducted as per ISO 3251:2008. The clean and dry flat-bottomed aluminum test dish with inner diameter of base of 50 mm was weighed. About 1.0 g test portion was added onto the dish and weighed and distributed uniformly on the dish. Then the dish was weighed and transferred to the oven at 125 °C and kept in the oven for 60 minutes. When the period of heating was completed, the dish was transferred to the desiccator, allowed to cool to room temperature, and weighed.

The non-volatile matter content (NV) was calculated in a percentage by mass using the following equation:

$$NV = 100 \times (m_2 - m_0) / (m_1 - m_0)$$

where

m_0: the mass of the empty dish, g

m_1: the mass of the dish with the test portion, g

m_2: the mass of the dish with the residue, g

Duplicate samples were tested for the coating product. If the two results (duplicates) differed by more than 2 % (relative to the mean), the test would be repeated.

RESULTS

Results obtained are given in the attached data sheet on the following page. The non-volatile matter content of the Rust Grip® ULVOC coating (Batch No.: 071817MT) was 47.5 % by mass.

CHARTER COATING SERVICE (2000) LTD.
NON-VOLATILE-MATTER CONTENT DATA SHEET
(ISO 3251:2019)

Project Number:	0614-22-02-1	**Date:**	September 23rd, 2021
Type of Dish Used:	Aluminium Dish	**Type of Oven Used:**	Forced Air Oven
Temperature:	125 ℃	**Duration:**	60 minutes
Coating Name:	Rust Grip® ULVOC	**Test Performed By:**	S. Yin, I. Stevens

Sample ID	Mass of the Empty Dish and Cover, m_0 (g)	Mass of the Dish and Cover with the Test Portion, m_1 (g)	Mass of the Dish and Cover with the Residue, m_2 (g)	Non-Volatile-Matter Content, NV (%) *	
1	54.5720	55.5499	55.0332	47.2	Average of 47.5
2	54.5527	55.6585	55.0815	47.8	

*Two results should differ by less than 2 % to the mean (absolute) for paints, varnishes and binders or by less than 0.5 % for polymer dispersions.

Calculation:

$$\text{Non} - \text{Volatile} - \text{Matter Content Percentage, NV} = \frac{m_2 - m_0}{m_1 - m_0} \times 100$$

Where:

m_0 = Mass of the Empty Dish and Cover, g

m_1 = Mass of the Dish and Cover with the Test Portion, g

m_2 = Mass of the Dish and Cover with the Residue, g

DENSITY

The density of a paint is a property that is conventionally measured to identify a material, to follow physical changes in a sample, to indicate degree of uniformity among different sampling units or specimens, or to indicate the average gravity of a large item. Changes in gravity of a single material are due to localized differences in crystallinity, loss of additives, adsorption of solvent, or to other causes such as the differences in thermal history, porosity or/and composition. The objective of the test was to determine the density of the Rust Grip® ULVOC coating material.

METHODOLOGY

The density of the paint was measured according to ISO 2811-1:2016. A pycnometer was weighed and recorded the mass, m_1 to the 1 mg. Then the pycnometer was filled with the paint product, taking care to avoid the formation of air bubbles. A lid of the pycnometer firmly in position and wipe off any excess liquid from the outside of the pycnometer with an absorbent material wetted with solvent. The mass of the pycnometer filled with the paint product under test was recorded as m_2. The density ρ of the product in grams per cubic centimetre, using the following formula:

$$\rho = \frac{m_2 - m_1}{V_t}$$

Where

m_1 is the mass, in grams, of the empty pycnometer;

m_2 is the mass, in grams, of the pycnometer filled with the paint product at the test temperature;

V_t is the volume in cubic centimetres, of the pycnometer at the test temperature.

RESULTS

The results are given in the data sheet on the following page. The triplicate tests of density at 23 °C of the Rust Grip® ULVOC coating samples were 1.34 g/cm^3, 1.33 g/cm^3 and 1.34 g/cm^3. The average specific density of the Rust Grip® ULVOC coating product (Batch No.: 071817MT) was 1.34 g/cm^3.

CHARTER COATING SERVICE (2000) LTD.
DENSITY DATA SHEET
(ISO 2811-1:2016)

Project Number:	0614-22-02-1	**Date:**	November 5th, 2021
Temperature:	22.8 °C	**Test Performed By:**	D. Kuang & S. Yin
Coating Name:	Rust Grip® ULVOC		

Sample ID	**Mass of the Empty Pycnometer, m_1 (g)**	**Mass of the Pycnometer Filled with the Test Product, m_2 (g)**	**Volume of the Pycnometer, V (cm^3)**	**Density of the Test Product, ρ (g/cm^3)**	
1	4.1988	8.2235	3	1.342	Average of 1.336
2	4.1727	8.1610	3	1.329	
3	4.1524	8.1660	3	1.338	

Calculation:

$$\rho = \frac{m_2 - m_1}{V}$$

Where:

ρ = Density of the Test Product, g/cm^3

m_1= Mass of the Empty Pycnometer, g

m_2 = Mass of the Pycnometer Filled with the Test Product, g

V = Volume of the pycnometer, cm^3

ASH CONTENT

Ash content determines the percentage of the non-volatile inorganic matter of the coating that remains after subjecting it to high decomposition temperature. This relates to the mixing ratio of the base to hardener in the applied coating. This method is used to determine the proportion by weight of the coating sample under test that is left as a residue after ashing under the specified conditions. It includes inorganic pigments, extenders and other solid constituents of the coating sample which are not volatile under the test conditions; however, their state may have altered. The objective of the testing was to determine the ash content of the Rust Grip® ULVOC coating system.

METHODOLOGY

The ash content of the Rust Grip ® ULVOC coating system was determined as per modified ASTM D817-12. About 1 to 2 g sample (test portion) was weighed into a porcelain crucible. The crucible and sample were transferred to an oven set at 105 ± 2 ºC and conditioned for 2 hours. After conditioning, the crucible and sample were removed from the oven and cooled in a desiccator to room temperature. The crucible and sample were weighed and recorded. The crucible and sample were then placed in the muffle furnace and the content was incinerated at a temperature of 600 °C for 3 hours. After incineration, the crucible and sample were allowed to cool inside the muffle furnace to about 120 °C and then transferred to the desiccator to further cool to room temperature. The crucible and sample (ash) were weighed and recorded. The igniting, cooling and weighing were repeated until the difference between successive weightings did not exceed 1 mg. Triplicate samples were tested.

The ash (W_A) as a percentage by mass was calculated, using the following equation:

$$W_A = 100 \times m_1/m_0$$

where

m_1: the mass of the residue after ignition, g

m_0: the mass of the test portion, g

RESULTS

The test results are given in the below data sheet. The average ash content of the Rust Grip® ULVOC coating (Batch No.: 071817MT) was 23.8 %.

CHARTER COATING SERVICE (2000) LTD.
ASH CONTENT DATA SHEET
(ASTM D817-12 Modified)

Project Number:	0614-22-02-1	**Date:**	September 23rd, 2021
Temperature:	600 ºC	**Duration:**	3 hours
Coating Name:	Rust Grip® ULVOC	**Test Performed By:**	S. Yin & I. Stevens

Sample ID	Sample Used*, m_0 (g)	Ash, m_1 (g)	Ash Content (%)	
1	1.1233	0.2681	23.9	Average of 23.8
2	1.1456	0.2717	23.7	
3	1.1718	0.2771	23.7	

* Sample was dried at 105 ºC ± 3 ºC for 2 hours before weighing.

Calculation:

$$\text{Ash}, \% = \frac{m_1}{m_0} \times 100$$

Where:

m_1 = ash, g, and

m_0 = sample used, g

Approval Authority: Dr. Amal Al-Borno FM-505-00-283 Rev0 (2021-11-23)

FTIR ANALYSIS

Attenuated Total Reflectance - Fourier Transform Infrared Spectroscopy (ATR-FTIR) is used for analysis of coating microstructure such as functional groups by their characteristic absorption bands and their contents by the band intensity, therefore the coating material can be identified and/or quantitatively analyzed. In this project, ATR-FTIR was used to give the fingerprints of the Rust Grip® ULVOC coating material.

METHODOLOGY

A Perkin-Elmer Spectrum 100 FTIR with universal ATR accessory was used to record the IR spectrum of the coating powder and primer. The ATR crystal was a diamond/ZnSe prism. After a collection of the background spectrum, the coating material was dropped onto the ATR top plate. Then the samples were scanned over a range from 4000 cm^{-1} to 650 cm^{-1}, using scan number 20 and scan resolution 2 cm^{-1}. The collected spectrum was then analyzed.

RESULTS

The FTIR spectrum of the Rust Grip® ULVOC coating (Batch No.: 071817MT) showed characteristic absorption bands of naphtha, parachlorobenzotrifluoride and diphenylmethane. The FTIR spectrum of the Rust Grip® ULVOC coating is shown in Figure 4.

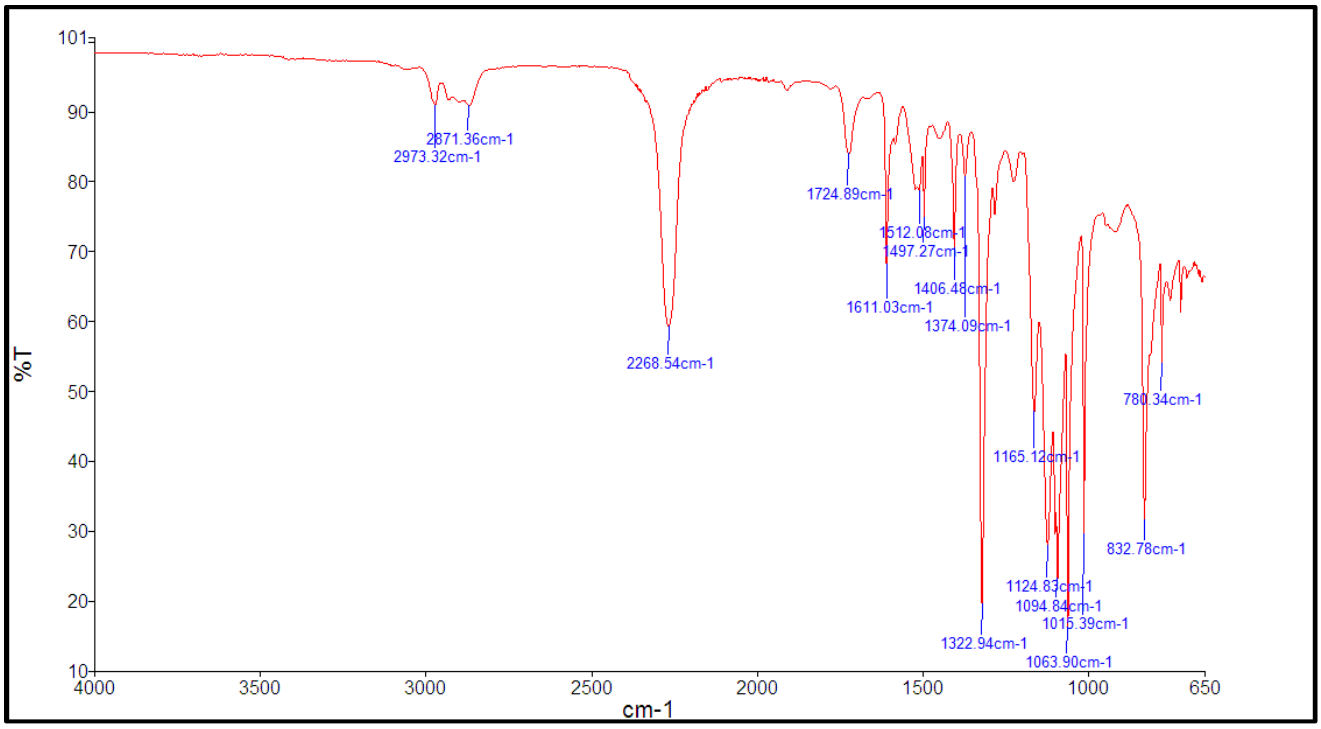

Figure 4. ATR-FTIR Spectrum of *Rust Grip® ULVOC* Coating System as per ASTM E1252

Figure 4 shows the FTIR spectrum of the Rust Grip® ULVOC coating. The FTIR spectrum of the peaks at 2973 cm^{-1}, 2871 cm^{-1}, 1374 cm^{-1}, 1095 cm^{-1} and 1064 cm^{-1} indicated the presence of solvent naphtha. The absorption bands at 780 cm^{-1}, 833 cm^{-1} and in the range of 1124 cm^{-1} to 1226 cm^{-1} are the main characteristic peaks of parachlorobenzotrifluoride. The absorption bands at 1611 cm^{-1}, 1497 cm^{-1} and 1015 cm^{-1} are the main characteristic peaks of diphenylmethane.

REVISION HISTORY

Revision Level	Revision Date	Revised by	Brief Description of Revision
Rev0	December 2nd, 2022	Skye Yin	Final Report
Rev01	December 8th, 2022	Skye Yin	Revised blistering assessment
Rev02	December 2nd, 2024	M. Stefanelli	Added Corrosivity Category: C5H

-END OF FINAL REPORT-