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Czech Republic

Department of Evaluation and Testing
Testing Laboratory No. 1105.2 accredited by CAI according to ČSN EN ISO/IEC 17025:2018

TEST REPORT
T 370/089

Name and contact information of the customer	Ing. František Koch , Rašínovo nábřeží 389/46, CZ 128 00 Praha 2, Nové Město, The Czech republic
Test item(s)	Protective coating system for steel Steel test sheet painted with a two-layer protective coating system. For detailed information see page 2 of protocol
Test procedure/method	APP1– Determination of the degree of degradation of coatings –(ČSN EN ISO 4628- 2, 3, 4, 5, 8) Test No. 3 – Determination of film thickness ČSN EN ISO 2808, Method 7B.2 Test No. 7 – Determination of resistance to salt spray ČSN EN ISO 9227NSS Test No. 16 – Cross-cut test - ČSN EN ISO 2409 Test No. 18: Pull – off test of adhesion - ČSN EN ISO 4624
Date of receipt of item(s)	January, 19, 2021
Internal laboratory number	21 0108
Date of the test	January, 27, 2021 – March, 8, 2031
Tested by	Jana Pilařová, Ing. Eva Kašparová
The report made by	František Herrmann, Ph.D.

This test report contains 7 pages and 3 annexes.



In Pardubice on March, 17, 2022

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Dr. Vladimír Špaček
Head of testing laboratory

The test results relate only to the test item(s) as received.
This test report by itself in no way constitutes or implies product approval by any other body.
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DESCRIPTION OF THE TEST ITEM

Test item ¹	Two layers coating system for steel substrates
Item form:	Steel panels with applied protective system
Coating system specification:	Protective coating system with a total nominal thickness (NDFT) of 160 µm, applied on a steel substrate
Substrate material:	Steel test panel made of structural steel S 235 according to ČSN EN 10025-2 with dimensions 150 mm x 100 mm x 2 mm.
Primer:	<u>Anti-corrosion paint, Patent No. 309009</u> NDFT 30 - 50 µm
Top coat:	<u>TIKKURILA® TEMADUR 10 + Hardener 7590</u> 2K-PUR Paint, NDFT 110 - 130 µm.
Test item preparation:	Test items (coated specimens) were made by the customer. Paints were applied by brush according to the specification of the coating system in two layers.
Receipt of samples:	The samples were delivered in person by the client on 19 January 2021.
Pre-Exam Handling:	The samples were not cleaned, thermally stressed or otherwise surface treated in any way prior to the test.
Conditioning of samples before test:	Samples before the corrosion test were stored in conditions for preparation and conditioning of coatings according to ČSN EN 23270.
Internal Lab code:	21 0108
Data supplied by the customer ¹	¹ The Laboratory is not responsible for the data supplied by the customer.

TEST PROCEDURE / METHOD

Test No. 3 – Determination of coating thickness

Test method identification:	ČSN EN ISO 2808 – Paint and varnishes – Determination of film thickness
Procedure:	7B.2 – non-destructive method of magnetic induction
Gauge:	Model 456 ((Elcometer, Ltd., Great Britain)
Calibration:	Two point calibration, performed before the measurement.
Calibration standard used:	384 µm ± 1%; (No 2156, Unimetra s.r.o., Czech republic).
Substrate for calibration:	Steel sheet, degreased, of 3 mm thickness
Number of measurements:	6 measurements on each test specimen.
Date of test:	January, 27, 2021
Deviation from procedure::	Any

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RESULTS

Internal Lab code	Dry film thickness in μm								
	1	2	3	4	5	6	Mean	Max	Min
21 0108/1	142	113	176	195,	95,5	237	160 \pm 53	237	96
21 0108/2	197	154	204	120	176	240	182 \pm 42	240	120
21 0108/3	161	296	112	81,8	177	80,6	151 \pm 81	296	81
21 0108/4	218	317	332	267	293	84,9	252 \pm 91	332	85
21 0108/5	280	323	379	300	279	376	323 \pm 45	379	279
21 0108/6	226	210	180	235	179	231	210 \pm 25	235	179
21 0108/10	267	162	216	175	179	334	222 \pm 67	334	162
21 0108/11	116	140	120	150	138	163	138 \pm 18	163	116

TEST PROCEDURE / METHOD

Test No. 16 - Cross-cut test

Test method identification: *ČSN EN ISO 2409 – Paints and varnishes – Cross-cut test*
 Cross-cut temple: ZCT 2160 (Zehntner GmbH Testing Instruments, Switzerland)
 Making cuts: The cuts were made manually.
 Cutting tools: Single-blade cutting tools and guiding edges
 Cut spacing: 3 mm according to standard specification (see art. 6.1.4 of ČSN EN ISO 2409);
 Procedure for removing loose paint: Adhesive tape was firmly attached to the grid by rubbing the tape firmly with fingertip. After, the tape was removed by grasping the free end and pulling it off steadily.
 Adhesive tape: Tesapack[®] 4657, width of 50 mm
 Adhesion strength: 4,6 N/1 cm
 Date of test: Before exposure and after exposure under salt spray test
 Any deviation from the test procedure: Any

RESULTS OF CROSS-CUT TEST ACCORDING TO ČSN EN ISO 2409

Sample exposure	Test panel laboratory number	Classification of test results according Table 1 of standard						
		Place A	Place B	Place C	Mean	Cuts spacing	Method	A place of separation
w/o exposure	21 0108/11	0	0	0	0	3 mm	1c	-
Salt spray 720 hours	21 0108/1-3	0	0	0	0	3 mm	1c	-

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TEST PROCEDURE / METHOD

APP 1 Determination of the degree of degradation of coatings

Test method identification: *ČSN EN ISO 4628 - Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance*

Part 2: *Assessment the degree of blistering*

Part 3: *Assessment the degree of rusting*

Part 4: *Assessment the degree of cracking*

Part 5: *Assessment the degree of flaking*

Part 8: *Assessment the degree of delamination and or corrosion around a scribe or other artificial defect.*

Handling samples: Samples were washed gently with lukewarm water and let dry before evaluation.

Lighting Day light used in the evaluation of defect.

Standard observation: The observation angle 0° / light incidence of angle 45°.

Assessed spots: All areas up to 10 mm from the edges

Test date: After exposure to salt spray test and after removal of the paint film

Any deviation from the test procedure: Any

Classification scheme for the size and density of defects in accordance with Table 1, Table 2 and Table 3 of ČSN EN ISO 4628-1

Classification	Table 1	Table 2	Table 3
	Density of defects	Size of defects	Intensity of uniform change
0	None, i.e. no detectable defects	Not visible under x 10 magnification	W/o changes, i.e. any recognizable change
1	Very few, i.e. small, barely significant number of defects	Only visible under magnification up to x 10	Very small, just recognizable change
2	Few, i.e. small but significant number of defects	Just visible with normal corrected vision (up to 0,2 mm)	A small, clearly recognizable change
3	Moderate number of defects	Clearly visible with normal corrected vision (larger then 0,2 mm, up to 0,5 mm)	Moderate, very clearly recognizable change
4	Considerable number of defects	larger then 0,5 mm, up to 5 mm	Large, i.e. significant change
5	Dense pattern of defects	Larger than 5 mm	Very significant change

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TEST PROCEDURE / METHOD

Test No. 7 - Determination of resistance to salt spray (NSS)

Test method specification: *ČSN EN ISO 9227 - Corrosion tests in artificial atmospheres – Salt spray test*

Method: *Neutral salt spray test (NSS tests)*

Testing equipment: Automatically operated corrosion chamber Q-FOG o 1100 liters volume (Q-Lab Corporation, Ltd., USA)

Chemicals: Sodium chloride, p. a.
 Distilled water with conductivity lower than 20 μS/cm

Temperature in chamber: (35 ± 2) °C

Concentration of salt solution: (50 ± 5) g/l

Stocked salt solution: pH 6,5 – 7,2

Collected salt solution|: pH 6,5 – 7,2

Speed of solution accumulation: (1,5 ± 0,5) ml of solution per 1 hour and an area of 80 cm²

Corrosion aggressiveness of chamber: (70 ± 20) g/m² per 48 hours. It meets the requirements of paragraph 7.5 of ČSN EN ISO 9227 standard.

Sample position in chamber: fixed in an non-corrosion stand under the angle of (20 ± 5)° from the vertical line

Sample repositioning: the position of sample during the test was not changed

Duration of test: 480 hours

Date of test: January, 29, 2021 – March, 1, 2021

Deviation from the procedure: Any

RESULTS –ASSESSMENT OF CORROSION DEFETS ACCORDING TO ČSN EN ISO 4628 DURING THE EXPOSURE UNDER NEUTRAL SALT SPRAY TEST ACCORDINMG TO ČSN EN ISO 9227 NSS

Duration of exposure	Internal laboratory number	Blistering in area	Rusting	Cracking	Flaking	Delamination at scribe
		ČSN EN ISO 4628/2	ČSN EN ISO 4628/3	ČSN EN ISO 4628/4	ČSN EN ISO 4628/12	ČSN EN ISO 4628/8
		Degree	Degree	Degree	Degree	(mm)
480 hours	21 0108/1	0 (S0)	Ri 0	0 (S0)	0 (S0)	< 0,5 mm
	21 0108/2	0 (S0)	Ri 0	0 (S0)	0 (S0)	< 0,5 mm
	21 0108/3	0 (S0)	Ri 0	0 (S0)	0 (S0)	< 0,5 mm
720 hours	21 0108/1	0 (S0)	Ri 0	0 (S0)	0 (S0)	< 1 mm
	21 0108/2	0 (S0)	Ri 0	0 (S0)	0 (S0)	< 1 mm
	21 0108/3	0 (S0)	Ri 0	0 (S0)	0 (S0)	< 1 mm

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RESULTS

EVALUATION OF CORROSION DEFECTS ACCORDING TO ČSN EN ISO 4628 AFTER 720 HOURS OF EXPOSURE IN NEUTRAL SALT FOG ACCORDING TO ČSN EN ISO 9227 NSS AND AFTER REMOVING THE PAINT FILM

Exposure time	Test panel label	Under-rusting of substrate	Corrosion at ascribe
		ČSN EN ISO 4628/3	ČSN EN ISO 4628/8
		Degree	(mm)
720 hours	21 0108/2	Ri 0	0,7 mm
	21 0108/3	Ri 0	0,6 mm

TEST PROCEDURE / METHOD

Test No. 18 - Pull-off test of adhesion

Test method identification:	ČSN EN ISO 4624 – Paints and varnishes – Pull-off test; method B
Testing equipment:	COMTEST OP 3/4 (COMING s.r.o., CZ) pull-off strength instrument with automatic recording
The speed of tension increase	900 kPa / s in accordance with the requirement of Article 8.5.1
Test pull-off doll:	Material – steel, doll surface area of 3,14 cm ² ;
Epoxy glue:	High strength epoxy 2-component thixotropic adhesive CHS-Epodur 520T-2608 (Spolchemie, a.s., The Czech Republic), hardened in a weight ratio (100 : 140), curing time 24hours; weighing 200 g
Cutting the paint:	The paint was cut to the ground by a circular milling cutter.
Sample conditioning before the test:	14 days in conditions according to ČSN EN 23270 at temperature (23 ± 2) ° C and humidity (50 ± 5) %.
Test conditions:	See conditions for testing and conditioning the samples
Number of determinations:	Six measurements were performed on each panel
Type of failure:	Assessed in accordance with Article 8. 5. 2 of the standard
Date of test:	March, 8, 2021, after 7 days of regeneration from the end of exposure
Deviation from the procedure	The result is given to one decimal place

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RESULTS

DETERMINATION OF PULL-OFF STRENGTH OF COATINGS ACCORDING TO ČSN EN ISO 4624

Test item	Aging conditions	Substrate		Pull-off strengths	Character of failure of testing assembly
				MPa	
Two-layer coating system for steel	Salt spray test 720 hours and then 7 days of regeneration under ČSN EN 23270 21 1018/1-3	Steel sheet	1.	5,069	50 % B/C; 50 % C
			2.	2,562	80 % B/C; 20 % C
			3.	5,336	40 % B/C; 60 % C
			4.	4,822	60 % B/C; 40 % C
			5.	4,312	80 % B/C; 20 % C
			6.	2,817	75 % B/C; 25 % C
Mean				(4,2 ± 1,2) MPa	

Test item	Aging conditions	Substrate		Pull-off strengths	Character of failure of testing assembly
				MPa	
Two-layer coating system for steel	Non-exposed specimen ČSN EN 23270 38 days 21 0108/4-6	Steel sheet	1.	4,319	80 % B/C; 20 % C
			2.	3,485	90 % B/C; 10 % C
			3.	3,266	60 % B/C; 40 % C
			4.	3,423	75 % B/C; 25 % C
			5.	5,274	75 % B/C; 25 % C
			6.	4,568	80 % B/C; 20 % C
Mean				(4,1 ± 0,8) MPa	

Character of the testing assembly failure according to chapter 8.5.2 of ČSN EN ISO 4624

- A Cohesion failure in the substrate
- A/B Adhesion failure between the substrate and the first coat
- B Cohesion failure in the first coat
- B/C Adhesion failure between the first coat and the second coat
- C Cohesion failure in the second coat
- /Y Adhesion failure between the upper coat and the glue
- Y/Z Adhesion failure between the glue and the doll

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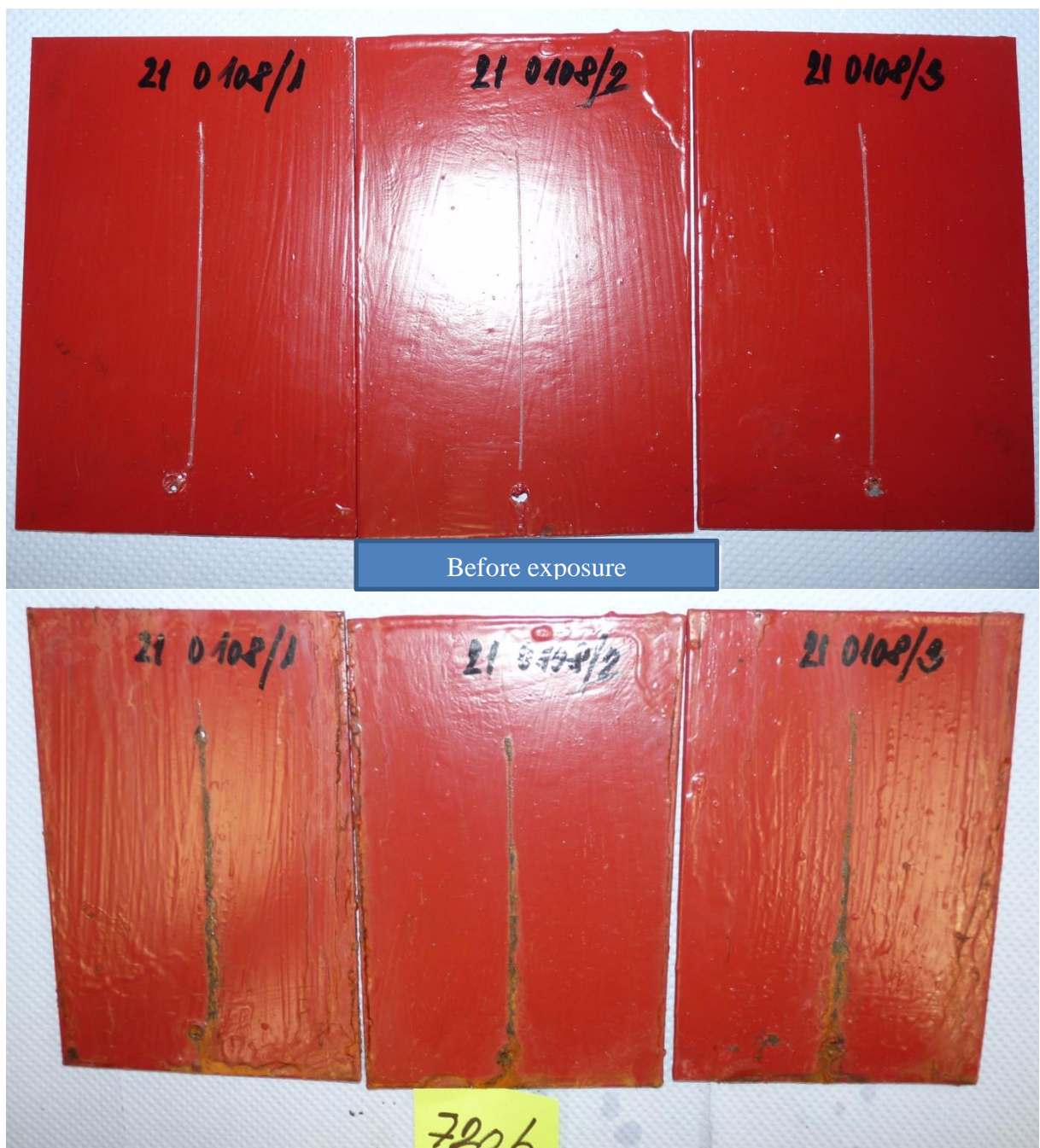
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DESCRIPTION OF TEST ITEM

Test item:	Two-layer coating system for steel
Internal Lab number:	21 0108

PHOTOGRAPHS OF SAMPLES BEFORE THE EXPOSURE IN NEUTRAL SALT SPRAY TEST AND AFTER 720 HOURS IN NEUTRAL SALT SPRAY TEST



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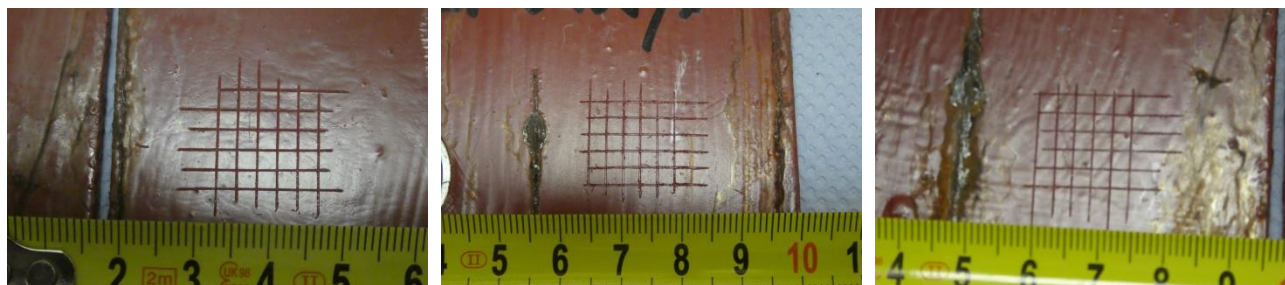
DESCRIPTION OF TEST ITEM

Test item:	Two-layer coating system for steel
Internal Lab number:	21 0108

PHOTOGRAPHS OF SAMPLES OF THE COATING SYSTEM AFTER 720 HOURS OF EXPOSURE IN NEUTRAL SALT SPRAY TEST AND AFTER THE PULL-OFF TEST OF ADHESION ACCORDING TO ČSN EN ISO 4624, PERFORMED AFTER 7 DAYS OF REGENERATION



CROSS CUT TEST MADE AFTER 720 HOURS OF EXPOSURE IN NEUTRAL SALT SPRAY TEST AND AFTER 7 DAYS OF REGENERATION



Panel 21 0108/1

Panel 21 0108/2

Panel 21 0108/3

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DESCRIPTION OF TEST ITEM

Test item:	Two-layer coating system for steel
Internal Lab number:	21 0108

PHOTOGRAPHS OF TEST ITEMS AFTER 720 HOURS EXPOSURE UNDER NEUTRAL SALT SPRAY TEST ACCORDING TO ČSN EN ISO 9227 NSS AND AFTER REMOVING THE PAINT FILM AT SCRIBE

