EGU HV LABORATORY

Since 1954
experience of testing
and research activities

L 1029

Testing laboratory No. 1029

Accredited by Czech Accreditation Institute according to ČSN EN ISO/IEC 17025:2018

TEST REPORT 12206/D/23

ACCREDITED TESTING LABORATORY EGU HV Laboratory No. 1029 CZECH REPUBLIC

CUSTOMER	Jiangsu Shemar Electric Co., Ltd. No. 66 Haiwei Road 226 017 Nantong, Jiangsu China
TEST OBJECT	138 kV Composite line insulator
TYPE SPECIFICATION	138 kV / 111 kN
SHEMAR IDENTIFICATION No.	n/a
TEST STANDARDS	CSA C411.4-16, IEC 60060-1 Ed.3:2010
NUMBER OF COPY	1
NUMBER OF PAGES	53
DATE OF ISSUE	2023-11-09

Michal Novotný
Test engineer

Marek Brosch
Head of
EGU HV LABORATORY

Jan Lachman, Ph.D.
Director of
EGU - HV Laboratory a.s.

REAL INDEPENDENT TESTING

WWW.EGUHV.COM

EGU – HV Laboratory a.s.
EGU HV LABORATORY, Podnikatelská 267, 190 11 Praha 9 – Běchovice, Czech Republic | +420 267 193 361 | info@eguhv.com

TEST REPORT 12206/D/23

TEST OBJECT	138 kV Composite line insulator
TYPE SPECIFICATION	138 kV / 111 kN
DRAWING No.	23SM510304
MANUFACTURER	Jiangsu Shemar Electric Co., Ltd. No. 66 Haiwei Road 226 017 Nantong, Jiangsu, China
DATE OF DELIVERY	2023-05-19
DATE OF TESTS	From 2023-05-26 till 2023-07-24
ORDER No.	4530505010
TESTS WITNESSED BY	n/a
ANNEX	Test report Testpolymer EU, No. 59/2022/EN Test report SYNPO a.s., No. T375/006

TABLE OF CONTENTS

1 TEST OBJECT IDENTIFICATION

The results presented in this test report apply only to test objects subjected to the testing. Responsibility for conformity of any objects having the same designation as the test object fully rests with the Manufacturer.

EGU HV LABORATORY is not responsible for the sampling. Samples are provided by a customer. Test results apply only to tested samples as received.

A customer guarantees a test object being made according to submitted product drawings and documents, see Table 1.

EGU HV LABORATORY confirms product drawings submitted by a customer fully represent in technical aspects (shape, dimensions etc.) a given test object and markings/nameplates on a test object conform with drawings.

Table 1 Drawings/documents submitted, and included in this test report

Title	Drawing No.	See
138 kV Composite line insulator	23SM510304	Figure 1

2 TEST SUMMARY

TEST TITLE	TEST STANDARD	RESULT
Test of core material	**CSA C411.4-16, clause 5.2**	**Pass**
Dye penetration test	CSA C411.4-16, clause 5.2.2	Pass
Water diffusion test	CSA C411.4-16, clause 5.2.3	Pass
Water penetration test	**CSA C411.4-16, clause 5.3**	**Pass**
Visual inspection of test specimen	CSA C411.4-16, clause 5.3.1	Pass
Visual examination	CSA C411.4-16, clause 5.3.3.1	Pass
Hardness test	CSA C411.4-16, clause 5.3.3.2	Pass
Steep-front impulse voltage test	CSA C411.4-16, clause 5.3.3.3	Pass
Power frequency voltage test	CSA C411.4-16, clause 5.3.3.4	Pass
Accelerated weathering test [1)]	**CSA C411.4-16, clause 5.4 ASTM D2565**	**Pass**
Tensile load test	**CSA C411.4-16, clause 5.6**	**Pass**
Thermal mechanical test	**CSA C411.4-16, clause 5.7**	**Pass**
Visual inspection of test specimen	CSA C411.4-16, clause 5.7.1	Pass
Moisture penetration test	CSA C411.4-16, clause 5.7.3.2	Pass
Assembled core time-load test	**CSA C411.4-16, clause 5.8**	**Pass**
Visual inspection and dimensional check	CSA C411.4-16, clause 5.8.1	Pass
Determination of the average failing load of the core	CSA C411.4-16, clause 5.8.2.2	Pass
Core time – load test	CSA C411.4-16, clause 5.8.2.3	Pass
Mechanical load-time test	**CSA C411.4-16, clause 5.9.**	**Pass**
Flammability test [1)]	**CSA C411.4-16, clause 5.10**	**Pass**

Explanatory notes for tests and standards:
[1)] The test was done in an external accredited laboratory
[2)] The test standard is not in the scope of EGU HV Laboratory accreditation

3 LIST OF SYMBOLS

Symbol	Description
k_1	Air density correction factor
k_2	Humidity correction factor
k_t	Atmospheric correction factor
T_0	Temperature of the shank before the dry power frequency withstand test
T_{30}	Temperature of the shank after the dry power frequency withstand test
U_{pk}	The maximum voltage of impulse wave
T_1	Front time of impulse wave
SR	Steepness of impulse wave

4 TESTS PERFORMED

4.1 TEST OF THE CORE MATERIAL

4.1.1 Dye penetration test

The test was carried out according to CSA C411.4-16, clause 5.2.2.

Ten test specimens of 10 mm ± 0,5 mm in length were cut from the 138 kV Composite line insulator.

The test specimens were placed (with fibers in vertical position) on a layer of glass balls (diameter 2 mm) in a glass vessel. A dye (1 % methyl alcohol solution of astrazon) was poured into the vessel, with its level was 2,5 mm above the glass balls. The time taken for the dye to rise (by capillary action) through the specimens was measured. Photo of test specimens after the dye penetration test is in Figure 18.

Testing and measuring equipment:

- digital stop-watch Kalenji PM-260
- slide gauge 150 mm, Kinex CZ, serial No. KN2038

Table 2 Results of the dye penetration test

Date	Duration (min)	Result
2023-06-01	15	No dye penetration

Evaluation:

There were no traces of dye penetration through the insulator core after 15 minutes.

Statement of conformity:

Specimens of rod diameter 18 mm from 138 kV Composite line insulator, drawing No. 23SM510304 passed the test according to requirements given in CSA C411.4-16, clause 5.2.2.

4.1.2 Water diffusion test

The test was carried out according to CSA C411.4-16, clause 5.2.3.

Six test specimens of 30 mm ± 0,5 mm in length were cut from the 138 kV Composite line insulator, see Figure 19).

The surfaces of the samples were cleaned with isopropyl-alcohol and filter-paper immediately before the boiling. The samples were boiled in a glass container for 100 hours in de-ionized water with 0,1 % by weight of NaCl.

After boiling, the samples were removed from the glass container and placed in another glass container filled with tap water at ambient temperature for 15 minutes. The voltage test was carried out within the next three hours.

Immediately before the voltage test the samples were removed from the glass container and their surfaces dried with filter paper. Each specimen was placed between the test electrodes. The test voltage was increased at rate of approximately 1 kV/sec up to 12 kV, kept at this level for one minute and then decreased to zero (see Figure 20).

Testing and measuring equipment:

- slide gauge 150 mm, Kinex, serial no. KN2038
- voltage source HVI 30kV, type HPA-305FC1, serial No. 006 + analog panel meters model 553
- multimeter UNIT UT71D, serial No. 1100420241
- digital stop-watch Kalenji PM-259
- weight Sartorius, type S210P, serial No. 39010002
- measuring cylinder 1000 ml, identification No. PM-243/ČMI19
- heating water vessel, type LTHS 4000, serial No. 18102

Test date: from 2023-06-01 till 2023-06-05

Table 3 Results of the water diffusion test

Sample No.	Test voltage (KV)	Leakage current (μA)	Duration (sec)	Result
1	12	17,6	60	pass
2	12	18,3	60	pass
3	12	16,7	60	pass
4	12	17,2	60	pass
5	12	17,6	60	pass
6	12	16,4	60	pass
Max. allowed leakage current ≤ 1000 μA				

Evaluation:

No puncture or external flashover occurred. The leakage current did not exceed maximum allowable current of 1 mA (r.m.s.).

Statement of conformity:

Samples of rod diameter 18 mm from 138 kV Composite line insulator, drawing No. 23SM510304 passed the test according to requirements given in CSA C411.4-16, clause 5.2.3.

4.2 WATER PENETRATION TEST

Tests were carried out according to CSA C411.4-16, clause 5.3.

4.2.1 Test specimens

The tests were performed on three insulator samples and on reference insulator sample:

Insulator No. 15, serial No. 2305096005

Insulator No. 16, serial No. 2305096028

Insulator No. 17, serial No. 2305096023

Insulator No. 22 Ref, serial No. 2305096012

The insulators were examined visually, and their dimensions were checked against the manufacturer's drawing (see Figure 1)

Testing and measuring equipment:

- slide gauge 150 mm, Kinex CZ, serial No. KN2038
- tape measure 5 m, Assist, PM-291

Table 4 Test specimens

Sample No.	Type	Visual/dimensional check
15, 16, 17 – test samples 22 Ref – reference sample	138 kV Composite line insulator	Pass

Evaluation:

Insulators were without damage and dimensions conform with the drawing.

4.2.2 Hardness test before boiling of the test samples

Test was carried out according to CSA C411.4-16, clause 5.3.3.2.

The hardness of two sheds of each insulator was measured with Shore A durometer Measured values were recorded (see Table 7).

Testing and measuring equipment:

- durometer Shore A, serial No. 45609010
- measuring system for atmospheric conditions Comet, serial No. 14900363

4.2.3 Water boiling test

Three tested insulators were immersed for 100 hours boiling in tap water with to 0,1 % by weight of NaCl (see Figure 21). At the end of boiling, the insulators remained immersed until the water cooled to approx. 50°C and maintained at this temperature until the verification tests started.

Testing and measuring equipment:

- Heating water vessel AKV2, No. 2420

Table 5 Water boiling test

Date	Sample No.	Duration
2023-06-23 to 2023-06-27	15, 16, 17	100 hours

4.2.4 Test evaluation

Insulators were inspected visually after water boiling test.

Table 6 Results of the visual test

Date	Sample No.	Result
2023-06-28	15, 16, 17	No cracks no signs of crumbling or dissolving

Evaluation:

No cracks and no signs of crumbling or dissolving were observed on test samples.

4.2.4.1 Hardness test after boiling of the test samples

Test was carried out according to CSA C411.4-16, clause 5.3.3.2.

The hardness of two sheds of each insulator was measured with Shore A durometer Measured values were recorded (see Table 7).

Testing and measuring equipment:

- durometer Shore A, serial No. 45609010
- measuring system for atmospheric conditions Comet, serial No. 14900363

Table 7 Results of the hardness before and after water boiling test

Sample No.	Sheds No.	Average value before boiling test Test date: 2023-05-19	Average value after boiling test Test date: 2023-05-23
15	Shed No. 1	71,6	71,7
	Shed No. 2	69,5	71,5
16	Shed No. 1	70,5	71,9
	Shed No. 2	67,6	71,6
17	Shed No. 1	69,6	71,6
	Shed No. 2	69,9	71,0
Temperature at the time of hardness measurement		21,5 °C	23,5 °C
Result		**The hardness of each specimen did not change from the pre-boiled value more than ±20 %**	

4.2.4.2 Steep-front impulse voltage test

Test was carried out according to CSA C411.-16, clause 5.3.3.3.

The test voltage - an impulse with a steepness of at least 1000 kV/µs - was applied between:

- the original upper metal fitting and an electrode made of a copper strip 20 mm wide and less than 1 mm thick (upper section)
- electrode made of a copper strip 20 mm wide and an electrode made of a copper strip 20 mm wide and less than 1 mm thick (middle section)
- electrode made of a copper strip 20 mm wide and less than 1 mm thick and an original bottom metal fitting (bottom section).

Each sample was stressed individually with 25 impulses of positive and 25 impulses of negative polarity.

The test arrangement and the flashover on the insulator are shown in Figure 22. Representative example of the wave shape of the test impulse is given in Figure 2.

Testing and measuring equipment:

– impulse generator TuR Dresden 750 kV, 30 kJ
– divider Haefely R800, serial No. 554333
– measuring system Haefely Trench, type HiAS 743, serial No. 175247
– measuring system for atmospheric condition Comet, serial No. 19910190
– tape measure 7,5 m, Assist, PM-292

Table 8 Steep-front impulse voltage test conditions

Date	Pressure (kPa)	Temperature (°C)	Rel. humidity (%)
2023-06-28	98,7	23,2	51,1

Table 9 Results of the steep-front impulse voltage test

Sample No.	No. of impulses		Result
	+ polarity	- polarity	
15 (upper section)	25	25	No puncture
15 (middle section)	25	25	No puncture
15 (bottom section)	25	25	No puncture
16 (upper section)	25	25	No puncture
16 (middle section)	25	25	No puncture
16 (bottom section)	25	25	No puncture
17 (upper section)	25	25	No puncture
17 (middle section)	25	25	No puncture
17 (bottom section)	25	25	No puncture

Evaluation:

No puncture of any part of the insulator occurred.

4.2.4.3 Power frequency voltage test

Test was carried out according to CSA C411.4-16, clause 5.3.3.4.

The flashover voltage sample was determined by averaging of five consecutive flashovers on each insulator. Before the flashover test begins, the shank temperatures of all samples were measured. The average of five flashover value was corrected to normal standard atmospheric conditions in accordance with IEC 60060-1, clause 4.3. The flashover voltage was obtained by increasing the voltage linearly from zero within one minute.

The flashover voltage of each sample shall be greater than or equal to 90 % of flashover voltage of the reference sample (reference flashover voltage).

Then the samples were subjected for 30 minutes to 80 % of the reference flashover voltage (not corrected to actual test conditions). Immediately after the test the temperature of the shank (at five locations distributed approximately evenly along the length of the insulators) of each sample was measured again and compared to ambient temperature.

The test arrangement and the flashover on the insulator are shown in Figure 23.

Testing and measuring equipment:

- resonant AC source Evergreen, MSR600-1200, serial No. 2001042-EGU
- capacitive divider Evergreen, HCC600-2, serial No. 200104-EGU
- universal voltmeter Haefely DMI 551, serial No. 188856
- digital stop-watch Fastime, PM-251
- measuring system for atmospheric condition Comet, serial No. 14900363
- digital thermometer Fluke 54 IIB, serial No. 41070290WS + touch probe 80PK-27
- tape measure 7,5 m, Assist, PM-292

Table 10 Power frequency voltage test conditions

Date	Pressure (kPa)	Temperature (°C)	Rel. humidity (%)	Arc. distance (m)
2023-06-28	98,6	24,3	48,6	1,320

Table 11 Results of power frequency flashover test

Sample No.	Measured flashovers (kV)	Average flashover (kV)		Atm. correction factors		
	Individual	Measured	Corrected	k_1	k_2	K_t
22 Ref	457; 462; 459; 460; 472	462	481	0,959	1,002	0,961
15	457; 461; 458; 459; 461	459	477	0,959	1,002	0,961
16	461; 461; 465; 456; 458	460	479	0,959	1,002	0,961
17	469; 469; 466; 457; 457	464	483	0,959	1,002	0,961
90 % of reference flashover voltage (corrected to std. atm. conditions): 0,9 x 481 kV = 433 kV						

Table 12 Results of the power frequency withstand voltage test and temperature of the housing

Sample No.	Test voltage (kV)	Temperature of the shank		Temperature rise (°C)	Result
		T_0 (°C)	T_{30} (°C)		
22 Ref	370	24,9; 24,9; 24,9; 25,0; 25,0	27,6; 27,6; 26,5; 27,6; 27,4	< 10	Pass
15	370	25,3; 25,4; 25,0; 24,9; 24,9	23,6; 23,6; 26,4; 27,9; 27,8	< 10	Pass
16	370	25,2; 25,2; 25,0; 25,3; 25,3	26,4; 26,4; 26,2; 27,0; 27,1	< 10	Pass
17	370	25,2; 25,2; 25,2; 25,2; 25,2	26,5; 26,6; 25,8; 26,6; 26,6	< 10	Pass
80 % of reference flashover voltage 0,8 x 481 kV = 385 kV (corrected to std. atm. conditions) i.e. 370 kV (corrected to actual test conditions)					

Evaluation:

Flashover voltages of test samples exceed 90 % of reference flashover voltage.

No puncture of any part of the insulator occurred.

The temperature rised of the housing between the sheds on the insulator of each sample measured immediately after the test was less than 10 K, with respect to ambient temperature.

Statement of conformity:

138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304 passed the tests according to requirements given in CSA C411.4-16, clause 5.3.

4.3 ACCELERATED WEATHERING TEST [1)]

Table 13 Silicone material specification

Manufacturer	Jiangsu Shemar Electric Co., Ltd.
Address	No. 66 Haiwei Road, Nantong City, Jiangsu 226 017, China
Type	HTV Silicone rubber
Color	Light gray
Batch number	N/A

NOTE: The specification of silicone material was provided by customer

The test was performed according to CSA C411.4-16, clause 5.4 and ASTM D2565. The samples of silicone material of required dimensions were provided by the customer.

The test was performed by accredited test laboratory SYNPO a.s., test report No. T375/006.

Evaluation:

No surface degradations such cracks, crumbling or blisters after the test.

Statement of conformity:

The specimens of HTV silicone material, passed the test according to requirements given in CSA C411.4-16, clause 5.4 and ASTM D2565.

4.4 TENSILE LOAD TEST

Tests were carried out according to CSA C411.4-16, clause 5.6.

4.4.1 Test specimens

The tests were performed on three insulator samples:

Insulator No. 3, serial No. 2305096029

Insulator No. 4, serial No. 2305096014

Insulator No. 5, serial No. 2305096041

The insulators were examined visually, and their dimensions were checked against the manufacturer's drawing (see Figure 1) according to CSA C411.4-16, clause 5.6.1.

Testing and measuring equipment:

- slide gauge 150 mm, Kinex CZ, serial No. KN2038
- tape measure 7,5 m, Assist, PM-292

Table 14 Test specimens

Sample No.	Type	Visual/dimensional check
3, 4, 5	138 kV Composite line insulator	Pass

Evaluation:

Insulators were without damage and dimensions conform with the drawing.

4.4.2 Test procedure and test result

Test was carried out according to CSA C411.4-16, clause 5.6.2. Three insulators No. 3, 4 and 5 were subjected to tensile load applied between couplings. The tensile load was increased rapidly but smoothly from zero to approximately 75 % of expected mechanical failing load and then gradually increased in a time between 30 s to 90 s until breakage of the core or complete pull-out occurs (see Figure 24, Figure 25, Figure 26 and Figure 27). The average of the three failing loads was calculated.

Records of measured mechanical loading during the mechanical failing tests are given in Figure 7, Figure 8 and Figure 9.

Testing and measuring equipment:

- hydraulic loading machine LabTest 5.600SP1, serial No. 15/12

Table 15 Results of the tensile load test

Test date: 2023-05-26			
Sample No.	**100 % SML**	**Failing load**	**Type of failure**
3	111 kN / 60 s - OK	146,4 kN	Pull out of the core from the end fitting
4	111 kN / 60 s - OK	140,0 kN	Pull out of the core from the end fitting
5	111 kN / 60 s - OK	162,0 kN	Pull out of the core from the end fitting

Evaluation:

No failure (breakage, partial pullout or complete pull-out of the core or fracture of the metal fittings) occurred during the 90 s time period on insulators No. 3, 4 and 5.

Statement of conformity:

138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304 passed the tests according to requirements given in CSA C411.4-16, clause 5.6.

4.5 THERMAL-MECHANICAL TEST

Test was carried out according to CSA C411.4-16, clause 5.7.

4.5.1 Test specimens

The tests were performed on three insulator samples:

Insulator No. 23, serial No. 2305096011

Insulator No. 24, serial No. 2305096025

Insulator No. 25, serial No. 2305096022

The insulators were examined visually, and their dimensions were checked against the manufacturer's drawing (see Figure 1) according to CSA C411.4-16, clause 5.7.1.

Testing and measuring equipment:

- slide gauge 150 mm, Kinex CZ, serial No. KN2038
- tape measure 7,5 m, Assist, PM-292

Table 16 Test specimens

Sample No.	Type	Visual/dimensional check
23, 24, 25	138 kV Composite line insulator	Pass

Evaluation:

Insulators were without damage and dimensions conform with the drawing.

4.5.2 Test procedure and test result

Three insulators No. 23, 24 and 25 were subjected to a tensile mechanical load to 5 % of SML for the duration one minute at ambient temperature, the reference length (include the end fittings, but exclude the coupling) was measured. Measured values are show in Table 18.

Insulators were subjected to a mechanical load to 50% of SML. Each insulator was subjected to four 24-hour cycles with one cooling period of -50°C ±5 °C, followed by one heating period of +50 °C ±5 °C. Following the thermal mechanical cycling, each insulator was permitted to reach ambient temperature and a tension load 5 % of SML was applied and the length again measured. The increased length shall be less than 2 mm (see Table 18).

The test arrangement during the thermal-mechanical test on the insulator is shown in Figure 28.

Records of measured temperatures and tensile load during the thermal-mechanical testing are given in Figure 3, Figure 4, Figure 5 and Figure 6.

Moisture penetration test was carried out according to CSA C411.4-16, clause 5.7.3.2. Each end of tested insulator was submerged in a dye composed 1 % alcohol solution of astrazon dye for a minimum 15 min. After that the insulator were removed from the solution, wiped dry (see Figure 29). The ends were cut nominally 90° to the axis of the core and about 50 mm from each metal fitting (see Figure 30). Then the portion of metal fitting was removed (see Figure 31).

The diagnostic test of metal end fittings was carried out according to CSA C411.4-16, clause 5.7.3.1 b) and ISO 3452 [2]. End fittings after dye penetration test were inspected (see Figure 32 and Figure 33).

Testing and measuring equipment:

- digital thermometer - datalogger, Comet system, serial No. 19270819
- digital thermometer - datalogger, Comet system, serial No. 06932373
- thermal mechanical chamber Horkan Klima, inventory No. 2237
- thermal mechanical chamber Creep test type 6.500.C3, serial No. UA/2018/51
- loading measuirng system Format 1, type EGU – 1V, serial No. Z201128287
- slide gauge 1 500 mm, Filleta, serial No. G10066
- tape measure 7,5 m, Assist, PM-292

Table 17 Results of the thermal-mechanical test

Date	Sample No.	Test	Test parameters	Result
2023-07-01 to 2023-07-05	23, 24	Thermal-mechanical	Temperature: hot cycle +50°C ±5 K cold cycle -50°C ±5 K Tensile load: 50 % of SML: 56 kN	pass
2023-07-05 to 2023-07-09	25	Thermal-mechanical	Temperature: hot cycle +50°C ±5 K cold cycle -50°C ±5 K Tensile load: 50 % of SML: 56 kN	pass

Table 18 Measured samples length before and after thermal-mechanical test

Sample No.	23	24	25
Reference length before test (mm)	1365,3	1363,8	1361,9
Length after test (mm)	1365,3	1363,9	1362,0
The length increase shall be equal or less than 2 mm			

Table 19 Results of the moisture penetration test after thermal-mechanical test

Test date: 2023-07-24			
Sample No.			**Test result**
23	Upper end fitting	Bottom end fitting	No evidence of dye on the core rod or interface
24	Upper end fitting	Bottom end fitting	No evidence of dye on the core rod or interface
25	Upper end fitting	Bottom end fitting	No evidence of dye on the core rod or interface

Table 20 Results of the dye penetration test of end fittings

Test date: 2023-07-24			
Sample No.			**Test result**
23	Upper end fitting	Bottom end fitting	No evidence of dye on the end fittings
24	Upper end fitting	Bottom end fitting	No evidence of dye on the end fittings
24	Upper end fitting	Bottom end fitting	No evidence of dye on the end fittings

Evaluation:

Increase length was not more than 2 mm.

Each insulator passed the moisture penetration test, there was no evidence of dye on the area of the core where the portion of end metal fitting were removed.

No fracture or cracking of the metal end fittings occurred at the mechanical load of 50 % SML.

No fracture or cracking of the metal end fittings were observed after dye penetration test.

Statement of conformity:

138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304 passed the test according to requirements given in CSA C411.4-16, clause 5.7.

4.6 ASSEMBLED CORE LOAD-TIME TEST

Tests were carried out according to CSA C411.4-16, clause 5.8.

4.6.1 Test specimens

The tests were performed on six insulator samples:

Insulator No. 6, serial No. 2305096038

Insulator No. 7, serial No. 2305096004

Insulator No. 8, serial No. 2305096015

Insulator No. 9, serial No. 2305096027

Insulator No. 10, serial No. 2305096042

Insulator No. 11, serial No. 2305096024

The insulators were examined visually, and their dimensions were checked against the manufacturer's drawing (see Figure 1) according to CSA C411.4-16, clause 5.8.1.

Testing and measuring equipment:

- slide gauge 150 mm, Kinex CZ, serial No. KN2038
- tape measure 5 m, Assist, PM-291

Table 21 Test specimens

Sample No.	Type	Visual/dimensional check
6, 7, 8, 9, 10, 11	138 kV Composite line insulator	Pass

Evaluation:

Insulators were without damage and dimensions conform with the drawing.

4.6.2 Determination of the average failing load of the core of the assembled insulator

Test was carried out according to CSA C411.4-16, clause 5.8.2.2. Three insulators No. 6, 7 and 8 were subjected to tensile load applied between couplings. The tensile load was increased rapidly but smoothly from zero to approximately 75 % of expected mechanical failing load and then gradually increased in a time between 30 s to 90 s until breakage of the core or complete pull-out occurs (see Figure 34, Figure 35, Figure 36, Figure 37 and Figure 38). The average of the three failing loads was calculated.

Records of measured mechanical loading during the mechanical failing tests are given in Figure 10, Figure 11 and Figure 12.

Testing and measuring equipment:

- hydraulic loading machine LabTest 5.600SP1, serial No. 15/12

Table 22 Results of the determination of the failing load

Test date: 2023-06-12		
Sample No.	**Type of failure**	**Failing load**
6	Pull out of the core from the end fitting	168,5 kN
7	Pull out of the core from the end fitting	146,8 kN
8	Pull out of the core from the end fitting	162,2 kN
	Average of the failing load M_{AV}	159,2 kN
	60 % of M_{AV}	**95,5 kN**

4.6.3 Verification of the slope of the strength-time curve of the insulator

Test was carried out according to CSA C411.4-16, clause 5.8.2.3. Three insulators No. 9, 10 and 11 were subjected to a tensile load applied between couplings. The tensile load was increased rapidly but smoothly, from zero up to 60 % of the average failing load and then maintained at this value for 96 hours.

Record of mechanical loading applied during mechanical 96 hours tests are given in Figure 13.

Test samples during the mechanical 96 hours load test are shown in Figure 39.

The diagnostic test of metal end fittings was carried out according to CSA C411.4-16, clause 5.8.2.3 and ISO 3452 [2]. End fittings after dye penetration test were inspected. The insulators after the dye penetration test are shown in Figure 40.

Testing and measuring equipment:

– hydraulic loading machine LabTest 5.600SP1, serial No. 15/12

Table 23 Results of the core time-load test

Test date: from 2023-06-12 to 2023-06-16		
Sample No.	**Tensile load**	**Test result**
9	95,5 kN / 96 hours	No failure occurred during the 96 hours withstand load test
10	95,5 kN / 96 hours	No failure occurred during the 96 hours withstand load test
11	95,5 kN / 96 hours	No failure occurred during the 96 hours withstand load test

Table 24 Results of the dye penetration test of end fittings

Test date: 2023-06-16			
Sample No.			**Test result**
9	Upper end fitting	Bottom end fitting	No evidence of dye on the end fittings
10	Upper end fitting	Bottom end fitting	No evidence of dye on the end fittings
11	Upper end fitting	Bottom end fitting	No evidence of dye on the end fittings

Evaluation:

No failure (breakage or complete pull-out of the core or fracture of the metal fittings) occurred during the 96 hours withstand load test.

No fracture or cracking of the metal end fittings were observed after dye penetration test on insulators No. 9, 10 and 11.

Statement of conformity:

138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304 passed the test according to requirements given in CSA C411.4-16, clause 5.8.

4.7 MECHANICAL LOAD-TIME TEST

Tests were carried out according to CSA C411.4-16, clause 5.9.

4.7.1 Test specimens

The tests were performed on six insulator samples:

Insulator No. 26, serial No. 2305096018

Insulator No. 27, serial No. 2305096032

Insulator No. 28, serial No. 2305096010

Insulator No. 29, serial No. 2305096002

The insulators were examined visually, and their dimensions were checked against the manufacturer's drawing (see Figure 1) according to CSA C411.4-16, clause 5.9.1.

Testing and measuring equipment:

- slide gauge 150 mm, Kinex CZ, serial No. KN2038
- tape measure 5 m, Assist, PM-291

Table 25 Test specimens

Sample No.	Type	Visual/dimensional check
26, 27, 28, 29	138 kV Composite line insulator	Pass

Evaluation:

Insulators were without damage and dimensions conform with the drawing.

4.7.2 Performance of the test

Date of test: from 2023-06-30 till 2023-04-07

This test was performed the ambient temperature as described in the following three paragraphs.

a) 96 hours withstand test

Test was carried out according to CSA C411.4-16, clause 5.9.2.1. All four specimens were subjected to a tensile load applied between couplings. The tensile load was increased rapidly but smoothly, from zero up to 70% of SML, and then maintained at this value for 96 hours. Test samples during tensile load test are shown in Figure 42.

Record of measured 96 hours mechanical test on test samples No. 26, 27, 28 and 29 is shown in Figure 14.

b) dye penetration test

Test was carried out according to CSA C411.4-16, clause 5.9.2.2. Both ends of section insulator No. 29 were subjected to the dye penetration test for 20 minutes. After the penetration test the specimens were inspected. Test sample after the dye penetration test is shown in Figure 47.

c) failing load test

Test was carried out according to CSA C411.4-16, clause 5.9.2.3. Three insulators No. 26, 27 and 28 were then again subjected to tensile load applied between couplings. The tensile load was increased rapidly but smoothly from zero to approximately 75% of SML and then gradually increased in a time between 30 s to 90 s to 100% of SML. Load was sustained for the reminder of the 60 s. After finishing the test according to paragraph c) the tensile load on composite silicone insulator samples No. 26, 27 and 28 were increased up to failing load. Records of mechanical test are in Figure 15, Figure 16 and Figure 17. Test samples after the mechanical test are shown in Figure 43, Figure 44, Figure 45 and Figure 46.

Testing and measuring equipment:

- hydraulic loading machine LabTest 5.600SP1, serial No. 15/12
- digital stop-watch Fastime PM-251

4.7.3 Test results

a) 96 h withstand test

Date of the test:	from 2023-06-30 to 2023-07-04
Insulators:	No. 26, 27, 28, 29
Applied load:	77,7 kN (70% of 111 kN)
Result:	No failure

b) Dye penetration test

Date of the test:	2023-07-04
Insulator:	No. 29
Result:	No cracks

c) SML test

Date of the test:	2023-07-04
Insulators:	No. 26, 27, 28.
SML:	111 kN
Result:	No failure during 1-min at SML
	Measured failing loads are below in Table 26

Table 26 Results of the SML test

Test date: 2023-07-04			
Sample No.	**100 % SML**	**Failing load**	**Type of failure**
26	111 kN / 60 s - OK	163,3 kN	Pull out of the core from the end fitting
27	111 kN / 60 s - OK	163,3 kN	Pull out of the core from the end fitting
28	111 kN / 60 s - OK	170,3 kN	Pull out of the core from the end fitting

Evaluation:

No failure (breakage or complete pull-out of the core or fracture of the metal fittings) occurred during 96 h test at 70 % of the SML on insulators No. 26, 27, 28 and 29.

No failure (breakage or complete pull-out of the core or fracture of the metal fittings) occurred during 1 minute withstand test at 100 % of the SML on insulators No. 26, 27 and 28.

No cracks were observed after dye penetration test on insulator No. 29.

Statement of conformity:

138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304 passed the test according to requirements given in CSA C411.4-16, clause 5.9.

4.8 FLAMMABILITY TEST [1)]

Table 27 Specification of the silicone material

Manufacturer	Jiangsu Shemar Electric Co., Ltd.
Address	No. 66 Haiwei Road, Nantong City, Jiangsu 226 017, China
Type	HTV Silicone rubber
Color	Light gray
Batch number	N/A

NOTE: The specification of silicone material was provided by customer

The test was performed according to CSA C411.4-16, clause 5.10. The samples of silicone material of required dimensions were provided by the customer.

The test was performed by accredited test laboratory TestPolymer EU, test report No. 59/2022/EN.

Evaluation:

Samples fulfil requirements for horizontal and vertical burning classification HB, V-0, V-1, and V-2.

Statement of conformity:

The specimens of HTV silicone material, passed the test according to requirements given in CSA C411.4-16, clause 5.10.

5 UNCERTAINTY OF MEASUREMENTS

Quantity		Uncertainty (k = 2)
Steep-front impulse voltage	U_{pk}	2,2 %
	T_1	6,5 %
Power-frequency current (Unit UT71D)		1,8 %
Power-frequency current (HCC600-2)		1,2 %
Power-frequency voltage (analog panel meters model 553)		0,3 kV
Mechanical load (LabTest 5.600SP1)		1,0 %
Mechanical load (Creep test 6.500.C3)		1,0 %
Mechanical load (Format 1)		1,3 %
Temperature (Fluke 54 IIB)		7,5 %
Temperature (datalogger Comet)		3,0 %
Weight (Sartorius)		0,5 %
Atmospheric pressure		0,5 %
Air temperature		4,0 %
Relative humidity		6,3 %
Time		0,7 %
Conductivity (0,1 µS/cm –1 000 mS/cm)		5,0 %
Slide gauge 150 mm		0,4 %
Slide gauge 1 500 mm		0,8 %
Measuring cylinder 1 000 ml		10,0 ml
Measuring cylinder 250 ml		1,0 ml
Hardness A		2,6 %
Length – tape measure (10–5 000 mm)		1,6 %
Length – tape measure (10–7 500 mm)		1,6 %

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a Normal (Gaussian) distribution corresponds to a coverage probability of approximately 95%.

EGU - HV Laboratory applies a binary decision rule to the statement of conformity which reports two statements: PASS – results are within limits or meet a given specification, FAIL – results are out of limits or fail a given specification. Calculated uncertainty of measurements are only informative with regards to the statement of conformity application.

6 PRODUCT DRAWING

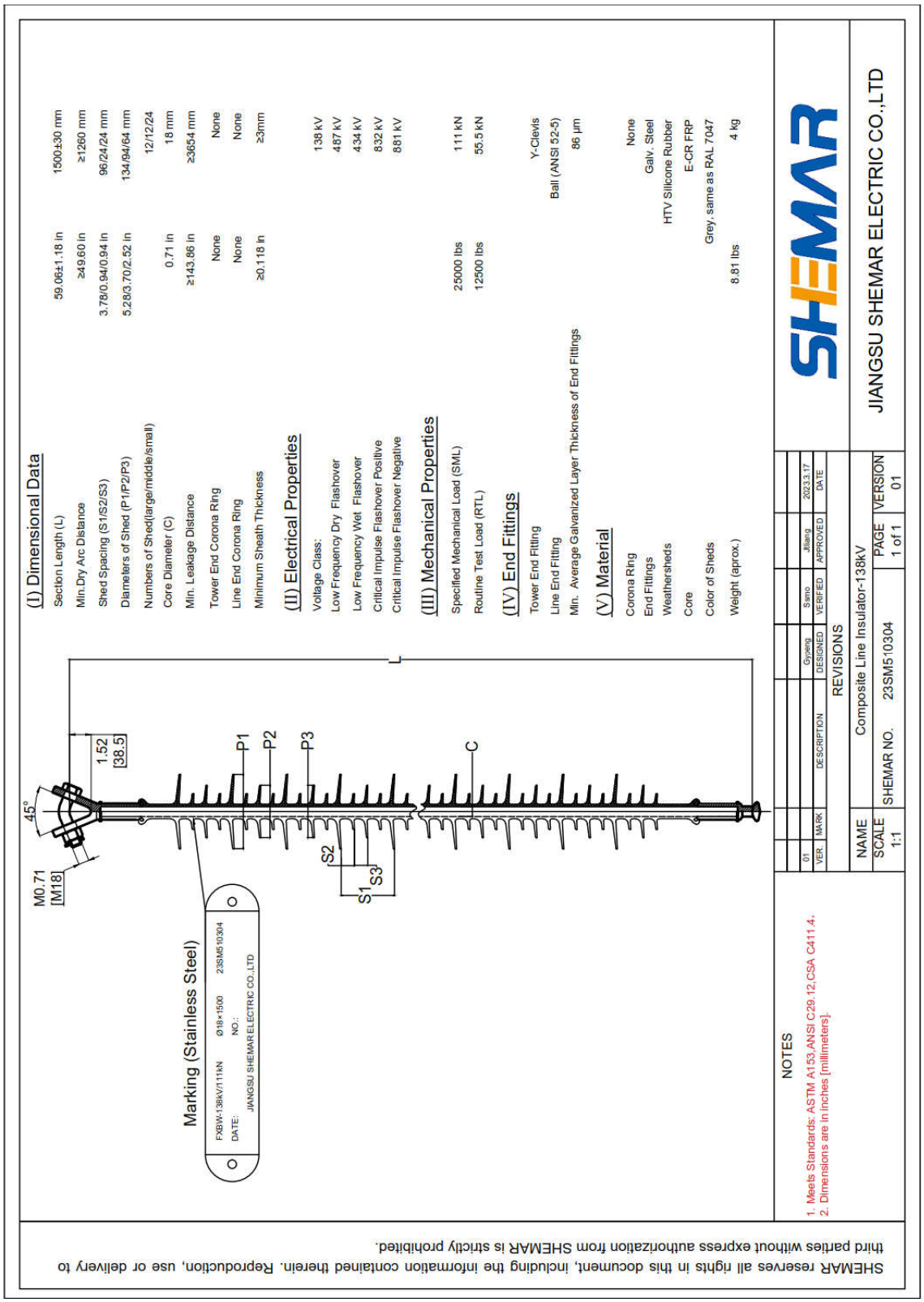


Figure 1 138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304

7 GRAPHS AND RECORDS

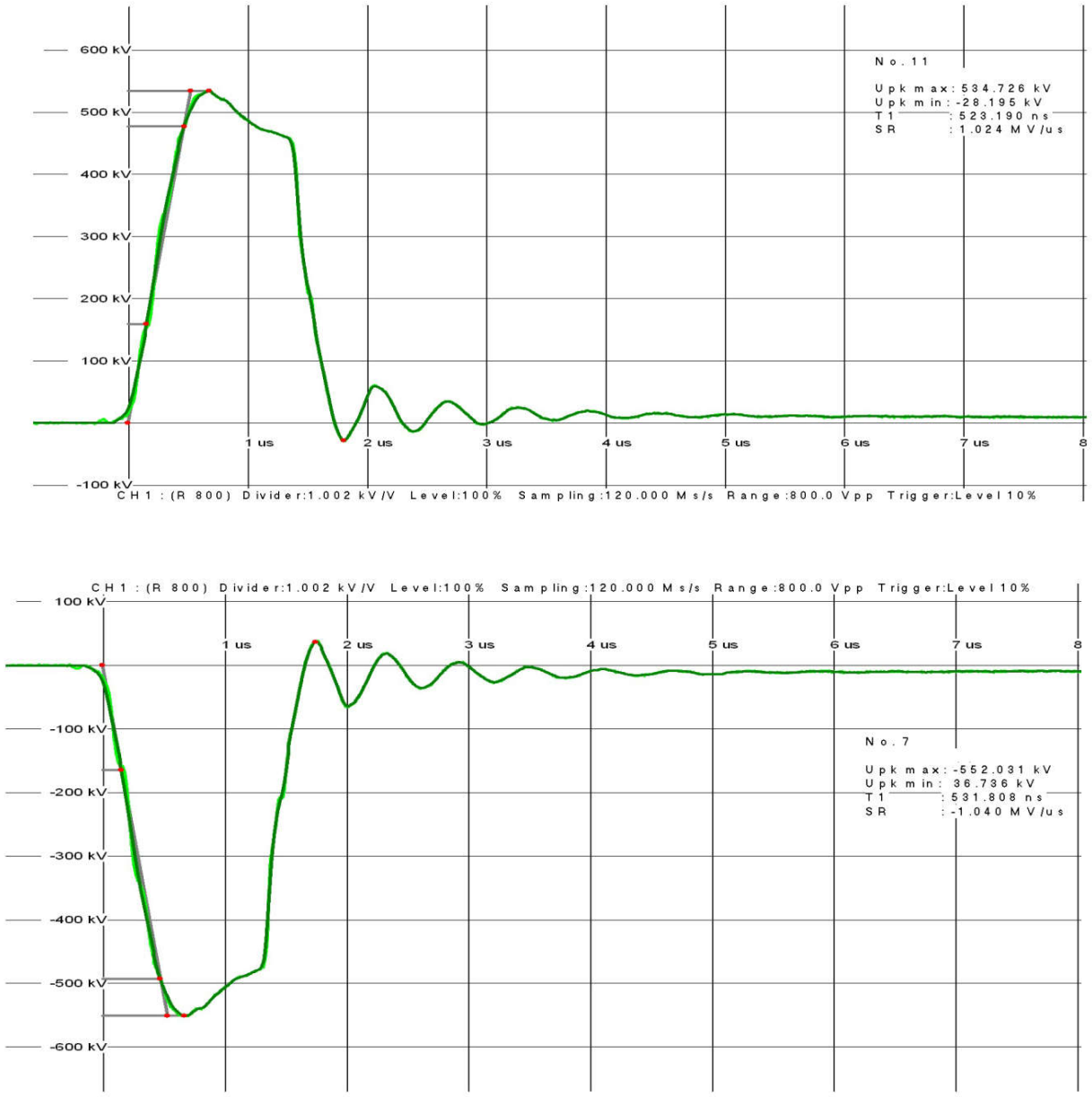


Figure 2 Representative wave shape of the steep-front impulse test

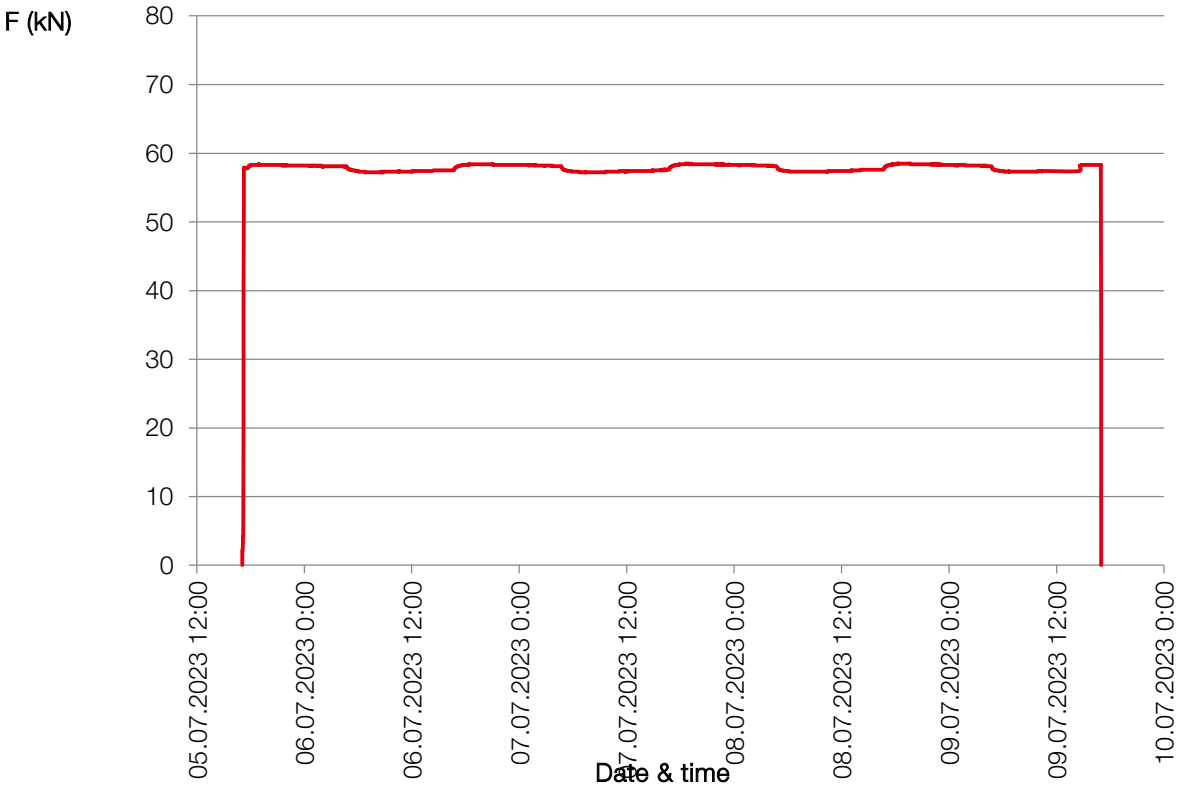


Figure 3 Record of tensile load during thermal-mechanical cycles, test samples No. 23

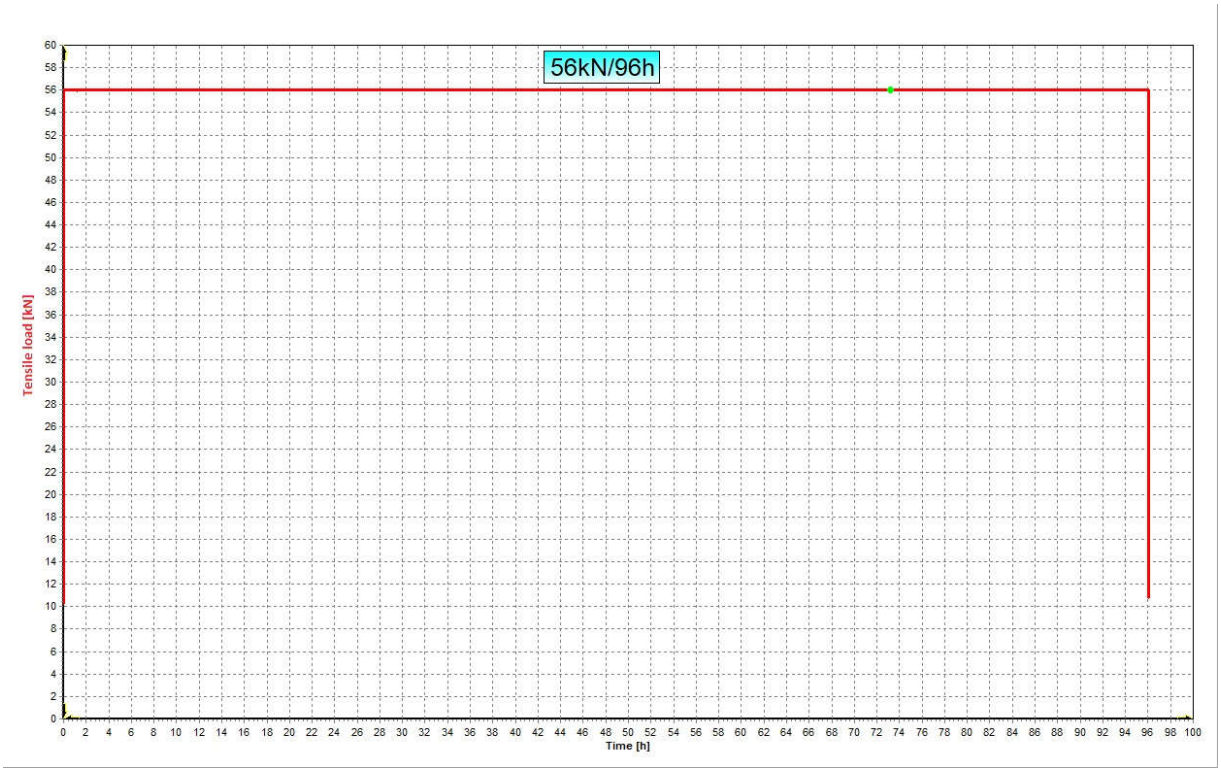


Figure 4 Record of tensile load during thermal-mechanical cycles, test samples No. 24 and 25

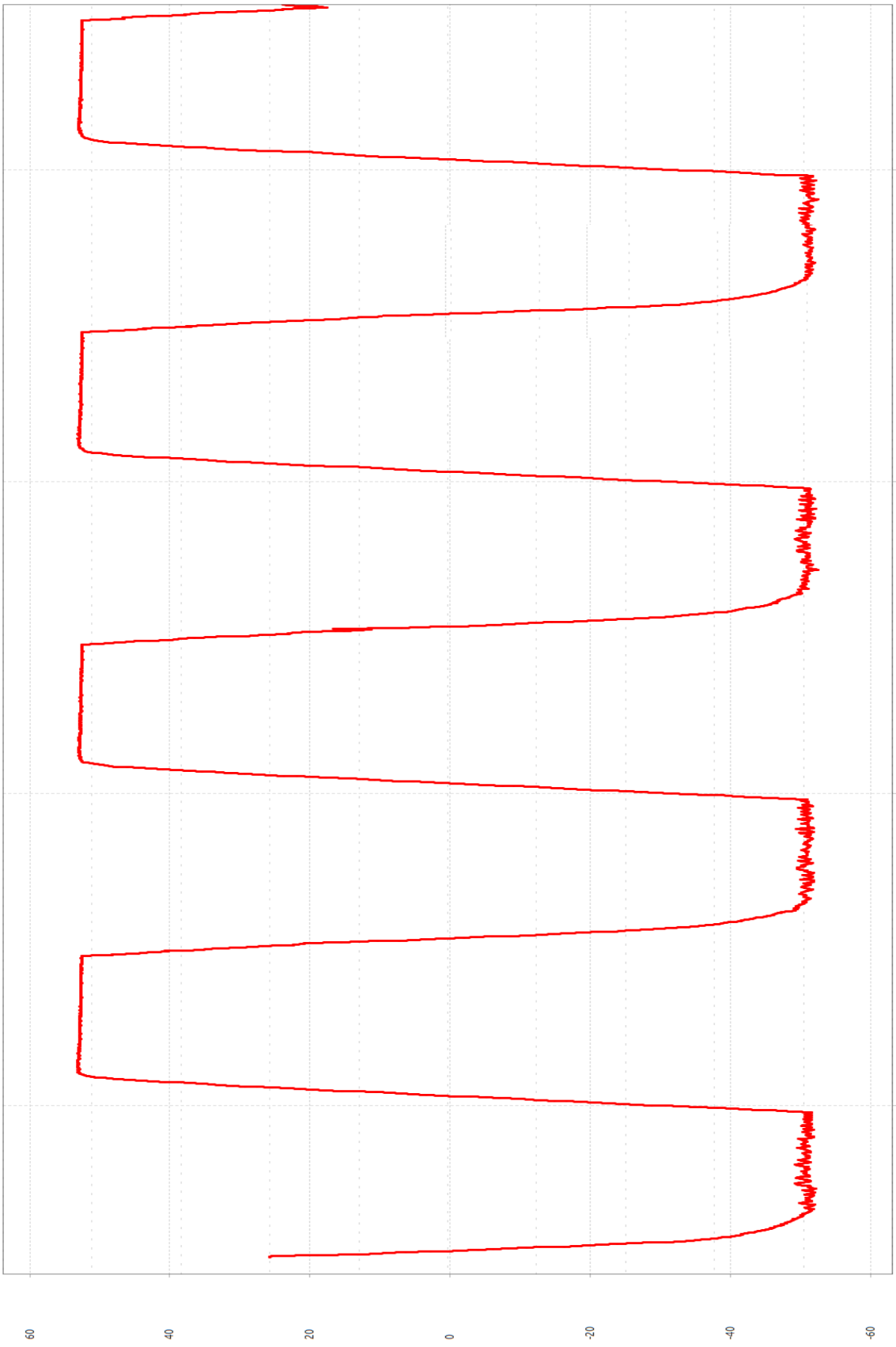


Figure 5 Record of temperature during thermal-mechanical cycles, test sample No. 24 and 25

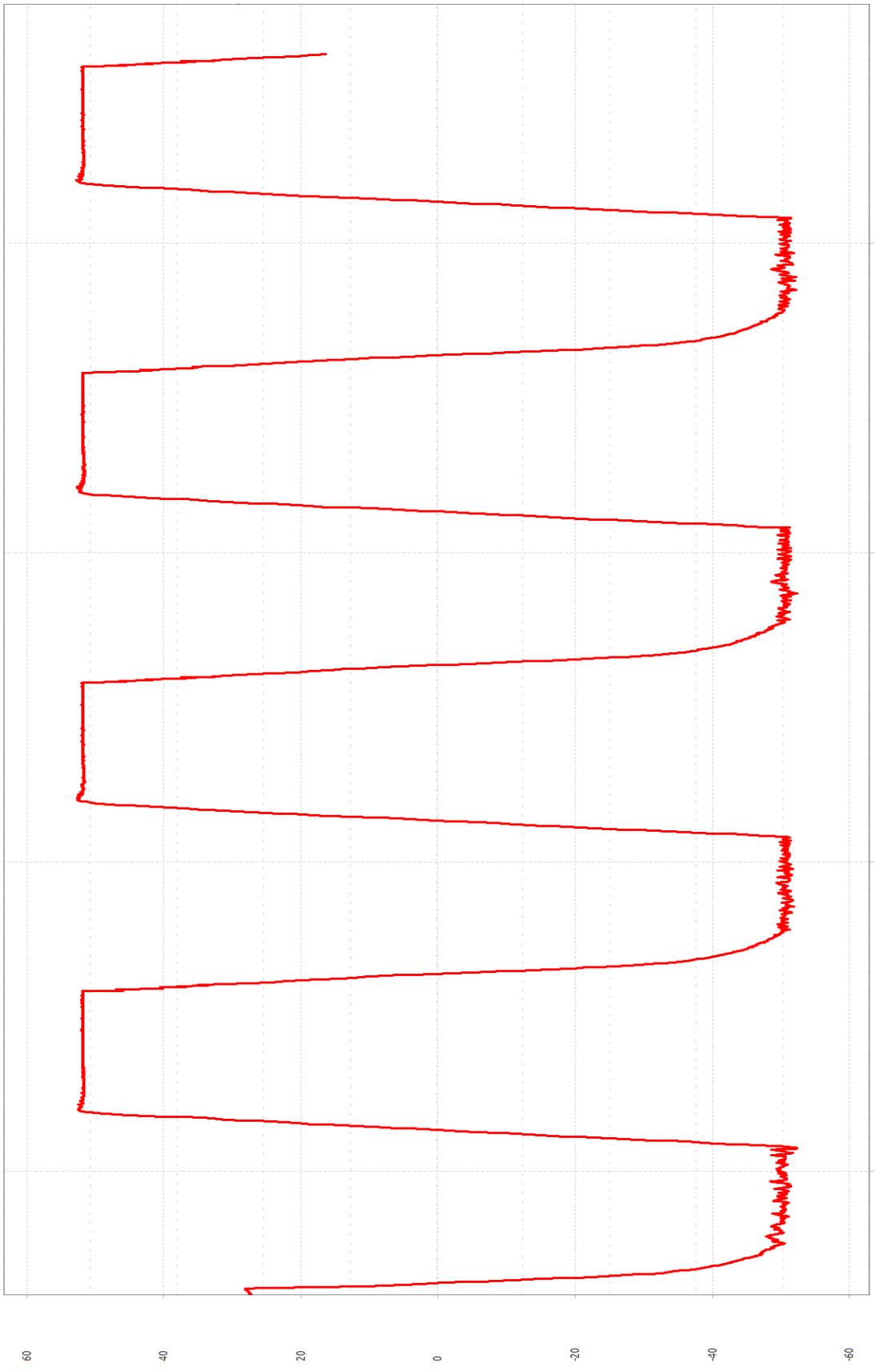


Figure 6 Record of temperature during thermal-mechanical cycles, test samples No. 23

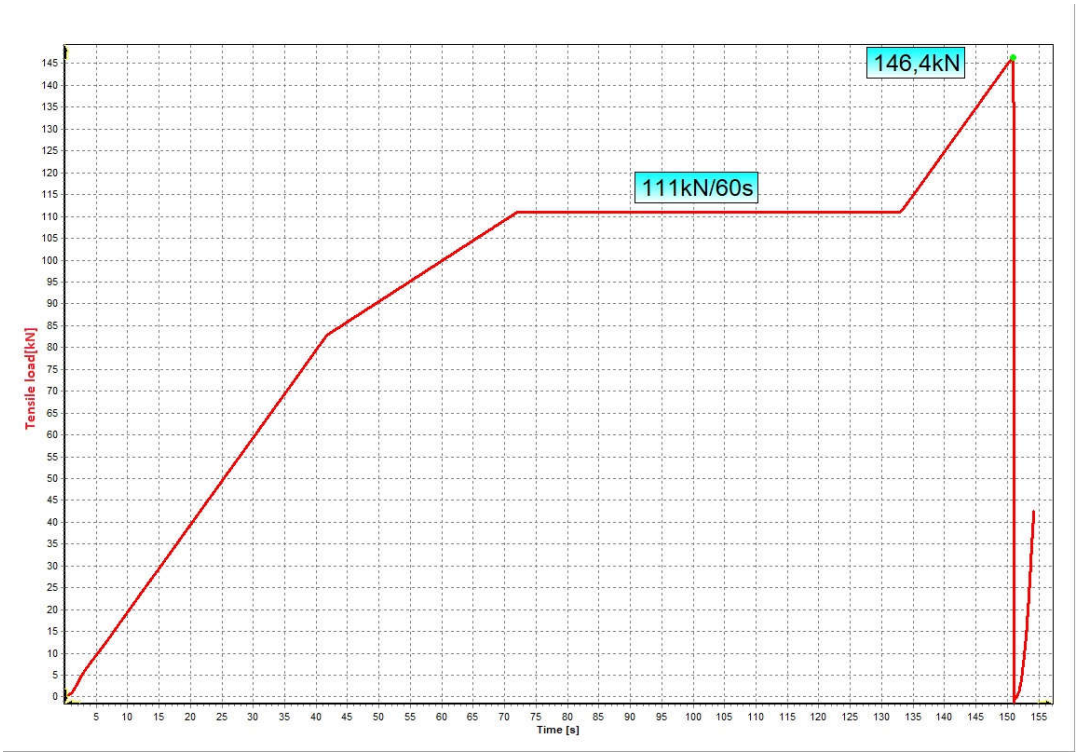


Figure 7 Record of tensile load test, test sample No. 3

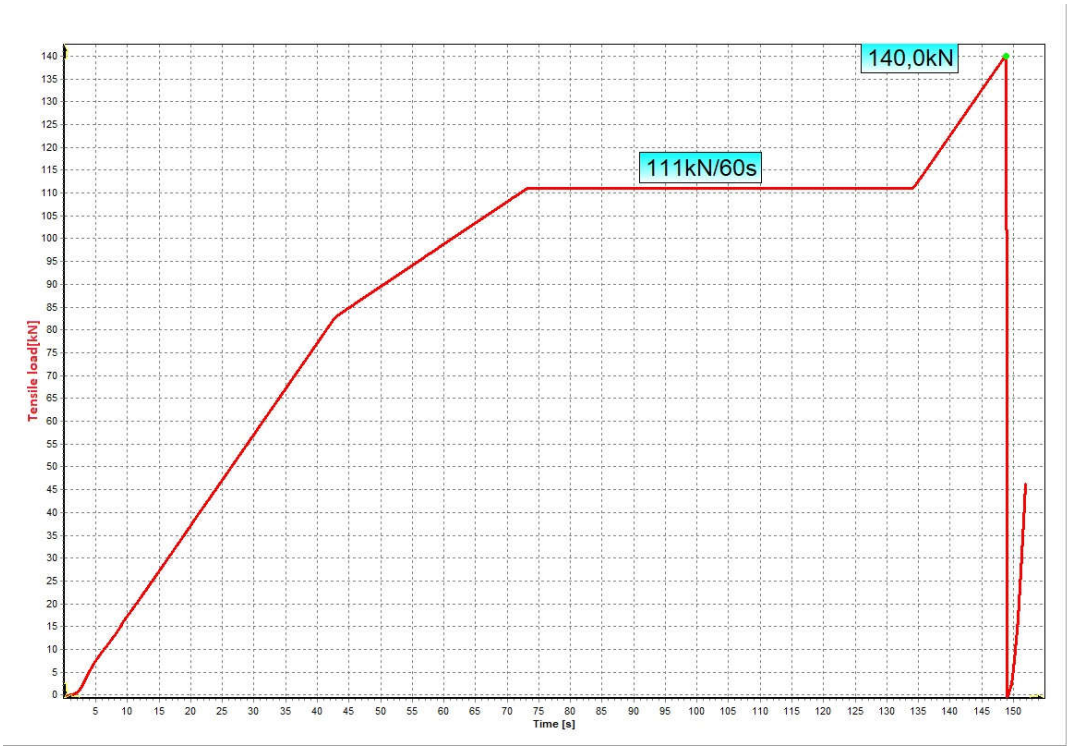


Figure 8 Record of tensile load test, test sample No. 4

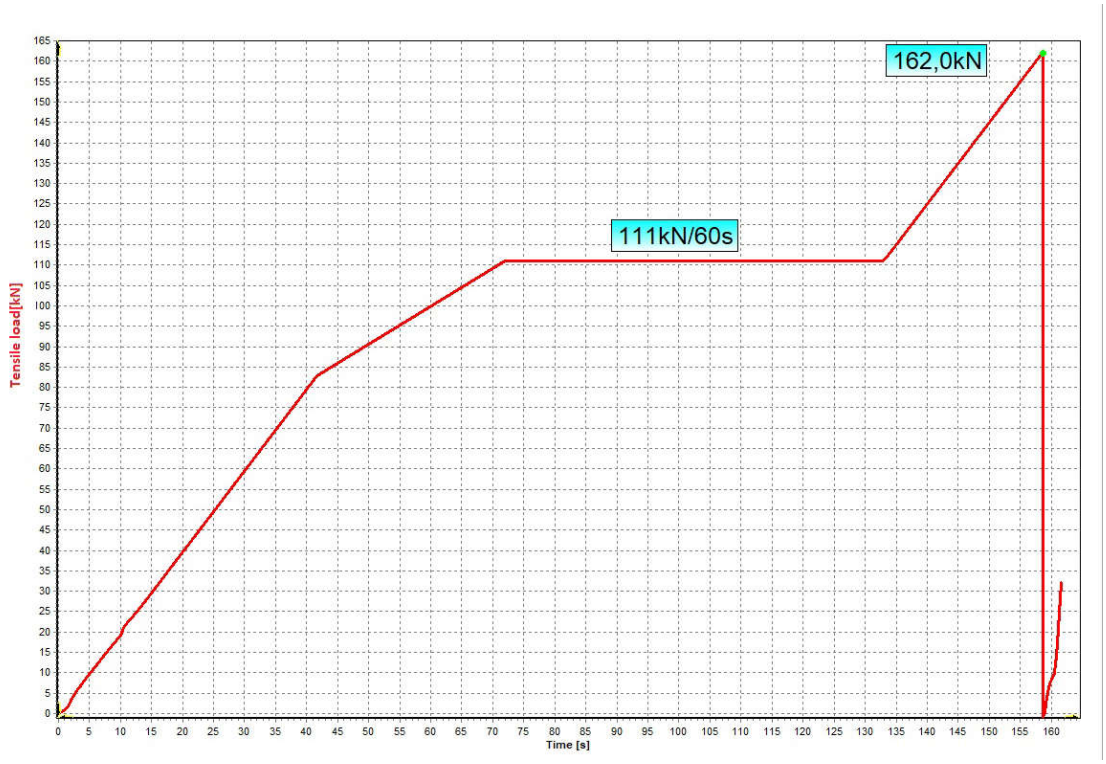


Figure 9 Record of tensile load test, test sample No. 5

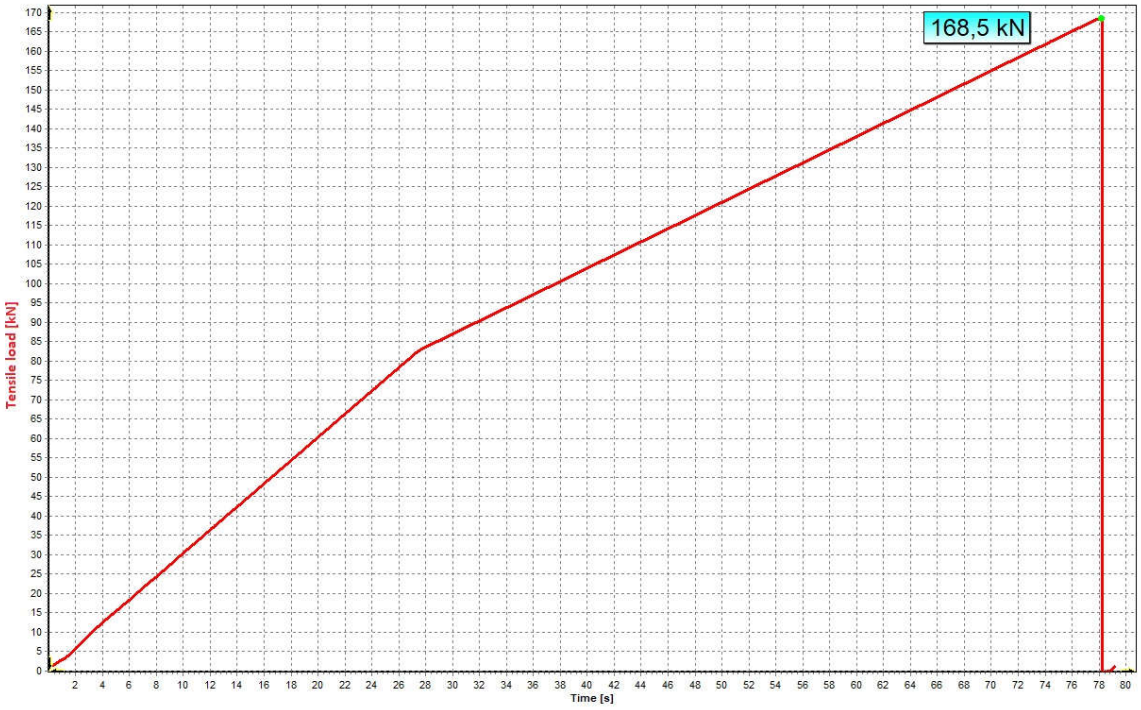


Figure 10 Record of mechanical failing test, test sample No. 6 (assembled core load-time test)

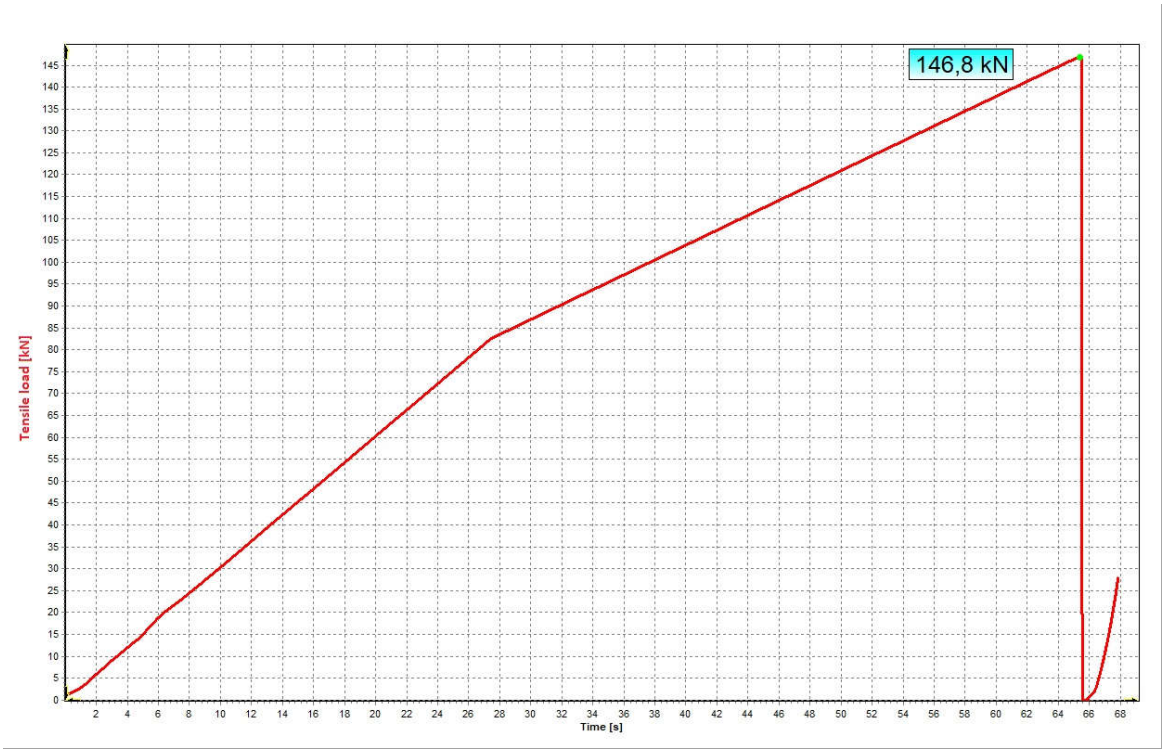


Figure 11 Record of mechanical failing test, test sample No. 7 (assembled core load-time test)

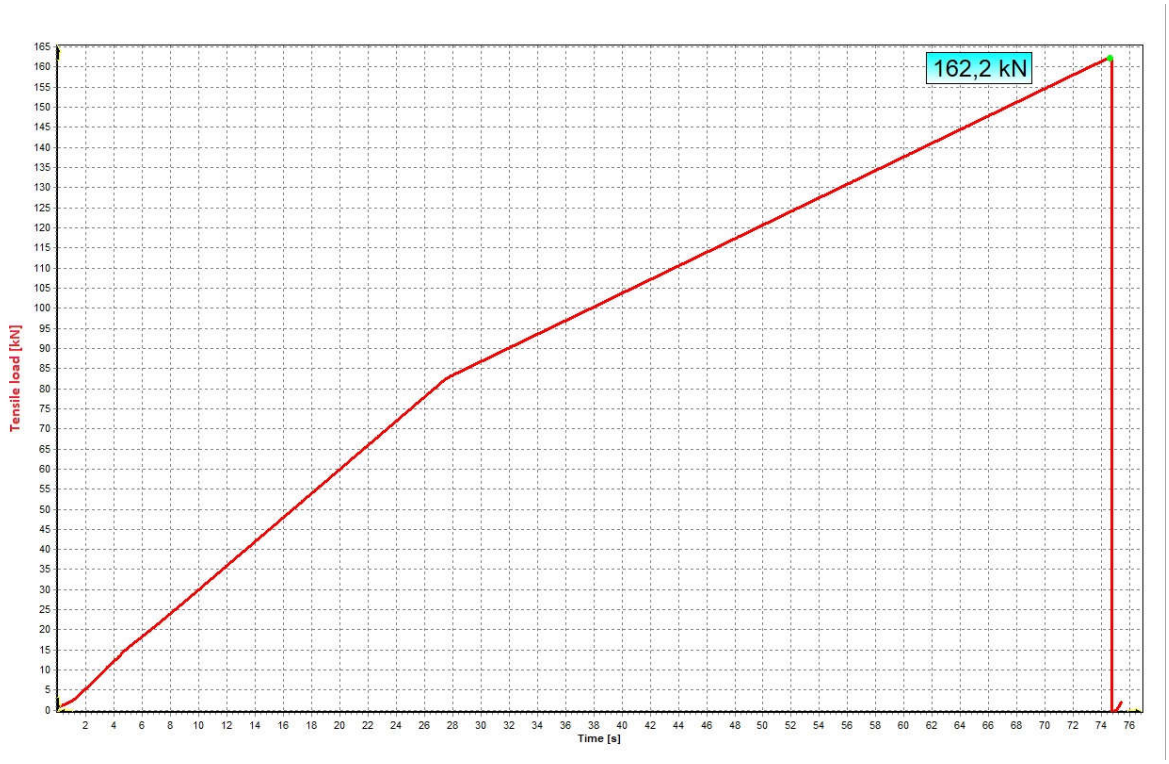


Figure 12 Record of mechanical failing test, test sample No. 8 (assembled core load-time test)

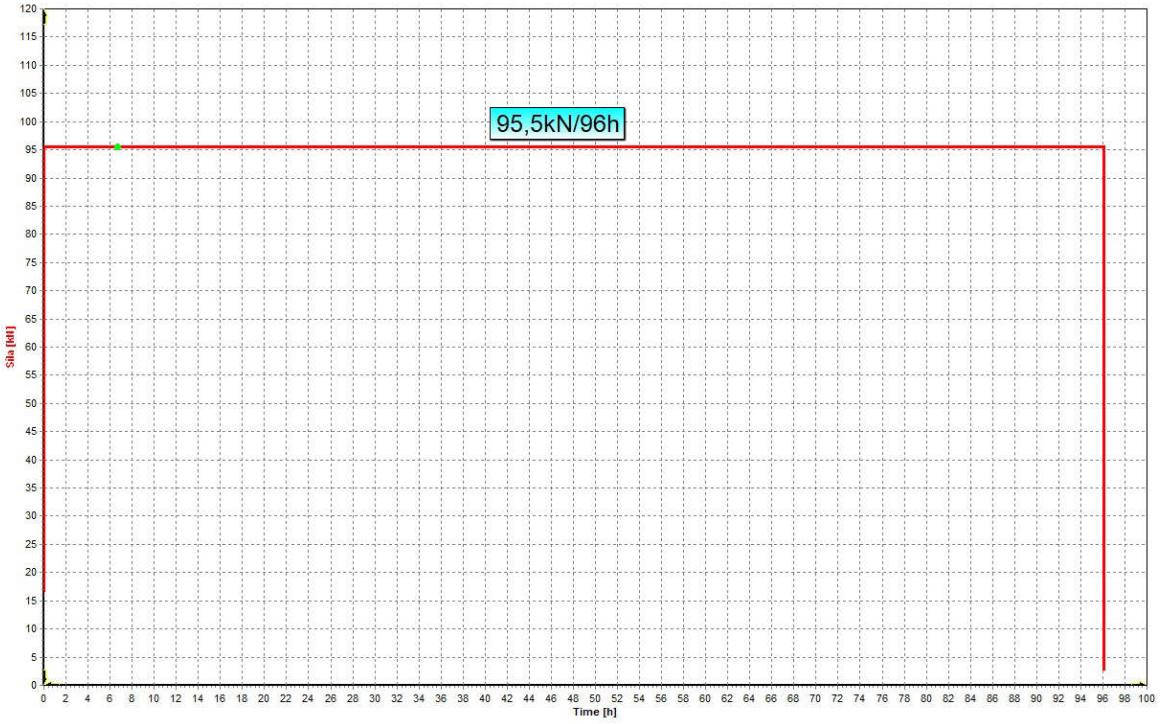


Figure 13 Record of mechanical withstand load test, test samples No. 9, 10 and 11 (assembled core load-time test)

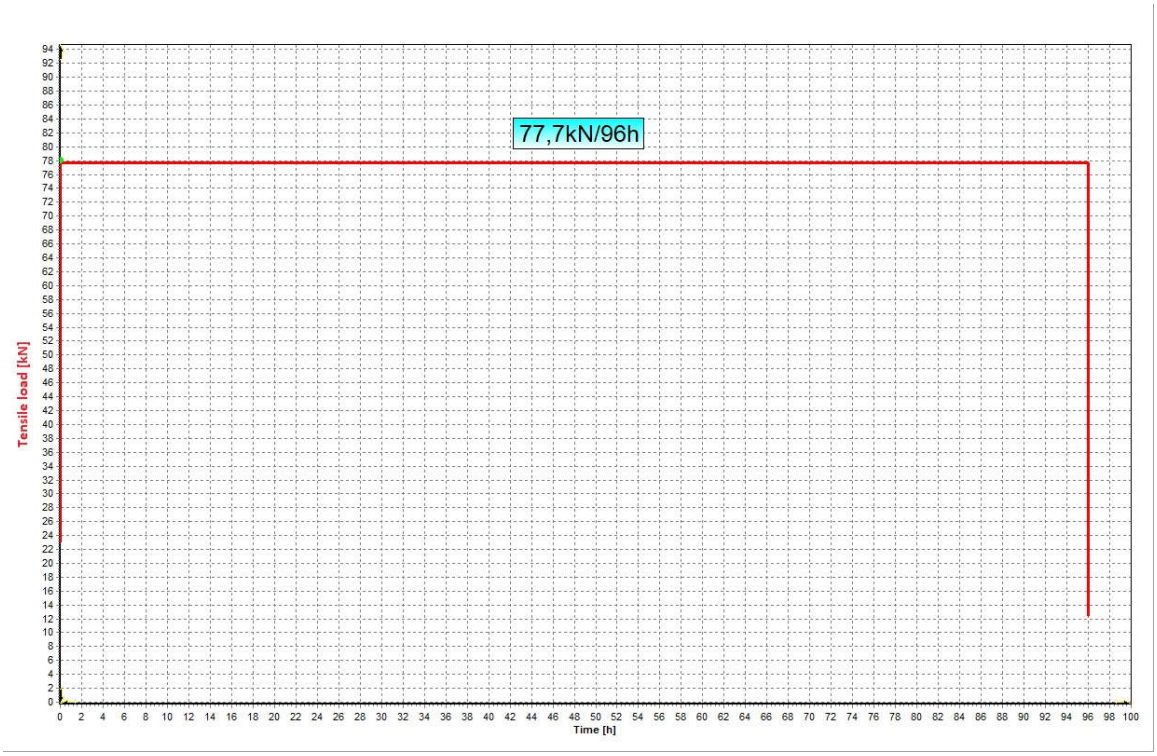


Figure 14 Record of mechanical withstand load test, test samples No. 26, 27, 28 and 29 (mechanical load-time test)

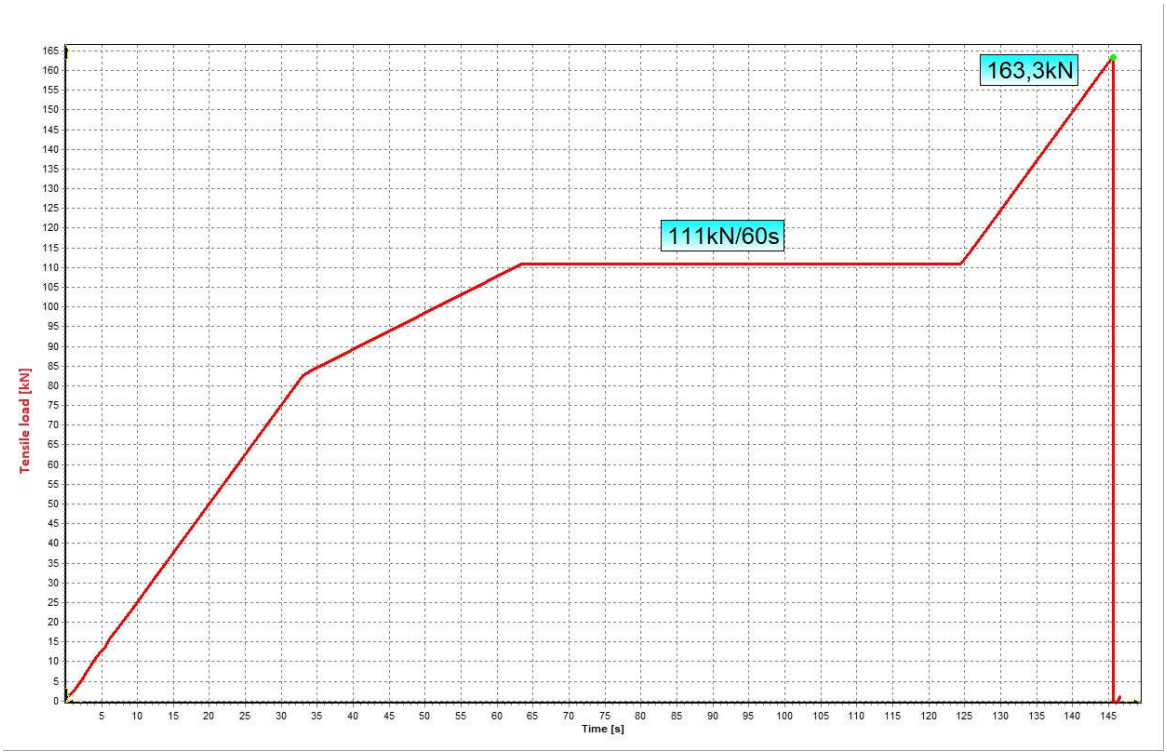


Figure 15 Record of mechanical failing test, test sample No. 26 (mechanical load-time test)

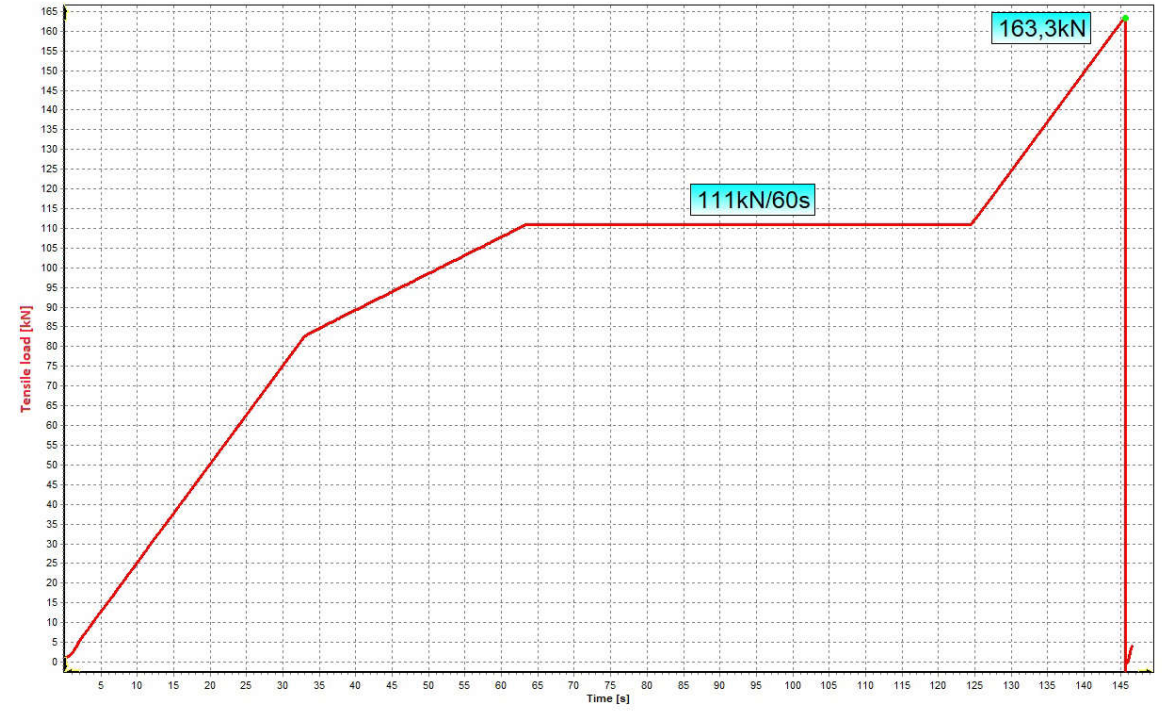


Figure 16 Record of mechanical failing test, test sample No. 27 (mechanical load-time test)

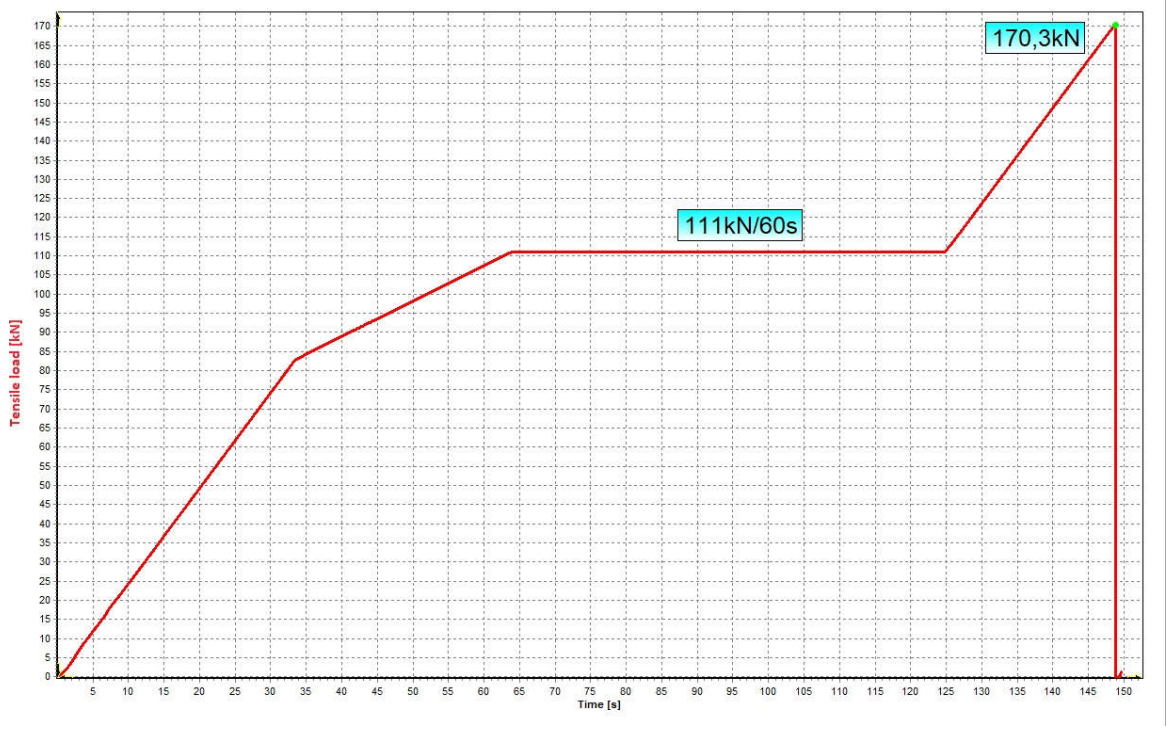


Figure 17 Record of mechanical failing test, test sample No. 28 (mechanical load-time test)

8 TEST OBJECT AND TEST SETUP PHOTOS

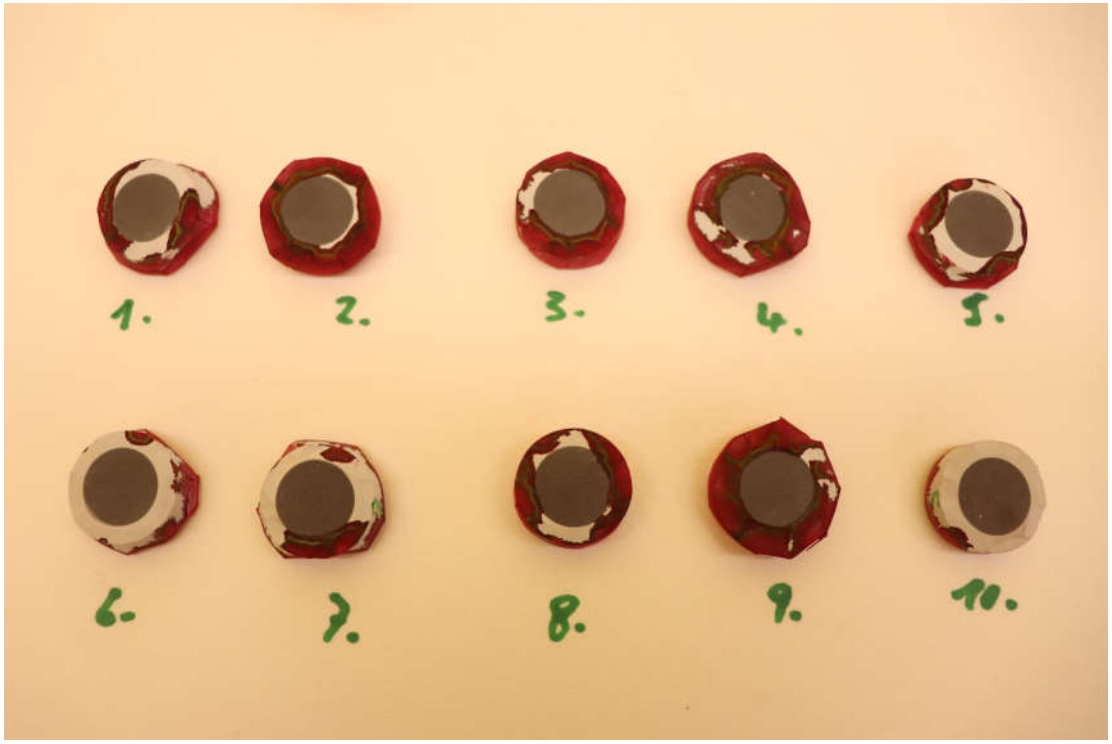


Figure 18 Test specimens after dye penetration test

Figure 19 Test specimens, water diffusion test

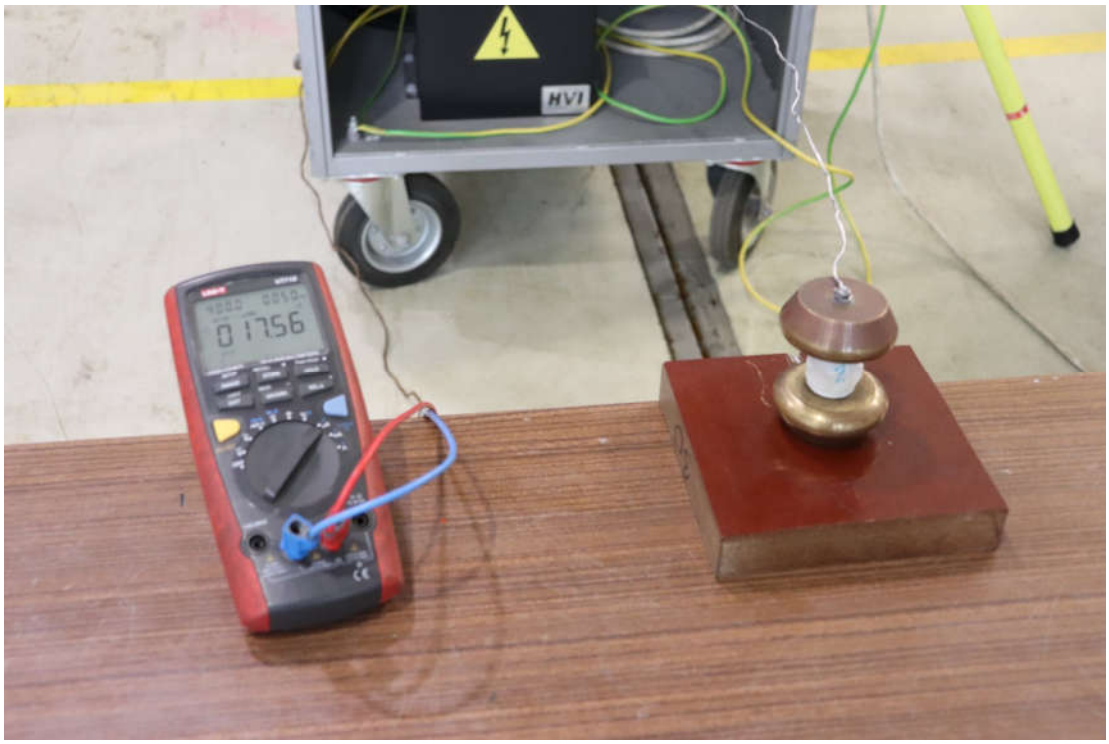


Figure 20 Test specimens during the voltage test (water diffusion test)

Figure 21 Boiling of the test samples (water penetration test)

Figure 22 Test sample during steep-front impulse voltage test (water penetration test)

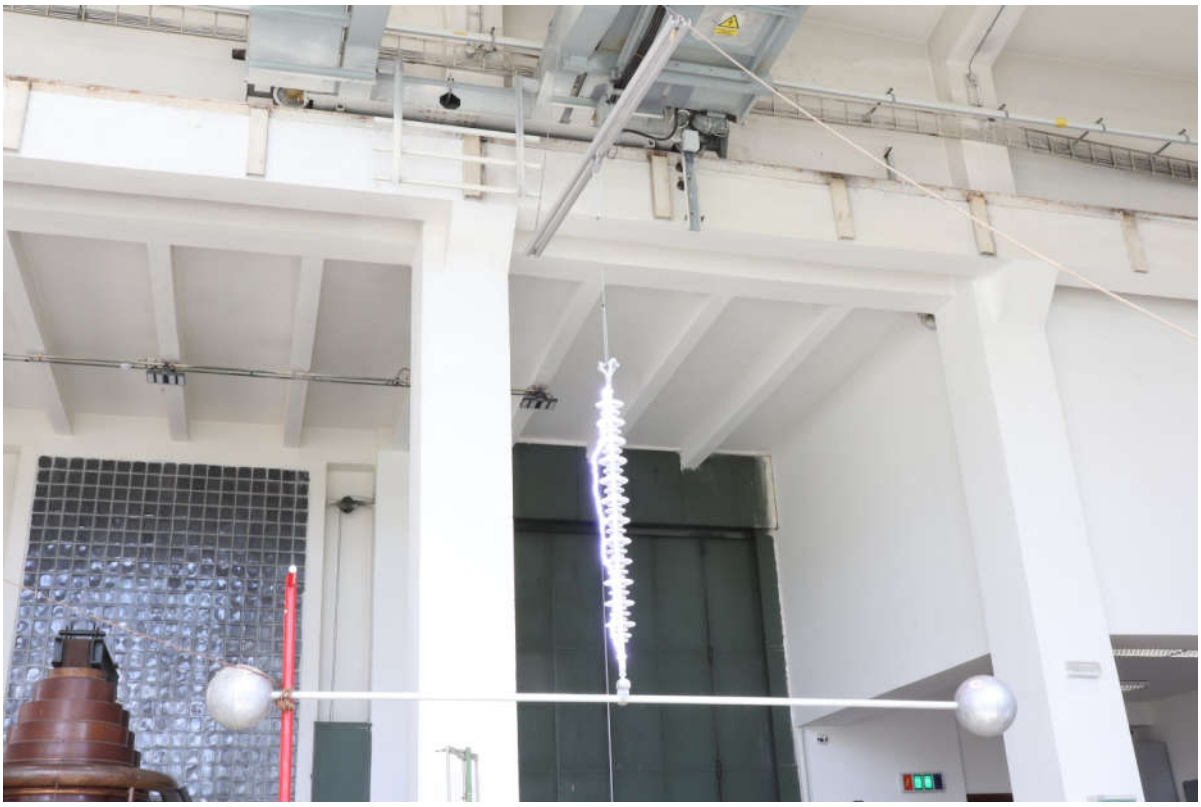


Figure 23 Test sample during the dry power frequency flashover test (water penetration test)

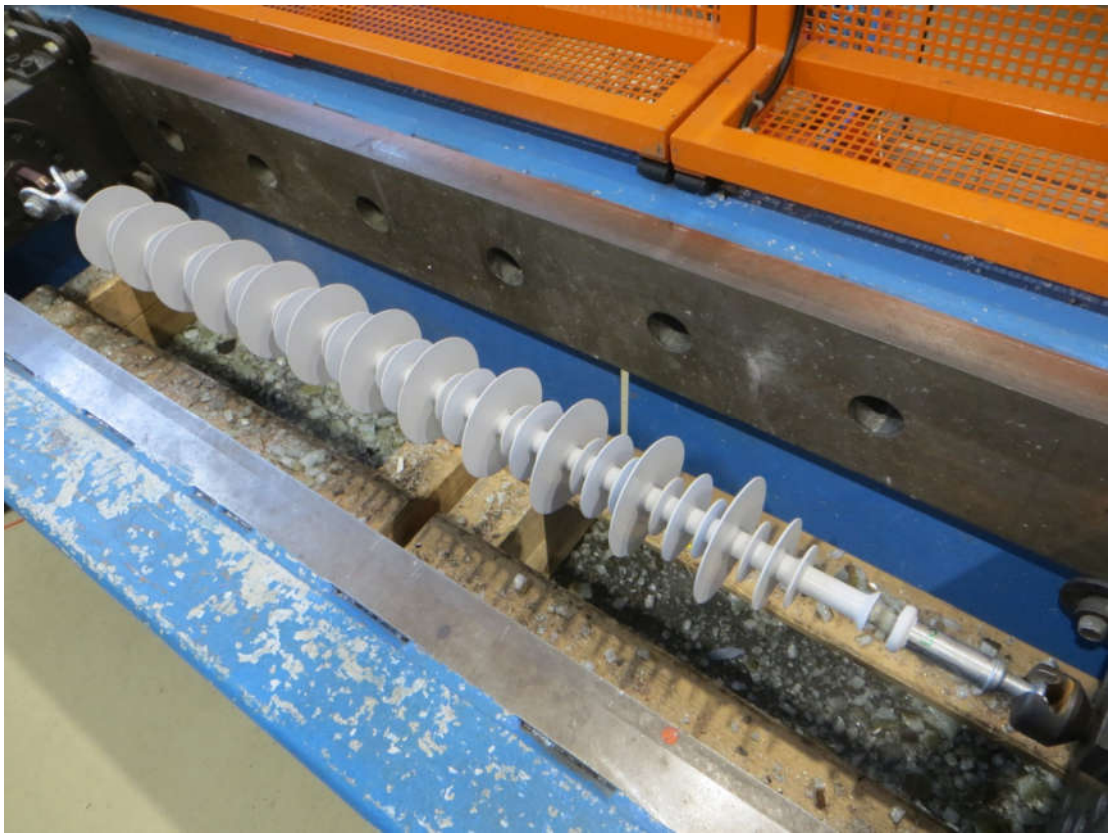


Figure 24 Tensile load test, test sample No. 3

Figure 25 Tensile load test, test sample No. 4

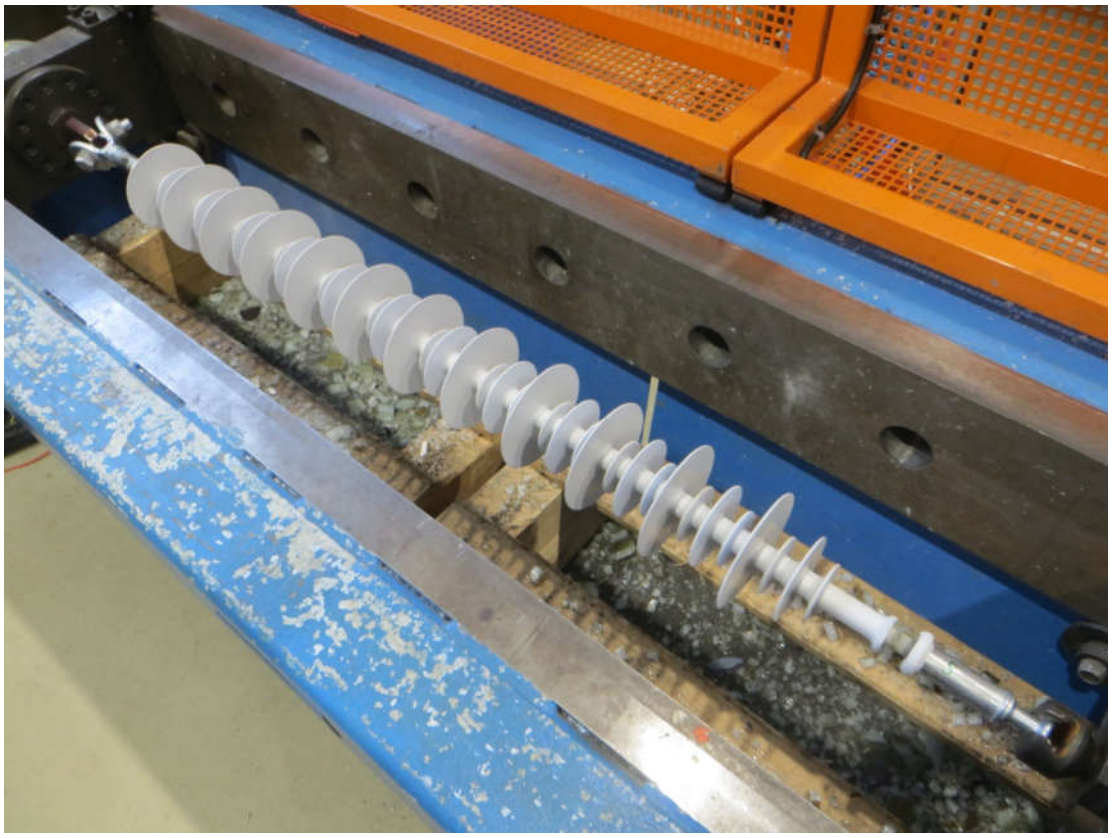


Figure 26 Tensile load test, test sample No. 5

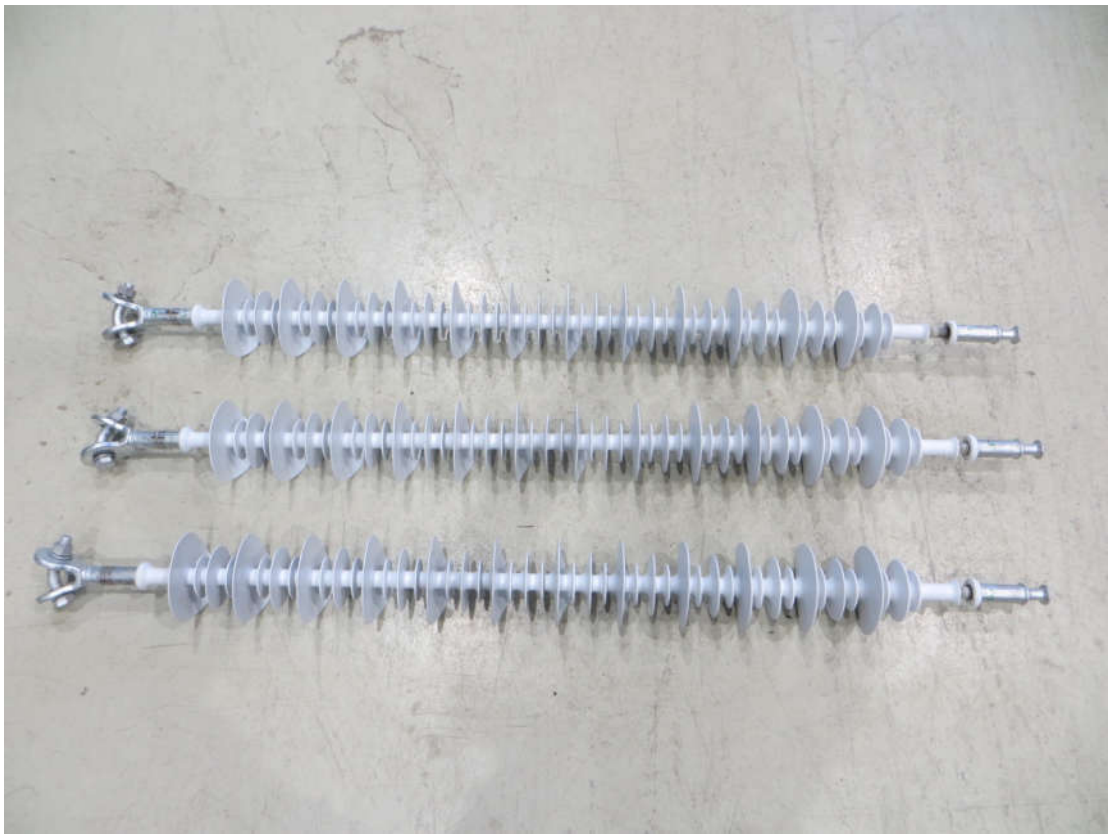


Figure 27 Test samples No. 3, 4 and 5, after tensile load test

Figure 28 Test samples No. 23, 24 and 25 during thermal mechanical test

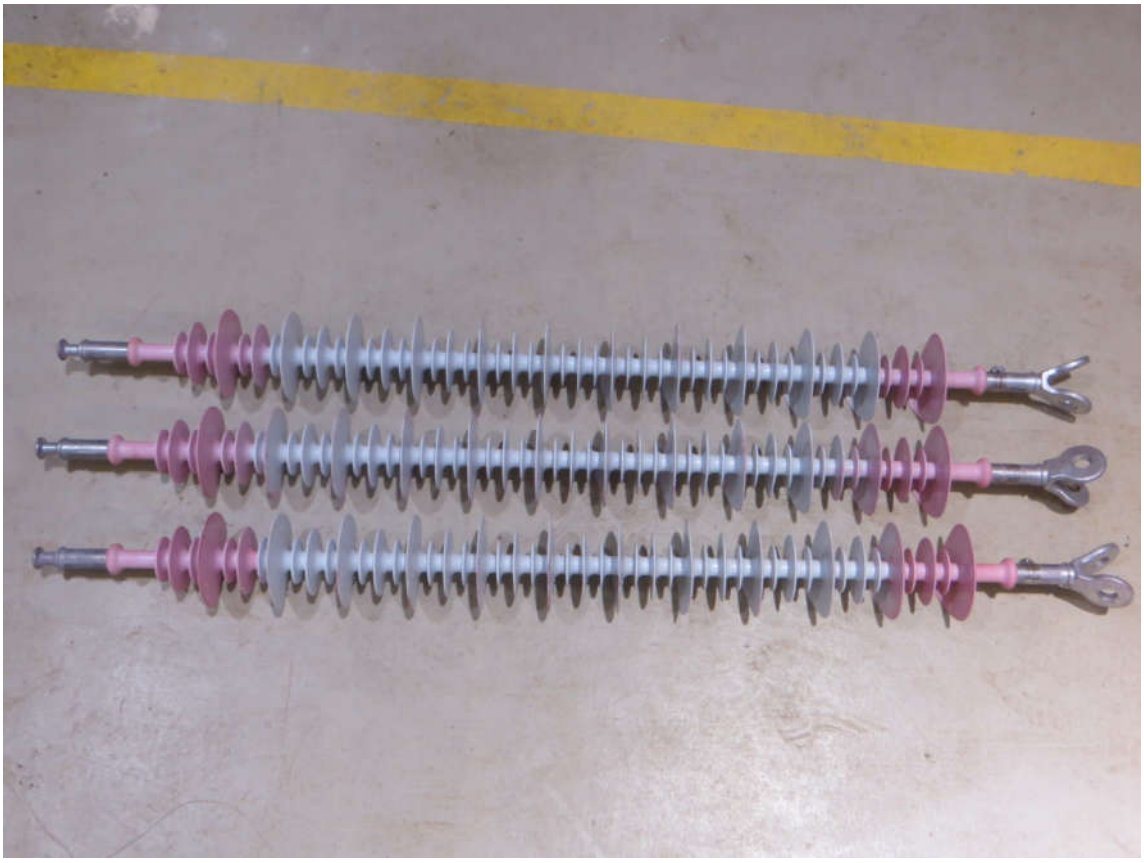


Figure 29 Test samples No. 23, 24 and 25 after submerging in a dye (moisture penetration test after thermal mechanical test)

Figure 30 Test samples after cut of end metal fittings
(moisture penetration test after thermal mechanical test)

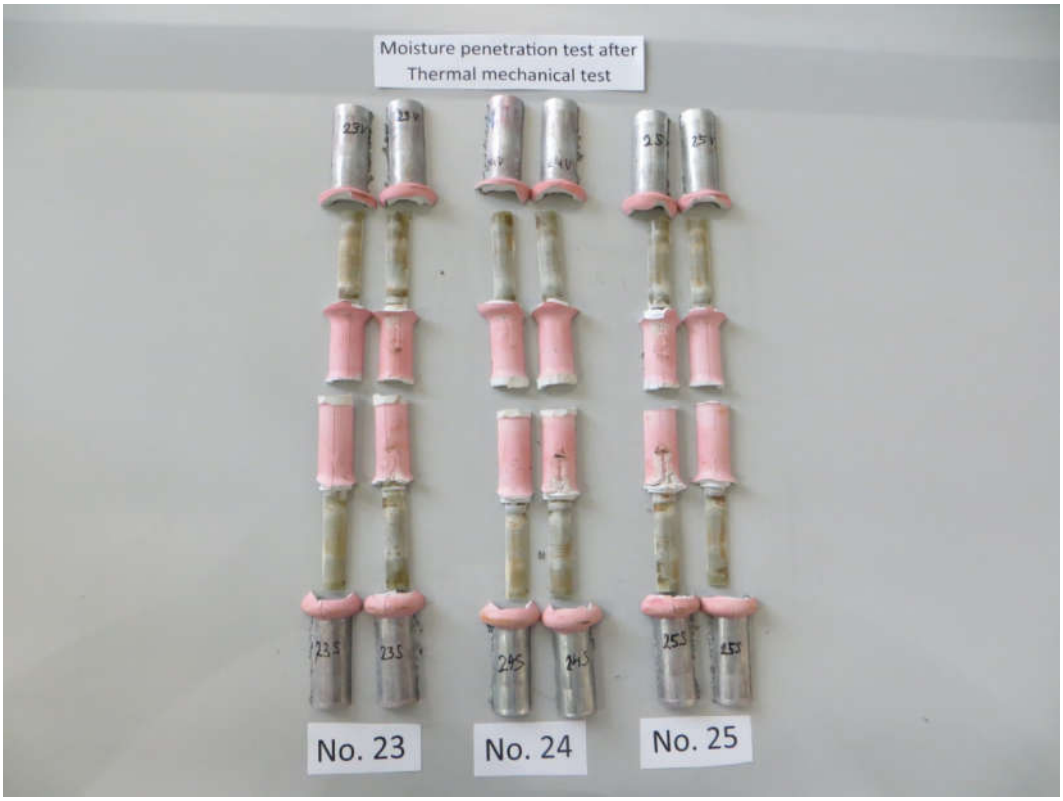


Figure 31 Test samples after removing the portion of metal fitting
(moisture penetration test after thermal mechanical test)

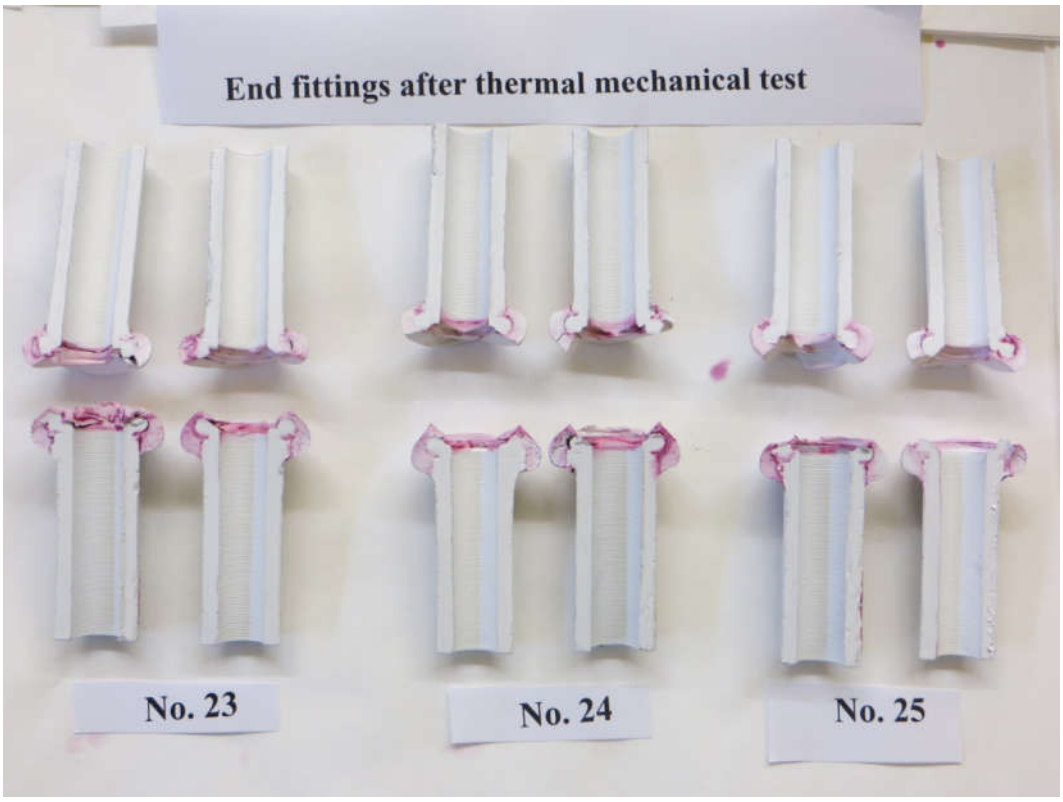


Figure 32 End fittings after penetration dye diagnostic test

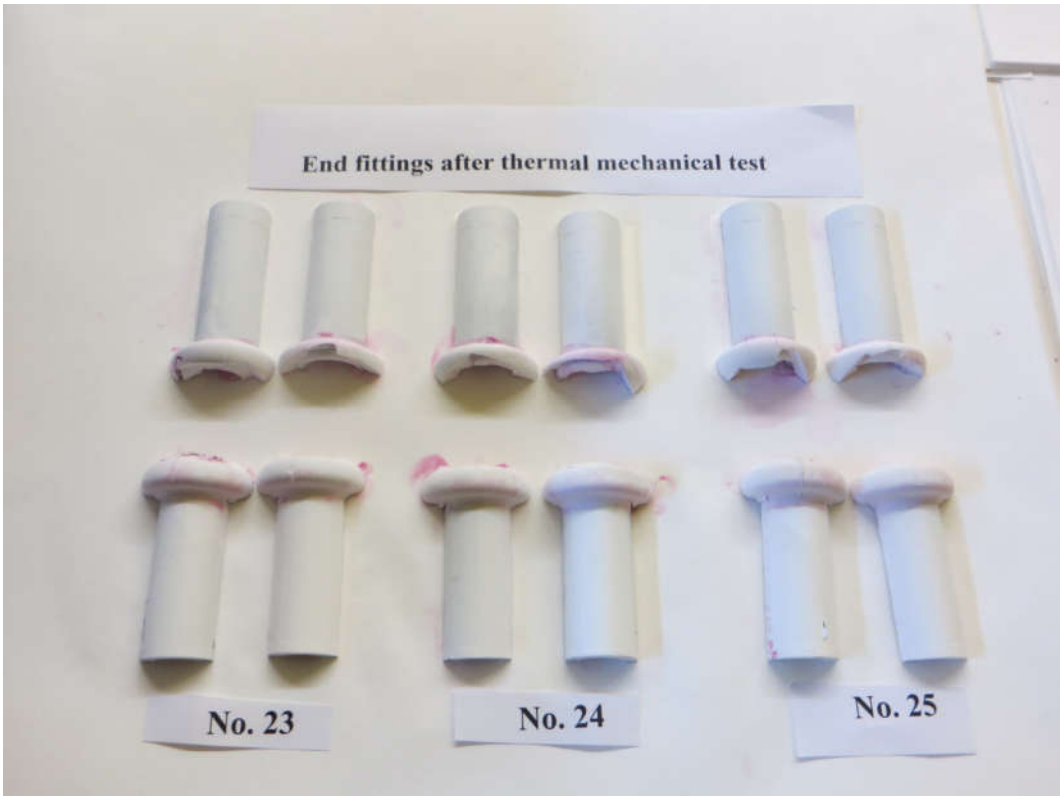


Figure 33 End fittings after penetration dye diagnostic test

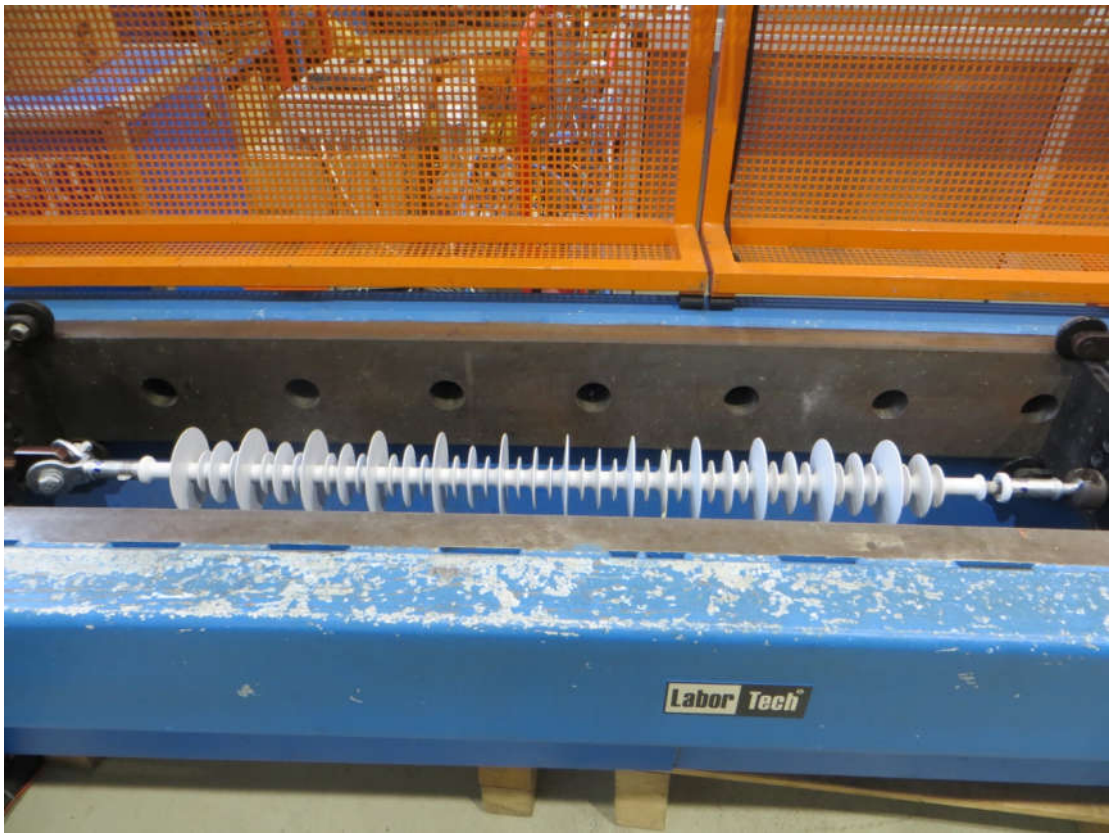


Figure 34 Assembled core load-time test, test sample No. 6

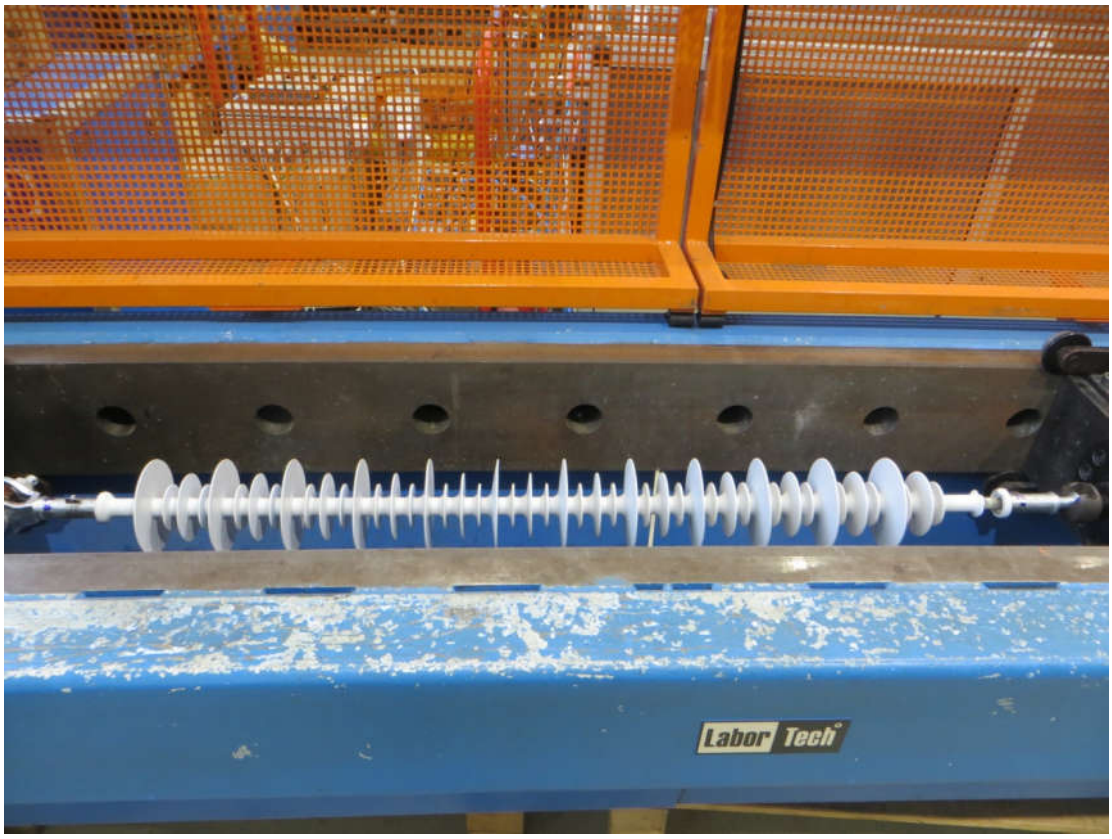


Figure 35 Assembled core load-time test, test sample No. 7

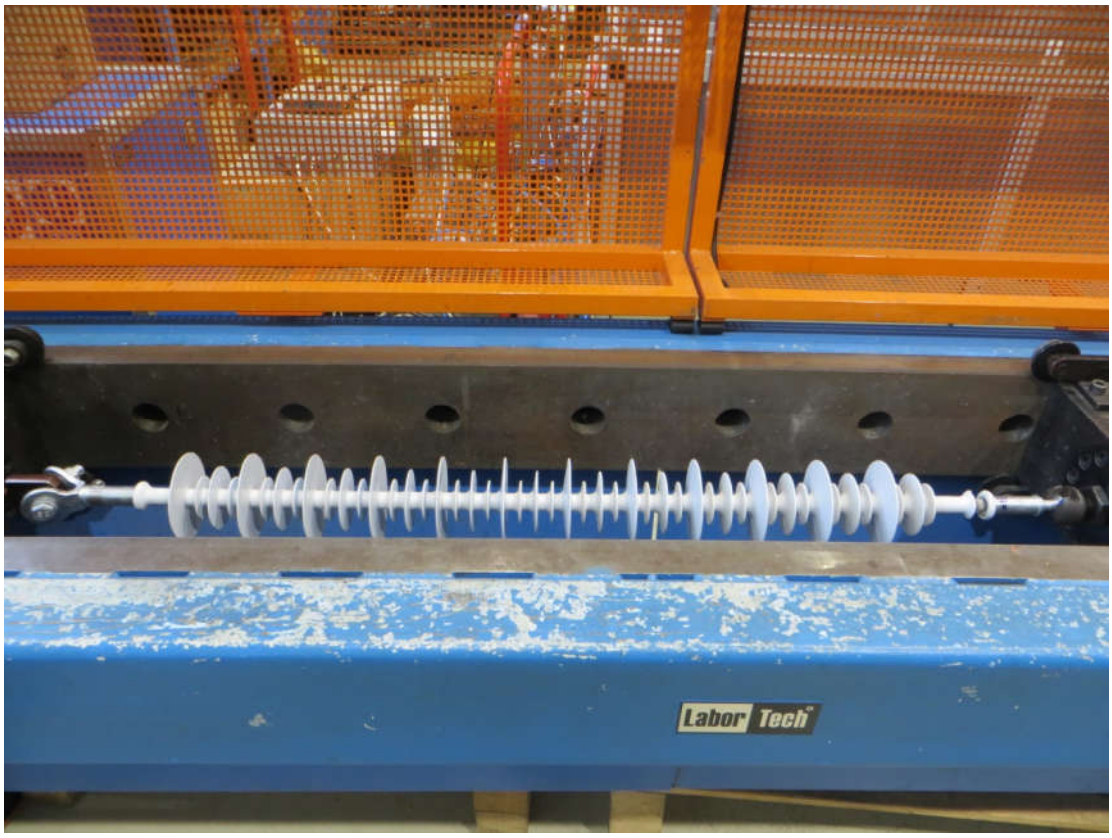


Figure 36 Assembled core load-time test, test sample No. 8

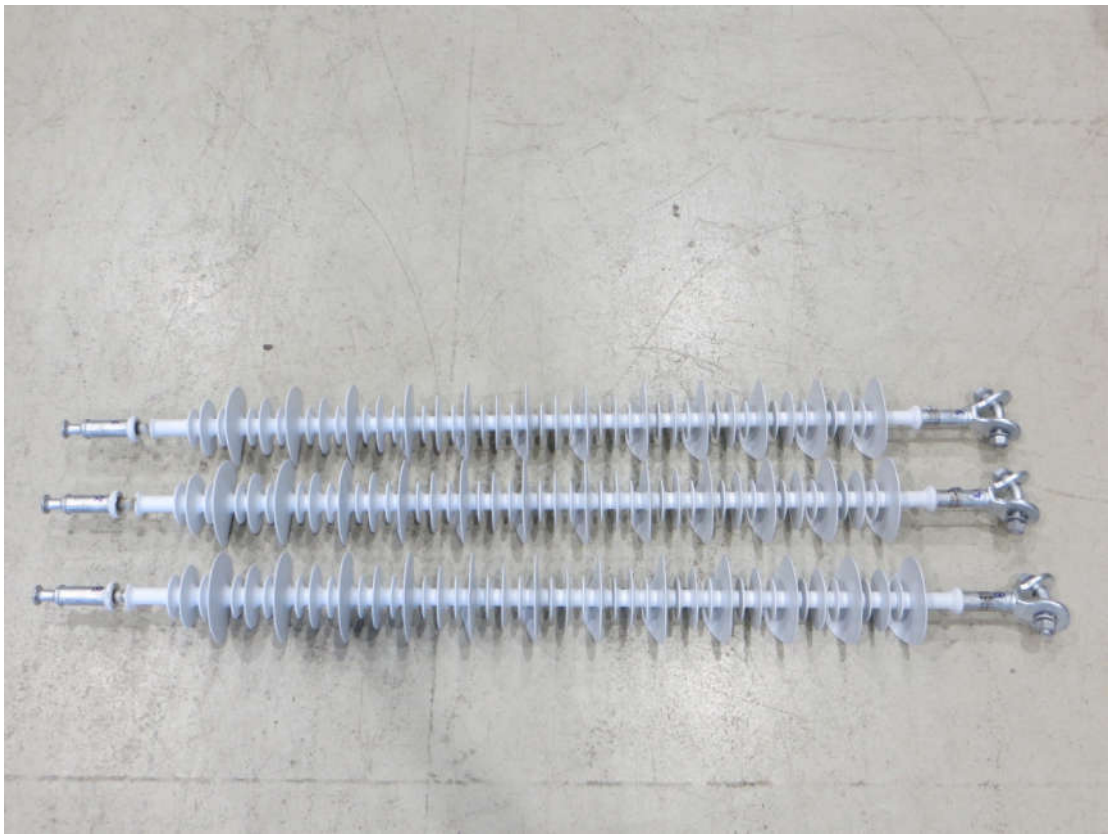


Figure 37 Test samples No. 6, 7 and 8 after Assembled core load-time test

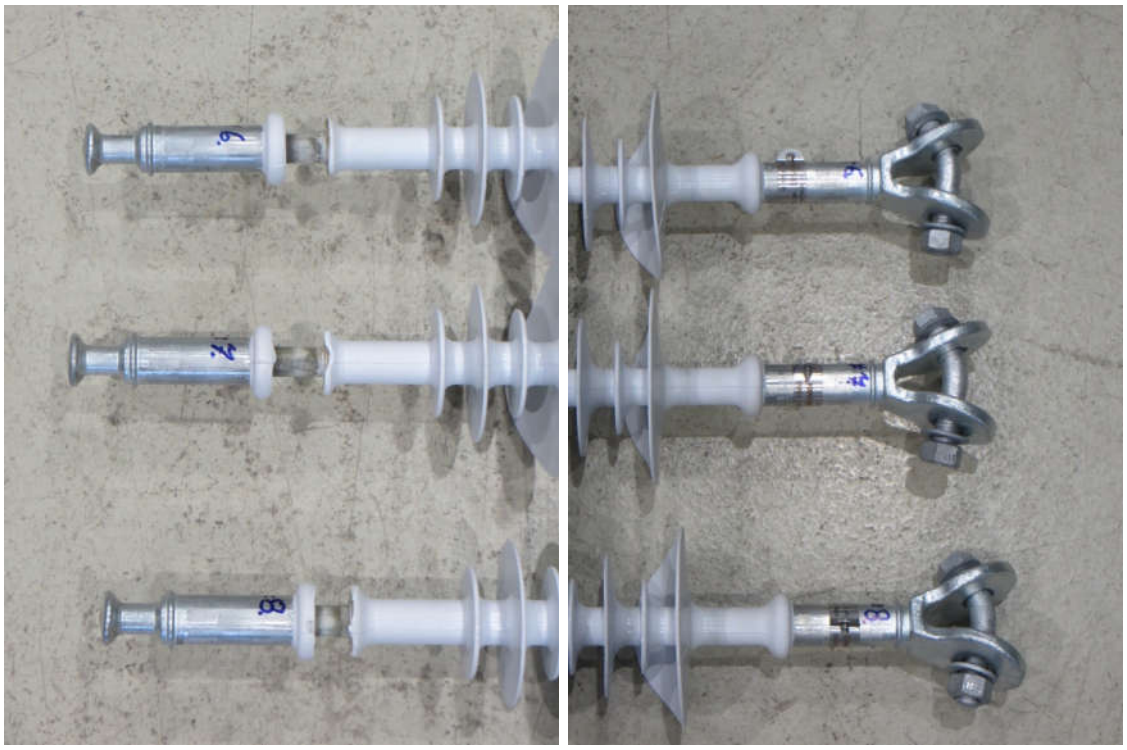


Figure 38 Test samples No. 6, 7 and 8 after Assembled core load-time test

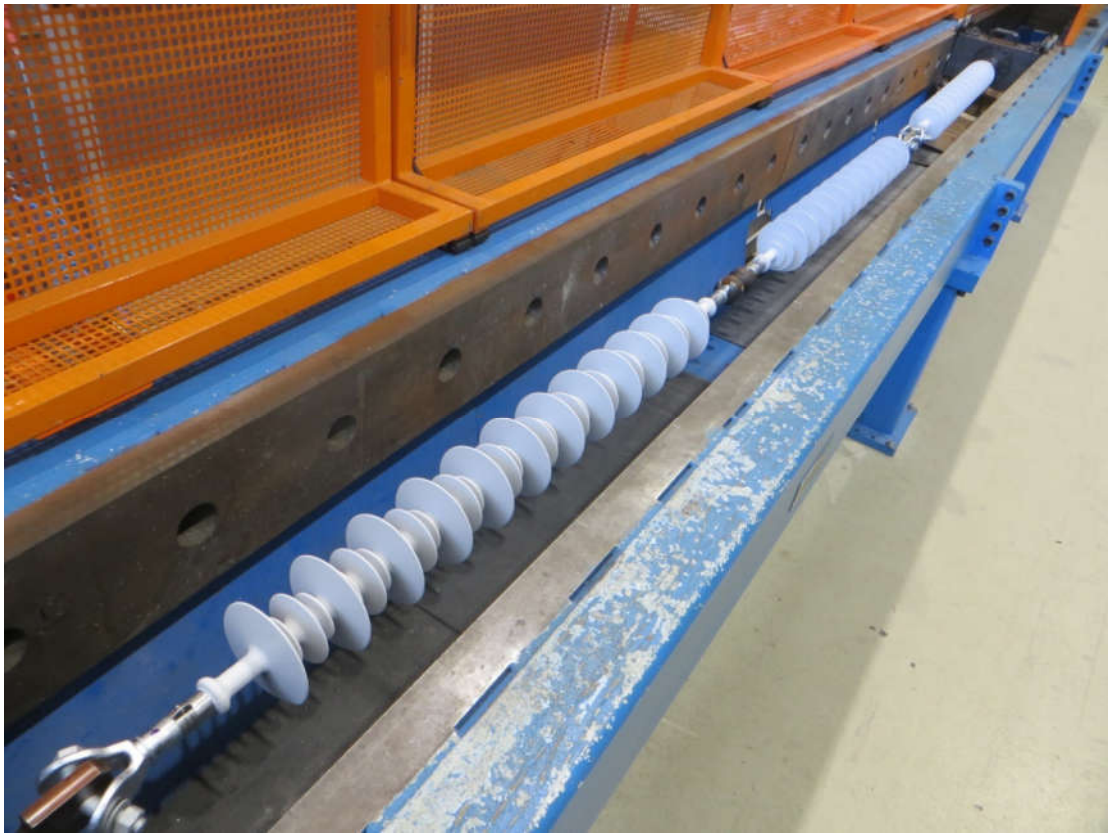


Figure 39 Assembled core load-time test, withstand tensile load test, test samples No. 9, 10 and 11

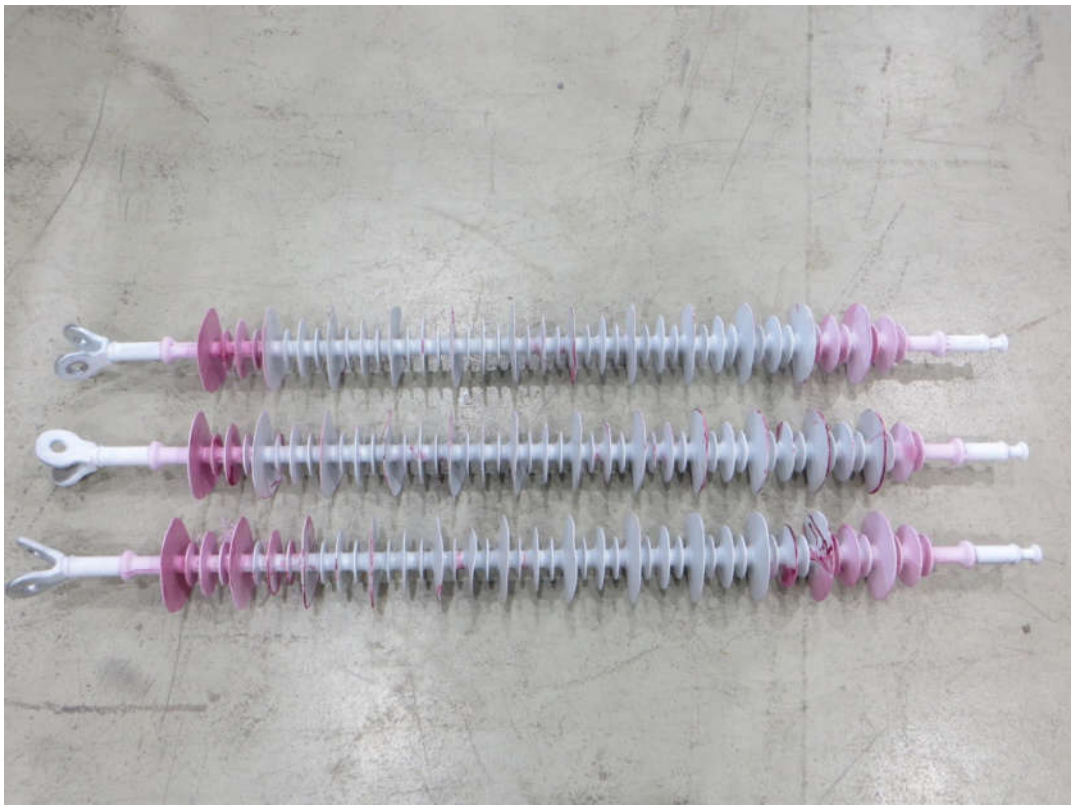


Figure 40 Assembled core load time-test, test samples No. 9, 10 and 11 after dye penetration test

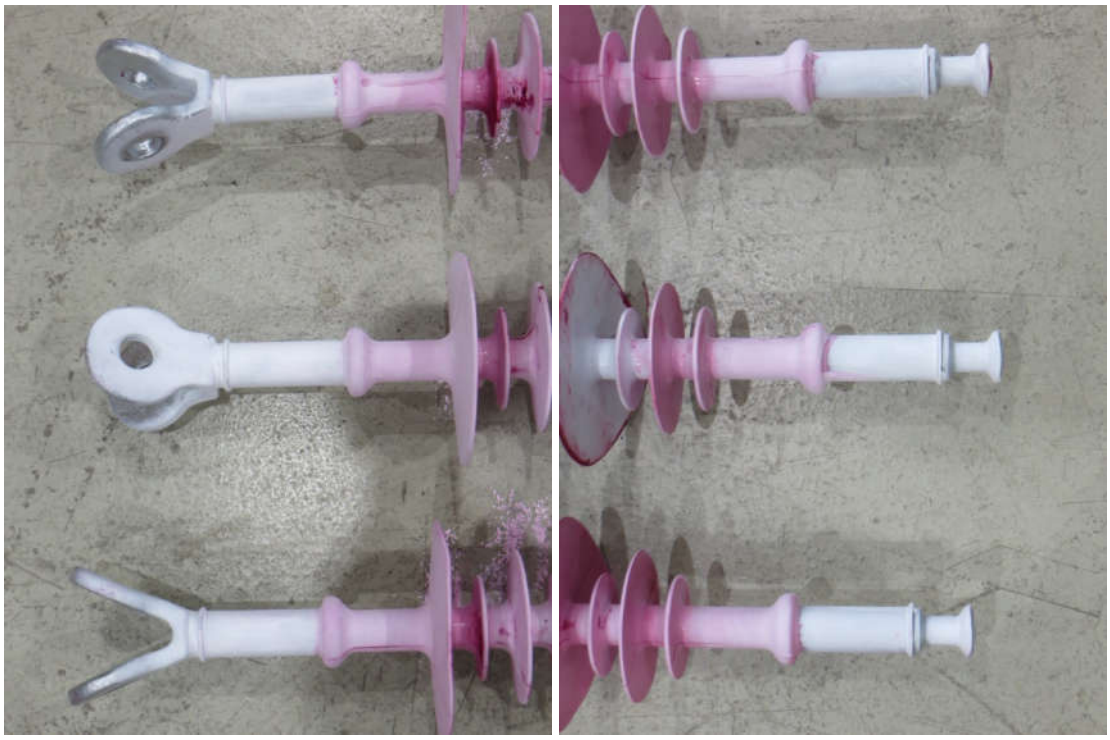


Figure 41 Assembled core load-time test, test samples No. 9, 10 and 11 after dye penetration test

Figure 42 Mechanical load-time test, withstand tensile load test, test samples No. 26, 27, 28 and 29

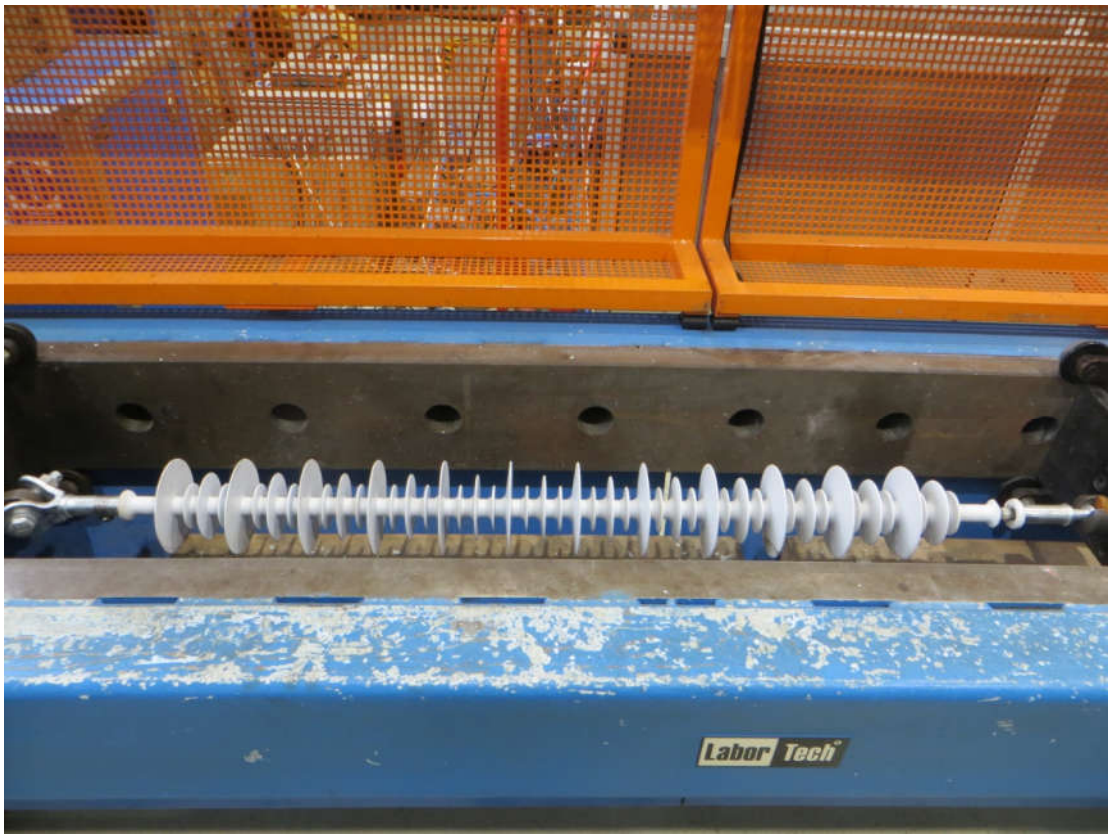


Figure 43 Mechanical load-time test, failing load test, test sample No. 26

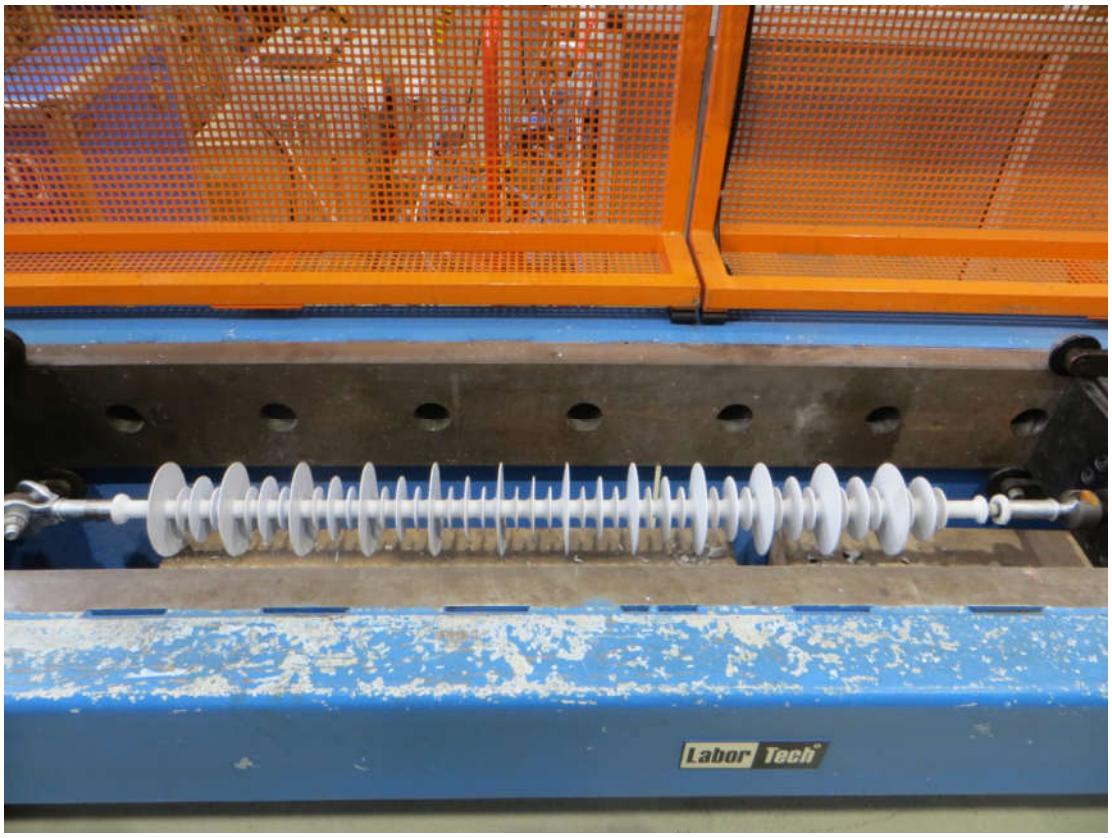


Figure 44 Mechanical load-time test, failing load test, test sample No. 27

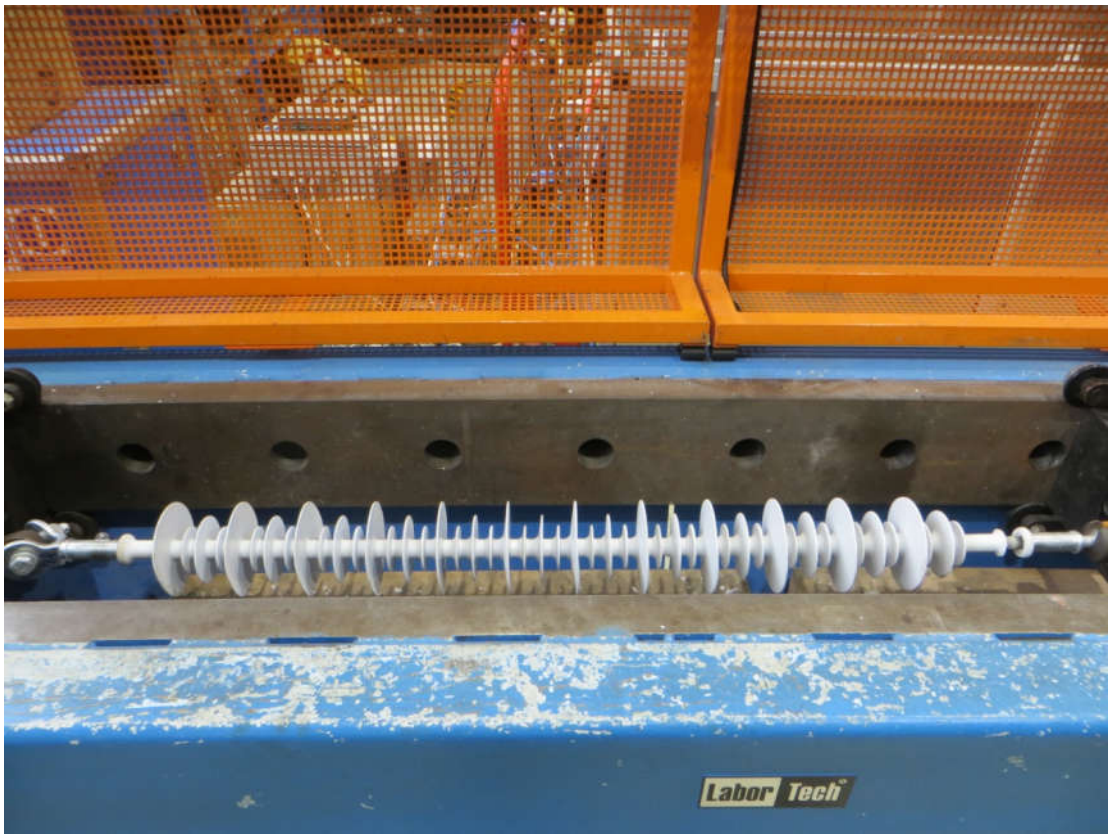


Figure 45 Mechanical load-time test, failing load test, test sample No. 28

Figure 46 Mechanical load-time test, test samples No. 26, 27 and 28 after mechanical failing load test

Figure 47 Mechanical load-time test, test samples No. 29 after dye penetration test

– end of the test report –

EGU HV LABORATORY

Since 1954
experience of testing
and research activities

L 1029

Testing laboratory No. 1029

Accredited by Czech Accreditation Institute according to ČSN EN ISO/IEC 17025:2018

TEST REPORT 12206/C/23

ACCREDITED TESTING LABORATORY EGU HV Laboratory EGU HV LABORATORY No. 1029 CZECH REPUBLIC

CUSTOMER	Jiangsu Shemar Electric Co., Ltd. No. 66 Haiwei Road 226 017 Nantong, Jiangsu China
TEST OBJECT	138 kV Composite line insulator
TYPE SPECIFICATION	138 kV / 111 kN
SHEMAR IDENTIFICATION No.	n/a
TEST STANDARDS	CSA C411.4-16, CSA C411.1-16 NEMA 107:2016, IEC 60383-1 Ed.5:2023
NUMBER OF COPY	1
NUMBER OF PAGES	19
DATE OF ISSUE	2023-11-09

Michal Novotný
Test engineer

Marek Brosch
Head of
EGU HV LABORATORY

Jan Lachman, Ph.D.
Director of
EGU - HV Laboratory a.s.

REAL INDEPENDENT TESTING

WWW.EGUHV.COM

EGU – HV Laboratory a.s.
EGU HV LABORATORY, Podnikatelská 267, 190 11 Praha 9 – Běchovice, Czech Republic | +420 267 193 361 | info@eguhv.com

TEST REPORT 12206/C/23

TEST OBJECT	138 kV Composite line insulator
TYPE SPECIFICATION	138 kV / 111 kN
DRAWING No.	23SM510304
MANUFACTURER	Jiangsu Shemar Electric Co., Ltd. No. 66 Haiwei Road 226 017 Nantong, Jiangsu, China
DATE OF DELIVERY	2023-05-19
DATE OF TESTS	From 2023-06-19 to 2023-07-31
ORDER No.	4530505010
TESTS WITNESSED BY	N/A
ANNEX	N/A

TABLE OF CONTENTS

1 TEST OBJECT IDENTIFICATION

The results presented in this test report apply only to test objects subjected to the testing. Responsibility for conformity of any objects having the same designation as the test object fully rests with the Manufacturer.

EGU HV LABORATORY is not responsible for the sampling. Samples are provided by a customer. Test results apply only to tested samples as received.

A customer guarantees a test object being made according to submitted product drawings and documents, see Table 1.

EGU HV LABORATORY confirms product drawings submitted by a customer fully represent in technical aspects (shape, dimensions etc.) a given test object and markings/nameplates on a test object conform with drawings.

Table 1 Drawings/documents submitted, and included in this test report

Title	Drawing No.	See
138 kV Composite line insulator	23SM510304	Figure 1

2 TEST SUMMARY

Test title	Test standard	Result
Corona test	CSA C411.4-16, clause 6.4.4	Pass
Critical impulse flashover tests	CSA C411.4-16, clause 6.2 CSA C411.1-16, clause 6.5.1 to 6.5.3	Pass
Wet power frequency voltage test	CSA C411.4-16, clause 6.3 CSA C411.1-16, clause 6.4	No criteria

3 LIST OF SYMBOLS

Symbol	Description
RIV	Radio influence voltage (µV)
VT	Test voltage specified by client (kV)
U_e	Extinction corona voltage (kV), corresponding to actual atmosphere
U_p	The maximum voltage of impulse wave (kV)
T_1	Front time of impulse wave (µs)
T_2	Time to half-value of impulse wave (µs)

4 TESTS PERFORMED

4.1 CORONA TEST

4.1.1 Test procedure

The test was carried out according to CSA C411.4-16, clause 6.4.4 and customer requirements.

The test was performed on one composite insulator assembly, including grading rings.

The test was carried out on one insulator No. 12, serial No. 2305096037.

After the test room was thoroughly darkened the voltage above corona point was applied and held for 5 minutes. The voltage was then reduced until corona disappeared from the test object to measure the corona extinction voltage. This procedure was three (3) times repeated. Field glasses were used for the observation of the corona. Measured extinction voltages are shown in Table 3.

The test arrangement was set up according to CSA C411.4-16, clause 6.4.2.2 (see Figure 3). The single conductor was simulated using an aluminum tube of 8 m length and 30 mm diameter. Both ends of the tube were terminated with corona shielding spheres (screening electrode) with a diameter of 300 mm. Conductor was at a height of 4 m above the ground.

The exact line configuration (conductor surface voltage gradient E2) was not known in time of the test. The client specified test voltage (minimum corona extinction voltage) as 120% of maximum design phase-to ground service voltage i.e. $VT = 1{,}2 \times 145/\sqrt{3} = 100$ kV.

The test object at the specified test voltage is shown in Figure 3. The corona discharges are shown in Figure 4.

Radio interference voltage RIV was measured according to NEMA 107. RIV (expressed in decibels relative to 1 µV across 150 Ω) was measured at the frequency of 1,0 MHz in compliance with the circuit diagram in Figure 3-3a of NEMA 107, Section 3.

The circuit RIV factor was 0,42.

Measured RIV values are shown in Table 2.

Testing and measuring equipment:

- test transformer TuR Dresden 5,7/1 200 kV, 1 500 kVA
- inductive regulator ČKD Praha 6/ 0 - 3 kV, 50 kVA
- capacitive divider TuR Dresden 1 200 kV, 150 pF, type WMC 160/1200, serial No. 884470
- universal voltmeter Haefely, type DMI 551, serial No. 150505
- coupling capacitance, 1 000 pF, 800 kV, serial No. 11100108.10.1
- measuring receiver Power Diagnostix, type RIV meter, serial No. 035
- calibrator Power Diagnostix, type CAL3B, serial No. 3014
- impedance Power Diagnostix, type CIT4M/V8µ0/RIV, serial No. 12533
- measuring system for atmospheric condition COMET, serial No. 10910247
- measuring telescopic stick 5 m, type BMI, serial No. 102
- digital stopwatch Kalenji PM-260

4.1.2 Test results

Table 2 Results of the RIV test

Date of the test: 2023-07-31			
Atm. conditions			
pressure (kPa)			98,4
temperature (°C)			23,2
rel. humidity (%)			49,7
Test voltage (kV)	**Radio - influence voltage (µV)**		
	1st run ↓	**2nd run ↑**	**3rd run ↓**
160	12 589	14 125	14 125
150	7 943	6 310	6 310
140	89	100	89
130	71	71	71
120	50	50	50
110	28	28	28
100	**10**	**10**	**10**
90	10	10	10
80	10	10	10
70	10	10	10
|	|	|	|
0	–	–	10
Measuring frequency:	1,0 MHz	Circuit correction factor:	0,42

Table 3 Results of the corona voltage test

Date of the test: 2023-07-31	
Atm. conditions	
pressure (kPa)	98,4
temperature (°C)	23,2
rel. humidity (%)	49,7
Measurement No.	**Corona extinction voltage (kV)**
1	142
2	144
3	143
Average value	**143**
Location of corona	Insulator
Criteria U_e > 100 kV)	

Evaluation:

Measured corona extinction voltages U_e were greater than the specified minimum corona extinction voltage of 100 kV.

Statement of conformity:

138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304, passed the test according to requirements given in CSA C411.4-16, clause 6.4.4.

4.2 CRITICAL IMPULSE FLASHOVER TEST

4.2.1 Test procedure

The tests were carried out according to CSA C411.4-16, clause 6.2 and CSA C411.1, clause 6.5.

The test was carried out on three insulators:

No. 12, serial No. 2305096037,

No. 13, serial No. 2305096031,

No. 14, serial No. 2305096007.

The critical impulse voltage of positive and negative polarity was determined by the up and down method with 30 impulses according to CSA C411.1-16, clause 6.5.3.

All measured voltages were corrected to the standard reference atmospheric conditions according to CSA C411.1-16, clause 6.2.5. ad 6.2.6.

The wave shape of lightning-impulse 1,2/50 µs is given in Figure 2.

The test arrangement was set up according to CSA C411.1-16, clause 6.5.1 & IEC 60383-1, clause 36 (see Figure 6).

Testing and measuring equipment:

- impulse generator HighVolt IGL 180/1800G, serial No. IGG2295141
- capacitive/resistive divider, type MCR 0,4/2000-1000/1000 H391-41, serial No. MCR2295141/103732
- measuring system High Volt, type HiRES S4D, serial No. HIGG2295141
- measuring system for atmospheric condition COMET, serial No. 14900363
- tape measure, type 7,5 m, Assist, PM-292

4.2.2 Test results

Table 4 Results of the critical impulse flashover tests – positive and negative

Date of the tests: 2023-06-19						
Test sample No.	**12**		**13**		**14**	
Impulse polarity	**+**	**-**	**+**	**-**	**+**	**-**
Atm. conditions						
pressure (kPa)	98,5	98,5	98,5	98,5	98,5	98,5
temperature (°C)	22,6	22,6	22,5	22,5	22,6	22,6
rel. humidity (%)	52,8	52,8	52,4	52,4	51,3	51,3
correction factors						
k_1 air density correction	0,964	0,964	0,964	0,964	0,964	0,964
k_2 humidity correction	1,000	1,000	0,998	0,999	0,997	0,998
K_t atmospheric correction	0,964	0,964	0,963	0,963	0,961	0,962
arcing distance (mm)			1 320			
Critical impulse flashover voltage (kV)	**811**	**864**	**831**	**887**	**833**	**890**
Critical impulse flashover voltage positive polarity: 832 kV						
Critical impulse flashover voltage negative polarity: 881 kV						
CSA C411.4-16, Table 2 specified critical impulse flashover voltage: 780 kV						

Evaluation:

Critical impulse flashover value of positive polarity was equal to or exceed 95% of the rated critical impulse flashover voltage specified by drawing 832 kV, i.e. 790 kV.

Critical impulse flashover value of negative polarity was equal to or exceed 95% of the rated critical impulse flashover voltage specified by drawing 881 kV, i.e. 837 kV.

Statement of conformity:

138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304, passed the test according to requirements given in CSA C411.4-16, clause 6.2.

4.3 WET POWER FREQUENCY VOLTAGE FLASHOVER TEST

4.3.1 Test procedure

The tests were carried out according to CSA C411.4-16, clause 6.3 and CSA C411.1, clause 6.4.

The test was carried out on three insulators:

No. 12, serial No. 2305096037,

No. 13, serial No. 2305096031,

No. 14, serial No. 2305096007.

Characteristics of the artificial rain and precipitation method was in accordance with the CSA C411.1-16, clause 6.4.3 & IEC 60060-1, clause 4.4.

The low-frequency wet flashover test was performed according to CSA C411.1-16, clause 6.4.4. The flashover voltage was obtained by increasing the voltage continuously from zero up to flashover. The average of five flashovers was calculated.

All measured voltages were corrected to the standard reference atmospheric conditions according to CSA C411.1-16, clause 6.2.5 and 6.2.6.

The test arrangement was set up according to CSA C411.1-16, clause 6.4.1 & IEC 60383-1, clause 36 (see Figure 7).

Testing and measuring equipment:

- resonant AC source Evergreen, MSR600-1200, serial No. 2001042-EGU
- capacitive divider Evergreen, HCC600-2, serial No. 200104-EGU
- universal voltmeter Haefely DMI 551, serial No. 188856
- measuring system for atmospheric conditions Comet, serial No. 14900363
- tape measure, type 7,5 m, Assist, PM-292
- digital stopwatch Kalenji PM-259
- conductivity meter WTW Cond 3310, serial No. 12240282
- plastic measuring cylinder 50ml, identification No. 1/153/14 & 2/153/14

4.3.2 Test results

Table 5 Results of low - frequency wet flashover test

Date of the test: 2023-06-20			
Test sample No.	**12**	**13**	**14**
Atm. Conditions			
pressure (kPa)	98,5	98,5	98,5
temperature (°C)	22,5	23,8	23,8
rel. humidity (%)	61,3	56,8	58,1
Rain parameters			
vertical components (mm/min)	1,0	1,0	1,0
horizontal components (mm/min)	1,3	1,3	1,3
water conductivity (μS/cm)	104	104	104
Correction factors			
k_1 air density correction	0,965	0,960	0,960
k_2 humidity correction	1,000	1,000	1,000
K_t atmospheric correction	0,965	0,960	0,960
arcing distance (mm)		1 320	
Flashover voltage (kV)	**468**	**481**	**482**
The average wet flashover voltage of the three insulators (kV)		**477**	
Low-frequency wet flashover voltage: 434 kV			

5 UNCERTAINTY OF MEASUREMENTS

Quantity		Uncertainty (k = 2)
Lightning impulse voltage	U_{pk}	1,7 %
	T_1	8,0 %
	T_2	3,1 %
Power-frequency voltage (HCC600-2)		1,2 %
Power-frequency voltage (WMC 160/1200)		1,7 %
Radio influence voltage		1,0 dB
Temperature		4,0 %
Air pressure		0,5 %
Relative humidity		6,3 %
Time		0,7 %
Rainfall intensity		10,0 %
Conductivity		5,0 %
Length (tape measure 7,5m)		1,6 %
Length (telescopic stick 8 m)		0,8 %

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a Normal (Gaussian) distribution corresponds to a coverage probability of approximately 95%.

EGU - HV Laboratory applies a binary decision rule to the statement of conformity which reports two statements: PASS – results are within limits or meet a given specification, FAIL – results are out of limits or fail a given specification. Calculated uncertainty of measurements is only informative with regards to the statement of conformity application.

6 PRODUCT DRAWING

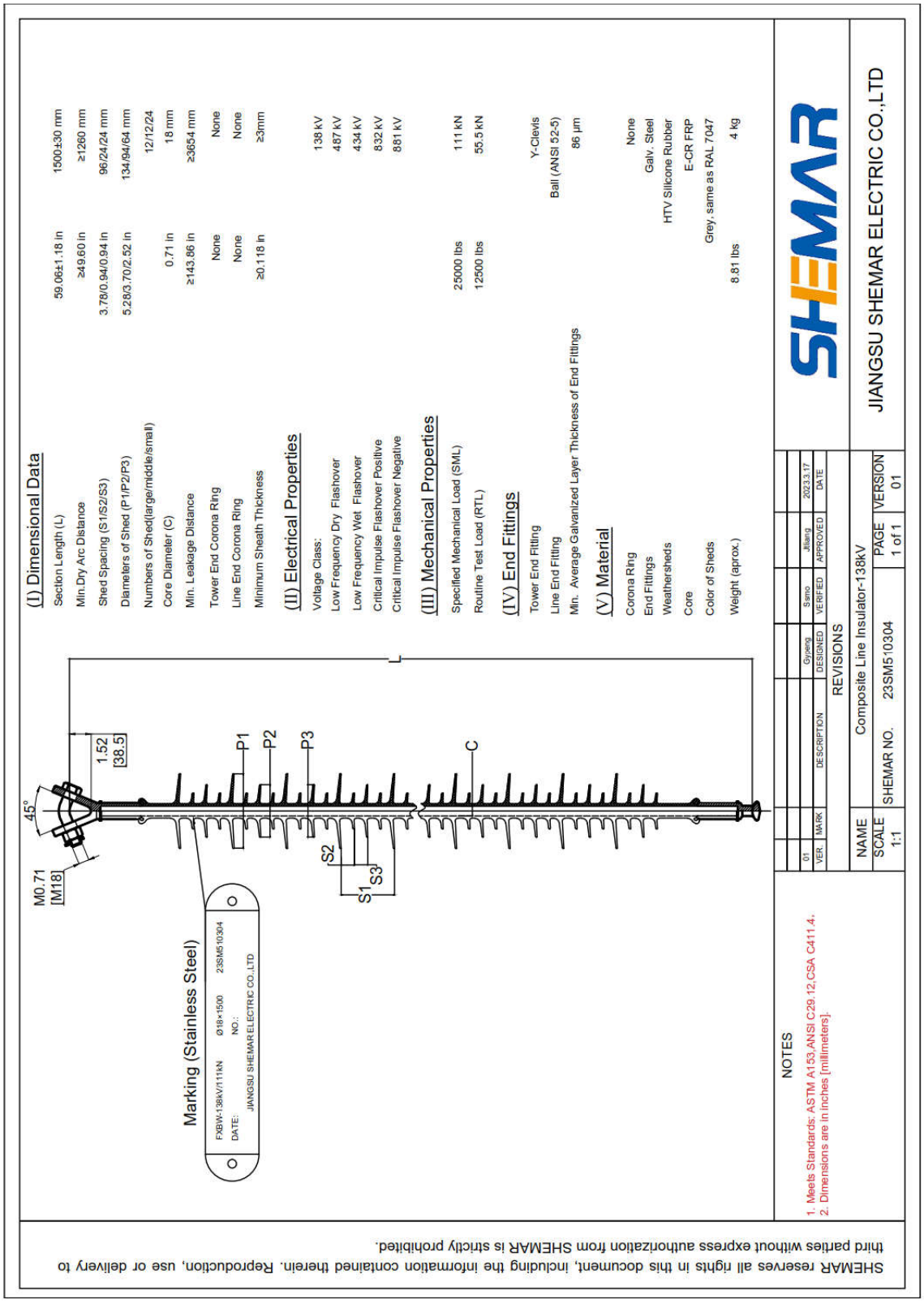
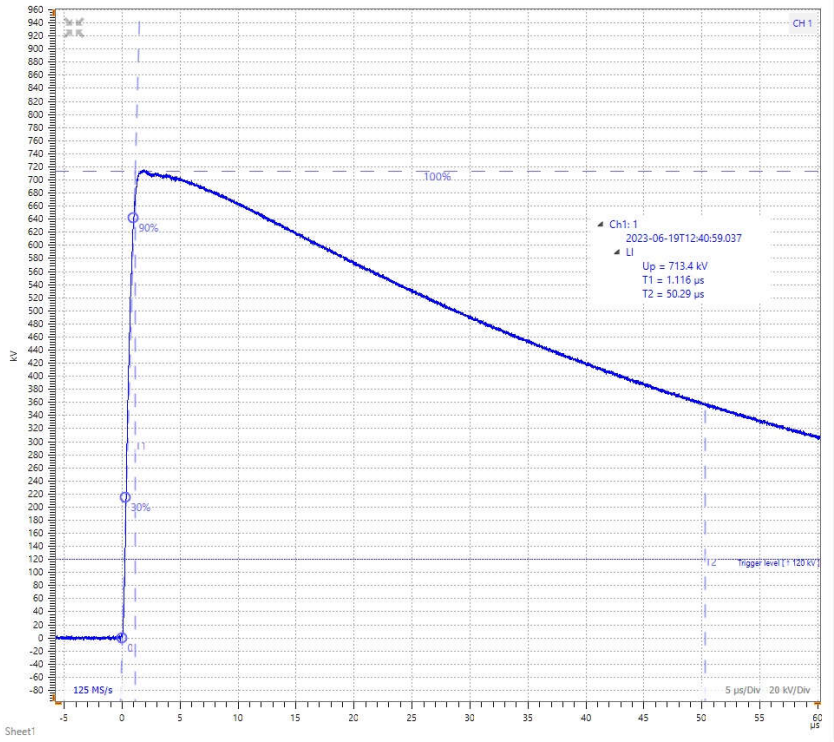


Figure 1 138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304

7 GRAPHS AND RECORDS



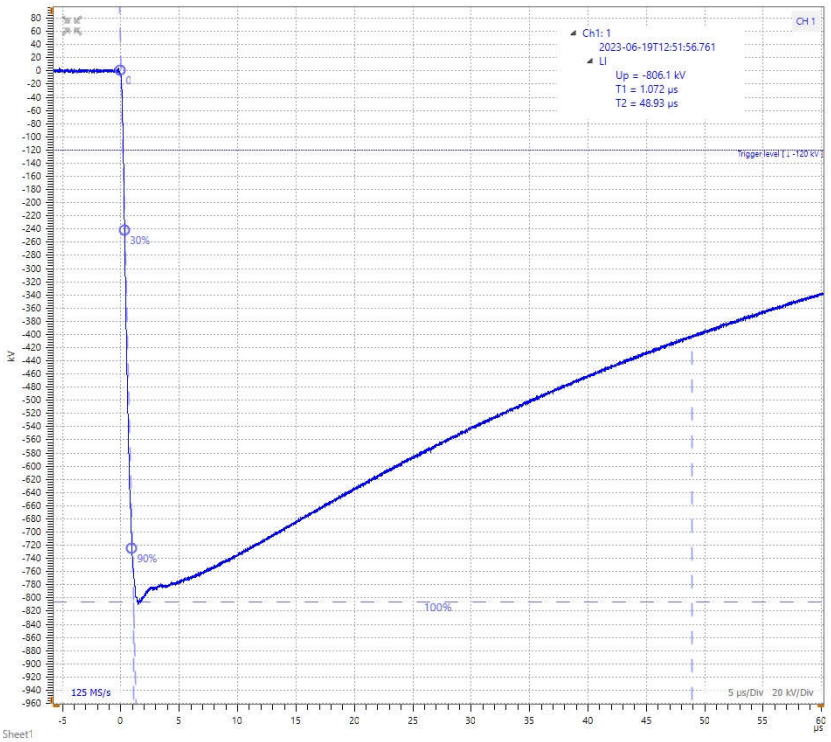


Figure 2 Record of the lightning impulse voltage 1,2/50 µs

8 TEST OBJECT AND TEST SETUP PHOTOS

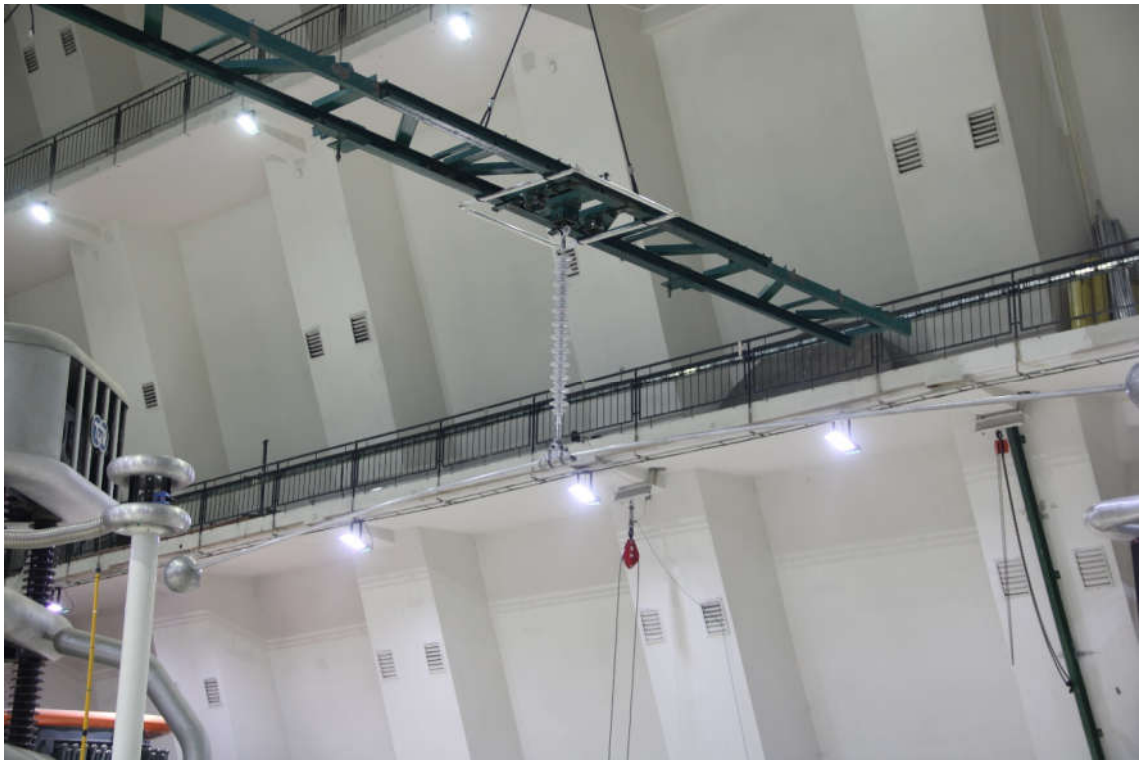


Figure 3 Test arrangement under corona test

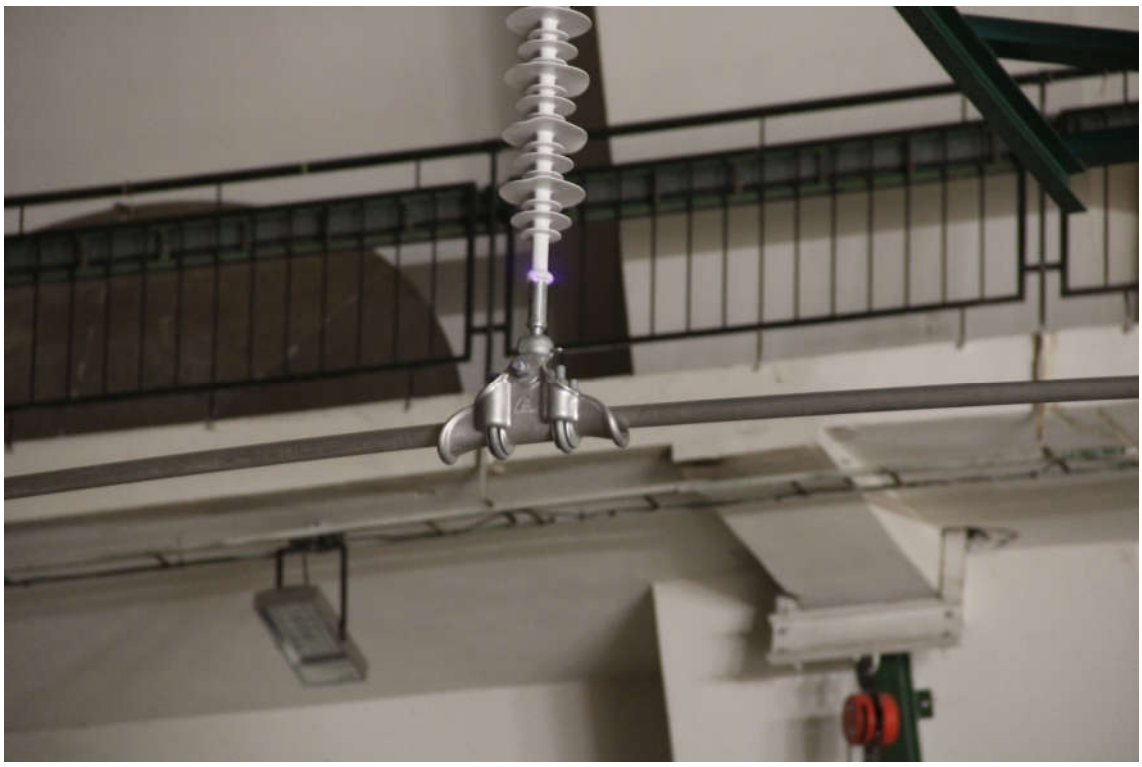


Figure 4 Test arrangement under corona test at 160 kV

Figure 5 Test arrangement under corona test at 100 kV (no visible corona)

Figure 6 Test arrangement and flashover under the critical impulse flashover test

Figure 7 Test arrangement and flashover under the wet power frequency voltage flashover test

– end of the test report –

EGU HV LABORATORY

Since 1954
experience of testing
and research activities

L 1029

Testing laboratory No. 1029

Accredited by Czech Accreditation Institute according to ČSN EN ISO/IEC 17025:2018

TEST REPORT 12206/F/23

ACCREDITED TESTING LABORATORY EGU HV Laboratory EGU HV LABORATORY No. 1029 CZECH REPUBLIC

CUSTOMER	Jiangsu Shemar Electric Co., Ltd. No. 66 Haiwei Road 226 017 Nantong, Jiangsu China
TEST OBJECT	138 kV Composite line insulator
TYPE SPECIFICATION	138 kV / 111 kN
SHEMAR IDENTIFICATION No.	n/a
TEST STANDARDS	CSA C411.4-16, IEC 60060-1 Ed.3:2010
NUMBER OF COPY	1
NUMBER OF PAGES	18
DATE OF ISSUE	2024-02-08

Michal Novotný
Test engineer

Marek Brosch
Head of
EGU HV LABORATORY

Jan Lachman, Ph.D.
Director of
EGU - HV Laboratory a.s.

REAL INDEPENDENT TESTING

WWW.EGUHV.COM

EGU – HV Laboratory a.s.
EGU HV LABORATORY, Podnikatelská 267, 190 11 Praha 9 – Běchovice, Czech Republic | +420 267 193 361 | info@eguhv.com

TEST REPORT 12206/F/23

TEST OBJECT	138 kV Composite line insulator
TYPE SPECIFICATION	138 kV / 111 kN
DRAWING No.	23SM510304
MANUFACTURER	Jiangsu Shemar Electric Co., Ltd. No. 66 Haiwei Road 226 017 Nantong, Jiangsu, China
DATE OF DELIVERY	2023-11-09
DATE OF TESTS	From 2023-11-10 till 2024-01-26
ORDER No.	4530505010
TESTS WITNESSED BY	n/a
ANNEX	n/a

TABLE OF CONTENTS

1 TEST OBJECT IDENTIFICATION

The results presented in this test report apply only to test objects subjected to the testing. Responsibility for conformity of any objects having the same designation as the test object fully rests with the Manufacturer.

EGU HV LABORATORY is not responsible for the sampling. Samples are provided by a customer. Test results apply only to tested samples as received.

A customer guarantees a test object being made according to submitted product drawings and documents, see Table 1.

EGU HV LABORATORY confirms product drawings submitted by a customer fully represent in technical aspects (shape, dimensions etc.) a given test object and markings/nameplates on a test object conform with drawings.

Table 1 Drawings/documents submitted, and included in this test report

Title	Drawing No.	See
138 kV Composite line insulator	23SM510304	Figure 1

2 TEST SUMMARY

TEST TITLE	TEST STANDARD	RESULT
Tracking end erosion test	CSA C411.4, clause 5.5	Pass
Test procedure, Method 2	CSA C411.4, clause 5.5.3	Pass
Steep-front impulse voltage test	CSA C411.4, clause 5.5.4.2 & 5.3.3.3	Pass
Power frequency voltage test	CSA C411.4, clause 5.5.4.2 & 5.3.3.4	Pass

3 LIST OF SYMBOLS

Symbol	Description
k_1	Air density correction factor
k_2	Humidity correction factor
K_t	Atmospheric correction factor
T_0	Temperature of the shank before the dry power frequency withstand test (°C)
T_{30}	Temperature of the shank after the dry power frequency withstand test (°C)
U_{pk}	The maximum voltage of impulse wave (kV)
T_1	Front time of impulse wave (μs)
SR	Steepness of impulse wave (MV/μs)

4 TESTS PERFORMED

4.1 TRACKING AND EROSION TEST

Table 2 Specification of the silicone material

Manufacturer	Jiangsu Shemar Electric Co., Ltd.
Address	No. 66 Haiwei Road 226 017 Nantong, Jiangsu China
Type	HTV Silicone rubber
Color	Gray
Batch number	N/A

NOTE: The specification of silicone material was provided by customer

Tests were carried out according to CSA C411.4, clause 5.5. The tests were performed on samples with reduced length of 138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304. The tests were performed on three insulator samples and on one reference insulator sample.

Insulator No. 1, serial No. 2309196403

Insulator No. 2, serial No. 2309196409

Insulator No. 3, serial No. 2309196408

Insulator No. 4 Ref, serial No. 2309196402.

4.1.1 Test procedure

Test was carried out according to CSA C411.4, clause 5.5.3, method 2 – tracking wheel No. 2.

The saline solution in the tank consisted de-ionised water with 1,40 ± 0,06 g/l of NaCl.

The voltage stress was 35 V/mm of insulator leakage distance. Each insulator was exposed to 30 000 cycles in accordance with CSA C411.4, annex B.

After every four days of testing the insulators were given a 24-hour recovery period. During this period, the test procedure was unchanged except that the saline solution was removed from the dip tank.

The test arrangement of the tracking and erosion test before start of the test is shown in Figure 3 and Figure 4. The test samples after the test are shown in Figure 5, Figure 6 and Figure 7.

Testing and measuring equipment:

- test transformer ABB 100 kVA, TNOSLC serial No. 600732
- frequency convertor, bubela power electronics, GS1, 37 kVA, serial No. 3122200062
- measuring Transformer UZGT 30, serial No. 02022
- multimeter UT71D, serial No. 1100420241
- conductivity meter, WTW Cond 3310, serial No. 12240282

Table 3 Results of tracking wheel test

Sample information:	
Type	FXBW-138 kV / 111 kN
Sample No.	1, 2, 3
Creepage distance (mm)	510
Test parameters:	
Test voltage (kV)	17,9
Beginning of the test	2023-10-11
End of the test	2024-01-26
Number of cycles	30 245
Salinity	1,4 ± 0,06 kg/m^3
Ambient temperature	20 °C ±5 K
Visual inspection after tracking wheel test:	
Sample No. 1, 2 and 3	no tracking, no erosion to the core, no shed or housing punctured

Table 4 Tracking wheel test – timeline

Start of the test period	End of the test period	Recovery period (h)	Cycle count
10.11.	14.11.	24	1 964
15.11.	19.11.	24	3 928
20.11.	24.11.	24	5 892
25.11.	29.11.	24	7 856
30.11.	4.12.	24	9 820
5.12.	9.12.	24	11 784
10.12.	14.12.	24	13 748
15.12.	19.12.	24	15 712
20.12.	24.12.	24	17 676
25.12.	29.12.	24	19 640
30.12.	3.1.	24	21 604
4.1.	8.1.	24	23 568
9.1.	13.1.	24	25 532
14.1.	18.1.	24	27 496
19.1.	23.1.	24	29 460
24.1.	26.1.	End of the test	30 245

Evaluation:

No tacking, no erosion to the core, no shed or housing puncture occurred.

4.1.2 Test evaluation

Tests were carried out according to CSA C411.4, clause 5.5.4.

Immediately after completion of the tracking wheel test, each sample was tested in accordance with CSA C411.4, clause 5.3.3.3 and 5.3.3.4.

Steep-front impulse voltage test

Test was carried out according to CSA C411.4, clause 5.3.3.3.

The test voltage - an impulse with a steepness of at least 1000 kV/µs - was applied between the original metal fittings. Each sample was stressed individually with 25 impulses of positive and 25 impulses of negative polarity.

The test arrangement and the flashover on the insulator are shown in Figure 8. Representative example of the wave shape of the test impulse is given in Figure 2.

Testing and measuring equipment:

- impulse generator TuR Dresden 750 kV, 30 kJ
- divider Haefely R800, serial No. 554333
- measuring system Haefely Trench, type HiAS 743, serial No. 175247
- measuring system for atmospheric condition Comet, serial No. 10910247
- tape measure 5 m, Assist, PM-291

Table 5 Steep-front impulse voltage test conditions

Date	Pressure (kPa)	Temperature (°C)	Rel. humidity (%)
2024-01-26	99,4	14,7	35,7

Table 6 Steep-front impulse voltage test

Sample No.	No. of impulses		Result
	+ polarity	- polarity	
1	25	25	No puncture
2	25	25	No puncture
3	25	25	No puncture

Evaluation:

No puncture of any part of the insulator occurred.

Power frequency voltage test

Test was carried out according to CSA C411.4, clause 5.3.3.4.

The flashover voltage sample was determined by averaging of five consecutive flashovers on each insulator. Before the flashover test begins, the shank temperatures of all samples were measured. The average of five flashover value was corrected to normal standard atmospheric conditions in accordance with IEC 60060-1, clause 4.3. The flashover voltage was obtained by increasing the voltage linearly from zero within one minute.

The flashover voltage of each sample shall be greater than or equal to 90 % of flashover voltage of the reference sample (reference flashover voltage).

Then the samples were subjected for 30 minutes to 80 % of the reference flashover voltage. Immediately after the test the temperature of the shank (at three locations distributed approximately evenly along the length of the insulators) of each sample was measured again and compared to ambient temperature.

The test arrangement and the flashover on the insulator are shown in Figure 9.

Testing and measuring equipment:

- synchronous generator BEZ Bratislava 6 kV, 1 300 kVA, 50 Hz
- test transformer TuR Dresden 5,7/1200 kV, 1500 kVA, serial No. 884469
- capacitive divider TuR Dresden 1200 kV, 150 pF, type WMC 160/1200, serial No. 884470
- universal voltmeter Haefely Trench, type DMI 551, serial No. 150505
- digital stop-watch Olympia, PM-172
- measuring system for atmospheric condition Comet, serial No. 14900363
- digital thermometer Fluke 52 II, serial No. 53310016WS + touch probe Greisinger GOF 130
- tape measure 5 m, Assist, PM-291

Table 7 Power frequency voltage test conditions

Date	Pressure (kPa)	Temperature (°C)	Rel. humidity (%)	Arc. distance (m)
2024-01-26	99,1	14,7	55,8	0,305

Table 8 Results of power frequency voltage test

Sample No.	Measured flashovers (kV)	Average flashover (kV)		Atm. correction factors		
	Individual	Measured	Corrected	k_1	k_2	K_t
4 Ref	136; 131; 130; 135; 130	132	132	0,996	n/a	0,996
1	128; 131; 132; 130; 127	130	130	0,996	n/a	0,996
2	128; 133; 127; 126; 125	128	128	0,996	n/a	0,996
3	126; 130; 130; 133; 125	129	129	0,996	n/a	0,996
90 % of reference flashover voltage (corrected to std. atm. conditions): 0,9 x 132 kV = 119 kV						

NOTE: Correction factor k_2 for humidity was not applied because the arcing distance was <0,5 m.

Table 9 Results of the power frequency withstand voltage test

Sample No.	Test voltage (kV)	Temperature of the shank		Temperature rise (°K)	Result
		T_0 (°C)	T_{30} (°C)		
4 Ref	106	16,5; 16,2; 16,0	16,6; 16,4; 16,1	< 10	Pass
1	106	16,3; 16,5; 15,9	16,5; 16,6; 16,1	< 10	Pass
2	106	16,1; 16,2; 15,8	16,2; 16,4; 16,0	< 10	Pass
3	106	16,2; 16,3; 15,9	16,4; 16,5; 16,1	< 10	Pass
80 % of reference flashover voltage 0,8 x 132 kV = 106 kV (corrected to std. atm. conditions)					

Evaluation:

No tacking, no erosion to the core, no shed or housing puncture occurred after tracking and erosion test.

Flashover voltages of test samples exceed 90 % of reference flashover voltage.

No puncture of any part of the insulator occurred. The temperature rise of the shank of each sample measured immediately after the test was less than 10 °K, with respect to ambient temperature.

Statement of conformity:

138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304 passed the tests according to requirements given in CSA C411.4, clause 5.5.

5 UNCERTAINTY OF MEASUREMENTS

Quantity		Uncertainty (k = 2)
Steep-front impulse voltage	U_{pk}	2,2 %
	T_1	6,5 %
Power-frequency voltage		1,7 %
Power-frequency voltage (tracking wheel test)		1,3 %
Temperature (Fluke 52 II)		7,5 %
Atmospheric pressure		0,5 %
Air temperature		4,0 %
Relative humidity		6,3 %
Time		0,7 %
Conductivity (0,1 µS/cm –1000 mS/cm)		5,0 %
Length – tape measure (100–5000 mm)		1,6 %

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a Normal (Gaussian) distribution corresponds to a coverage probability of approximately 95%.

EGU - HV Laboratory applies a binary decision rule to the statement of conformity which reports two statements: PASS – results are within limits or meet a given specification, FAIL – results are out of limits or fail a given specification. Calculated uncertainty of measurements are only informative with regards to the statement of conformity application.

6 PRODUCT DRAWING

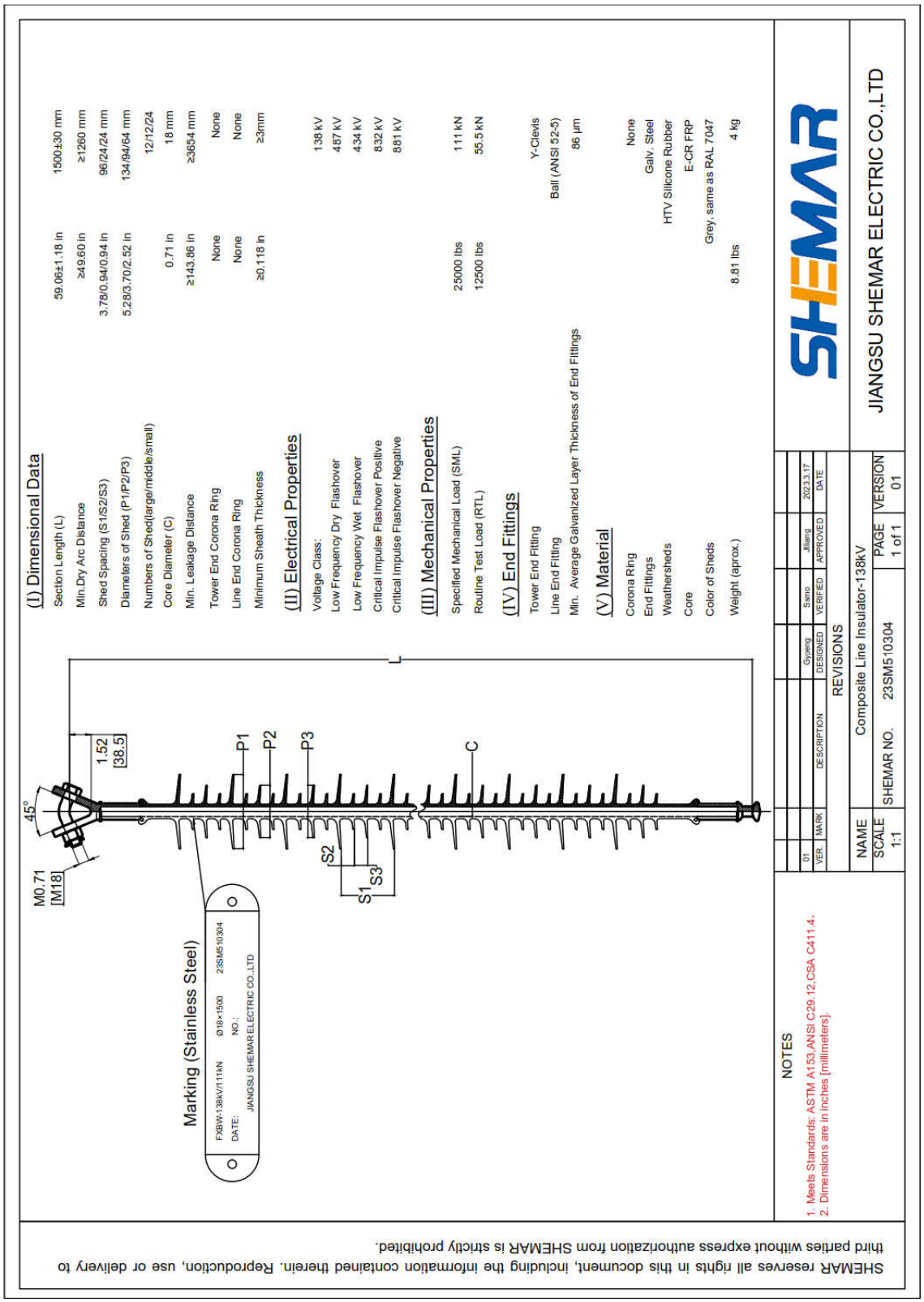


Figure 1 138 kV Composite line insulator, type 138 kV / 111 kN, drawing No. 23SM510304

7 GRAPH

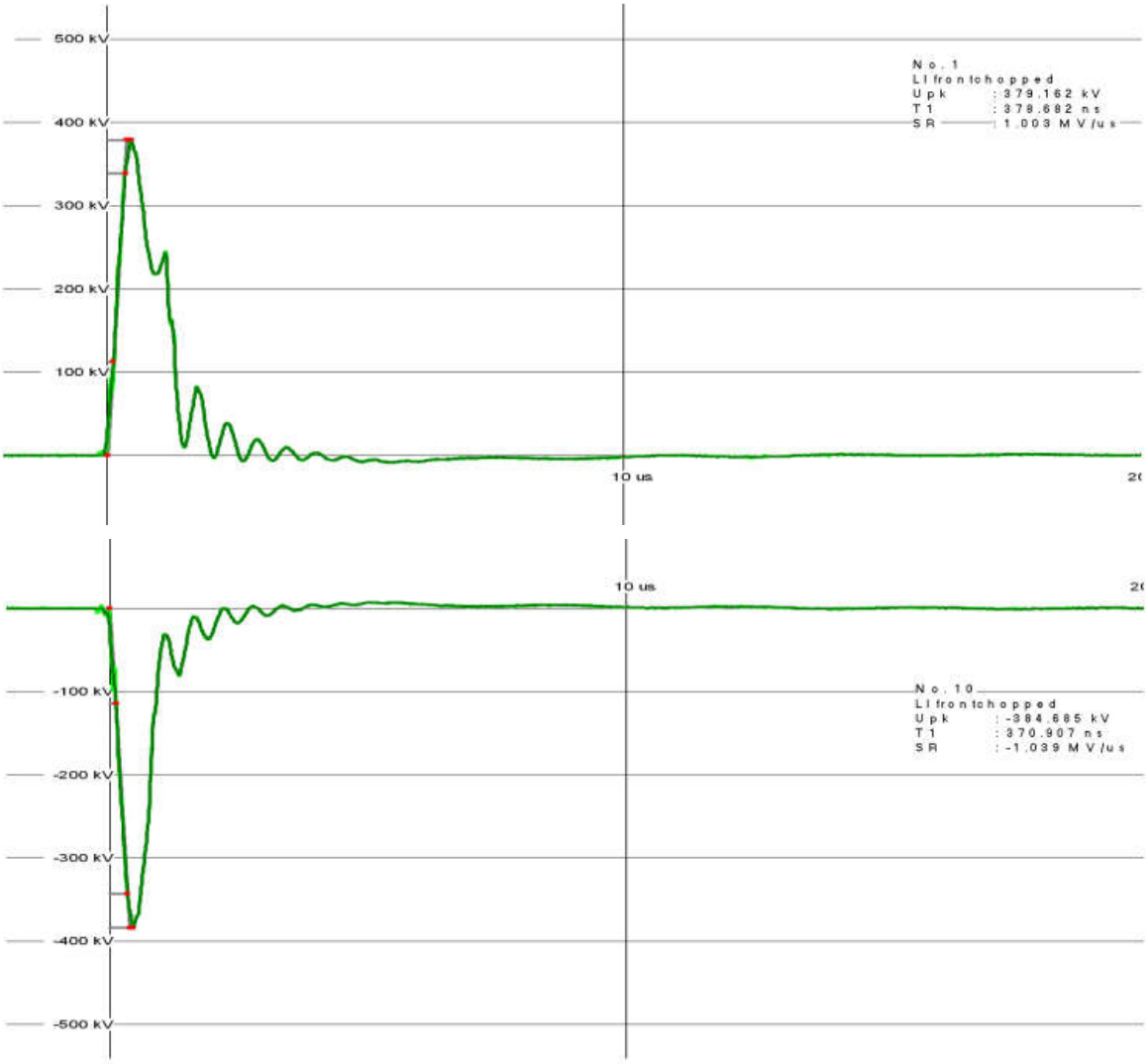


Figure 2 Representative wave shape of the steep-front impulse

8 TEST OBJECT AND TEST SETUP PHOTOS

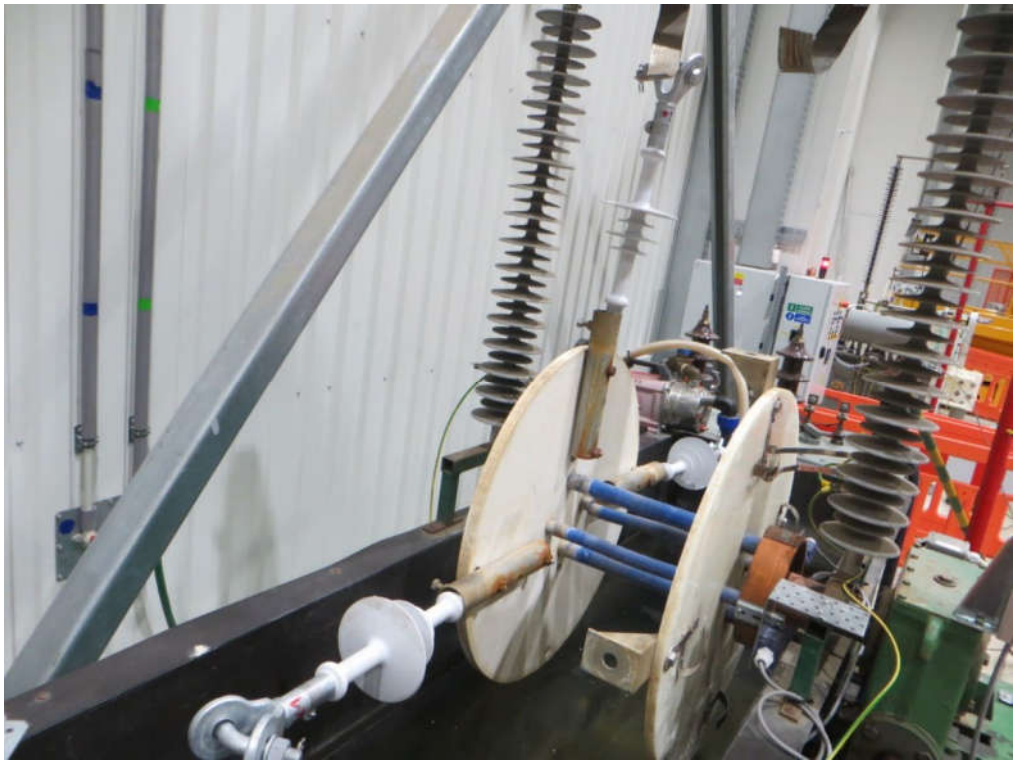


Figure 3 Tracking and erosion test (method 2 –Dip tank tracking wheel), test setup

Figure 4 Composite line insulator test samples No. 1, 2 and 3 before tracking and erosion test

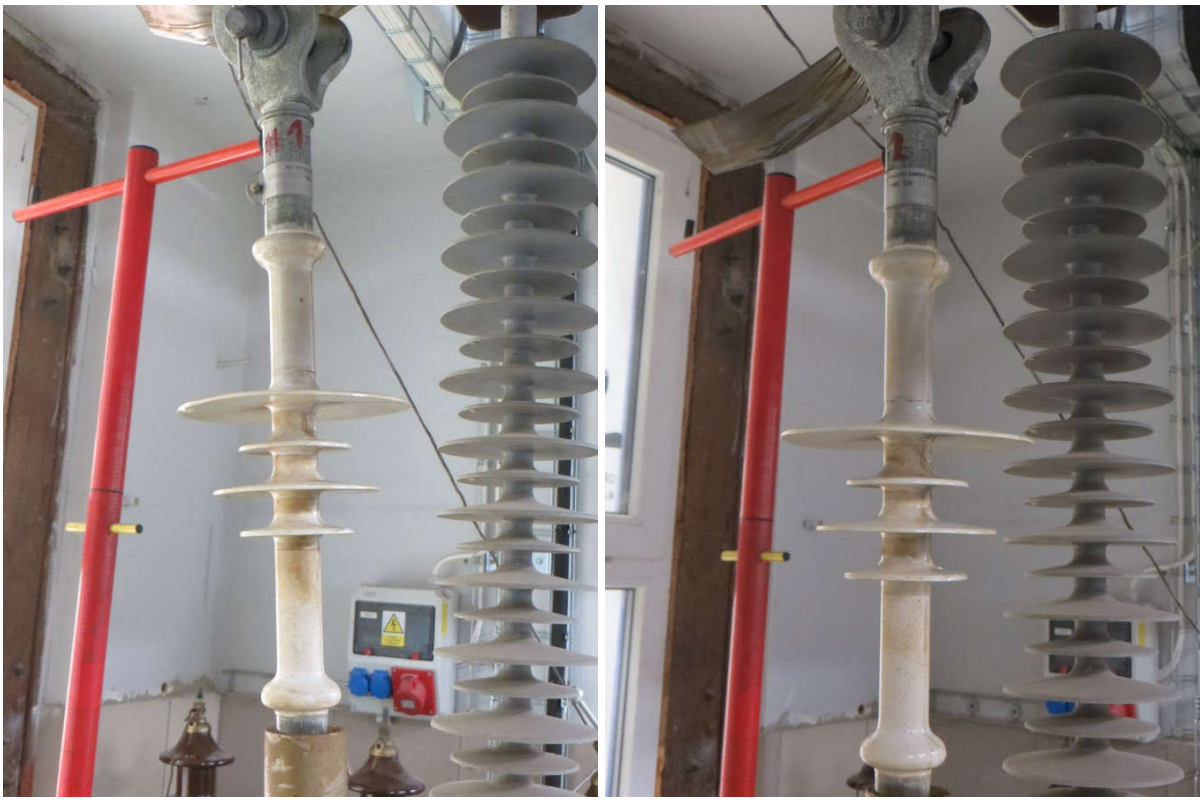


Figure 5 Composite line insulators, test sample No. 1 and 2, after tracking and erosion test

Figure 6 Composite line insulator, test sample No.3, after tracking and erosion test

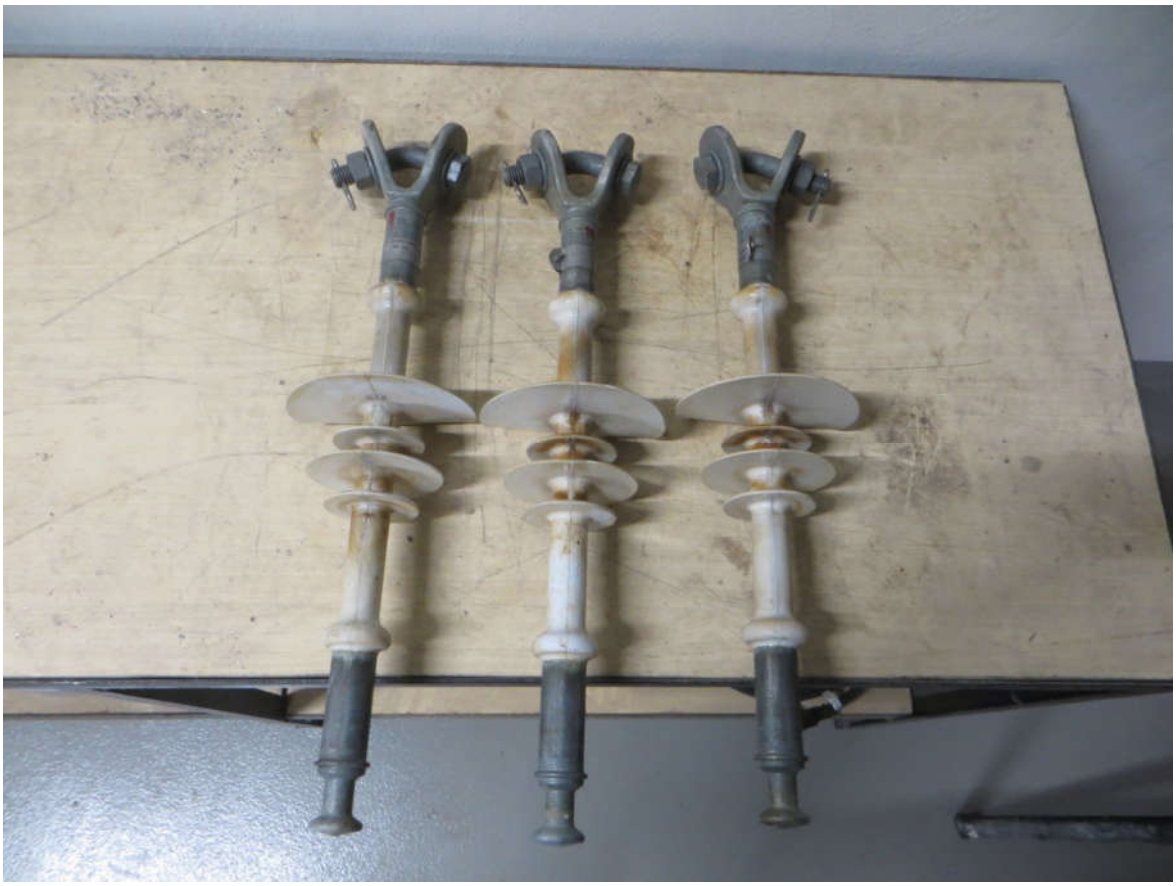


Figure 7 Composite line insulators, test samples No. 1, 2 and 3, after tracking and erosion test

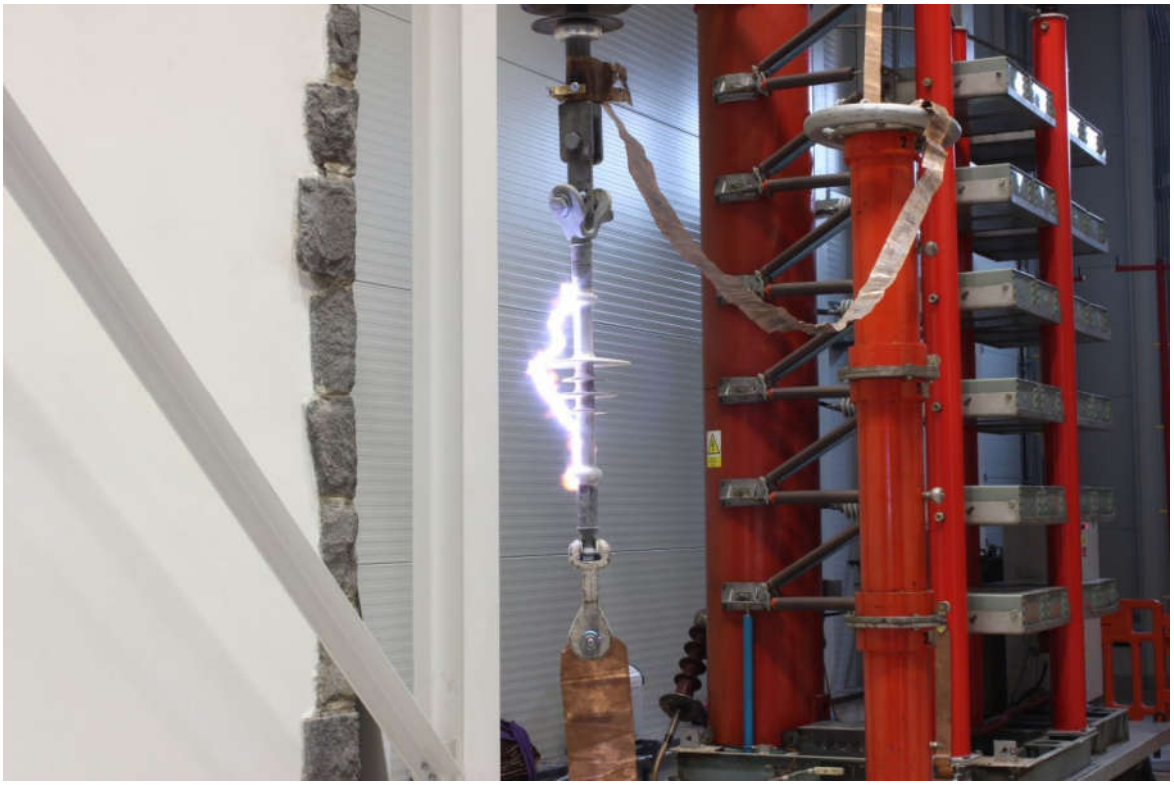


Figure 8 Composite line insulator during the steep front impulse voltage test

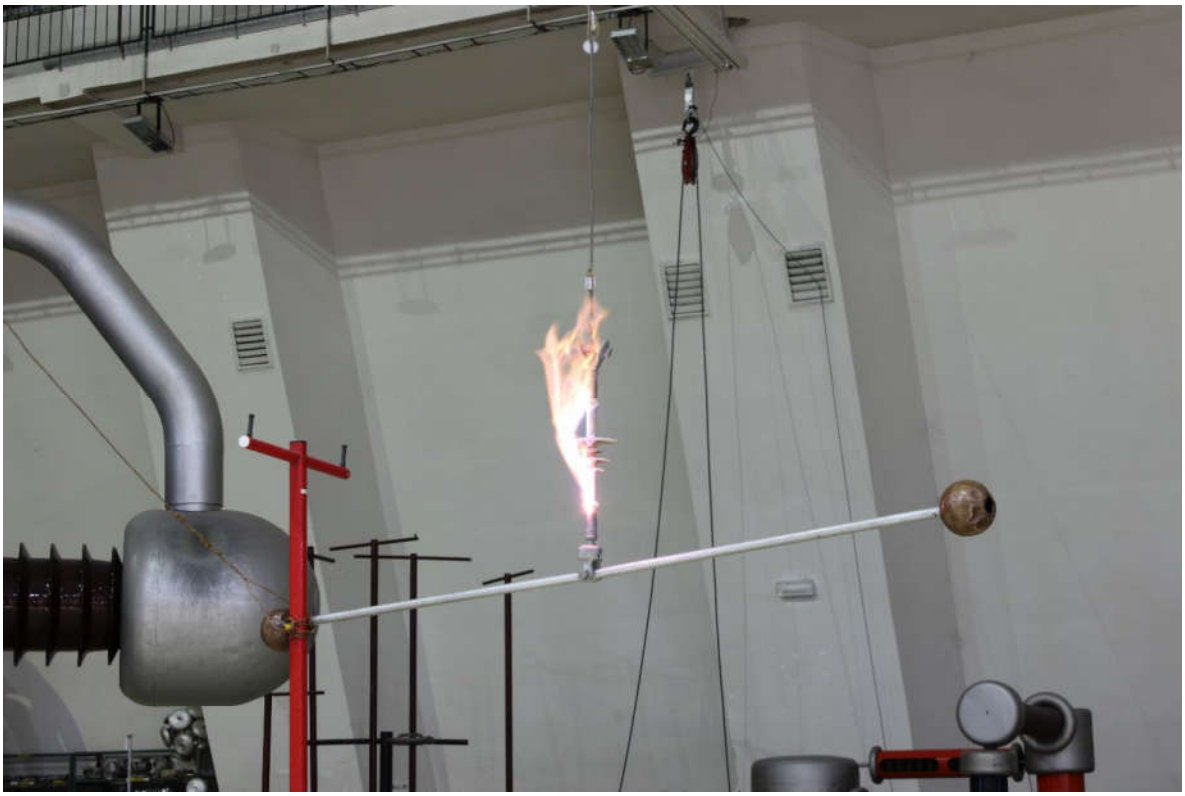


Figure 9 Composite line insulator during the power frequency voltage test

– end of the test report –

Testpolymer EU s.r.o.

Testing laboratory No. 1595
accredited by ČIA
according to ČSN EN ISO/IEC 17025: 2018

L 1595

Bohuslavice 123
798 56 Bohuslavice
IČO 29211506
DIČ CZ29211506

laboratory manager : Eva Kovářová
tel.: + 420 582 383 680

kovarova@testpolymer.cz
www.testpolymer.cz

Test report No. 59/2022/EN

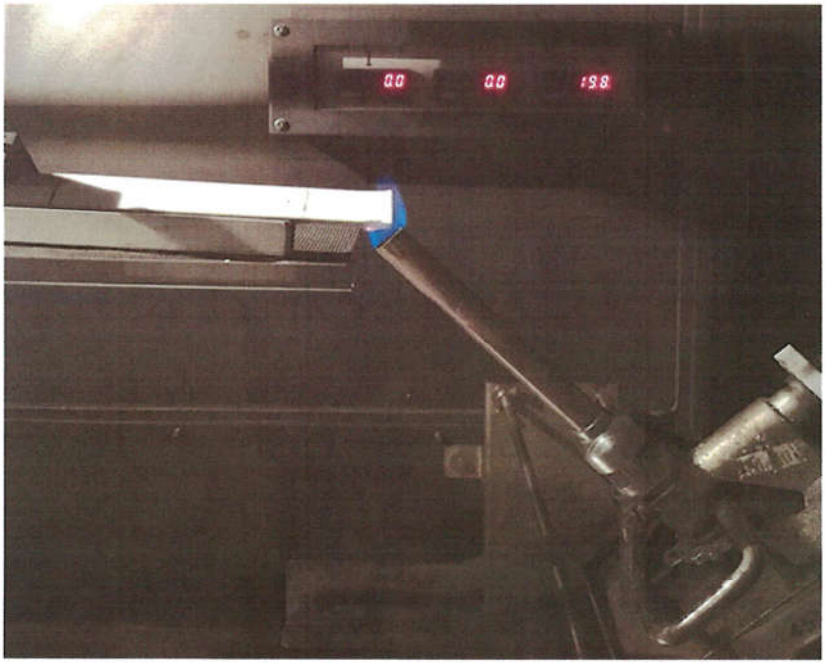
Customer:	**EGU - HV Laboratory a.s., Podnikatelská 267, 190 11 Praha 9, Běchovice**
	Company ID: 25634330, Tax ID: CZ25634330
Customer´s order:	**6/11788/2022**
Application form:	**2200223**
Tested material:	**HTV silicone material**
Detailed description:	**Manufacturer: Jiangsu Shemar Electric Co., Ltd.**
Form of material:	test specimens - sampled and delivered by customer
Preparation of samples:	test specimens supplied by customer
Date of receipt of the sample:	10.1.2022

Tests	Test specifications
Fire hazard testing - horizontal and vertical flame tests	UL 94: 2013 revision 05/2021 ČSN EN 60695-11-10 ed.2: 2014

These tests were performed in accordance with the standard ČSN EN 62217 ed.2: 2013, article 9.3.4.

Test No. 15	**Fire hazard testing - Horizontal and vertical flame tests - method A - horizontal burning test**

Photo of the position of the test specimen during the test:



Test report No. 59/2022/EN

Test standard:	ČSN EN 60695-11-10 ed. 2: 2014	
Test equipment:	Chamber Atlas HVUL2	
Ignition source:	Burner with an inner diameter 9.5 mm	
	The gas used: Methane 2.5	
Test conditions:	Blue flame height 20 mm, the exposure time 30s	
	No forced ventilation was used during the test	
	Temperature: 22,0 - 23,0°C	Humidity: 48,0 - 49,0%
Description of the sample (sample type, the color, the location in the product, the number of samples tested):	Test specimens of grey color 125x13x3mm, 3 pieces	
Conditioning of samples:	48 hours at 23±2°C and 50±5% relative humidity	
Conditioning of cotton indicator:	24 hours in desiccator 23±2°C	
Deviations from the standard:	no	
Test progress:	After removing the ignition flame, the test specimens do not burn. The flame did not exceed the 25 mm mark. A support fixture was used during the test due to the bending of the test specimens.	
Test specimen No.1	burning stopped before 25 mm	
Test specimen No.2	burning stopped before 25 mm	
Test specimen No.3	burning stopped before 25 mm	

No. of test specimen	Damaged length L (mm)	Burning time t (s)	Linear burn rate (mm/min)	**Linear burn rate average value (mm/min)**	Sample standard deviation (mm/min)
1	0	0	0	**0**	0
2	0	0	0		
3	0	0	0		

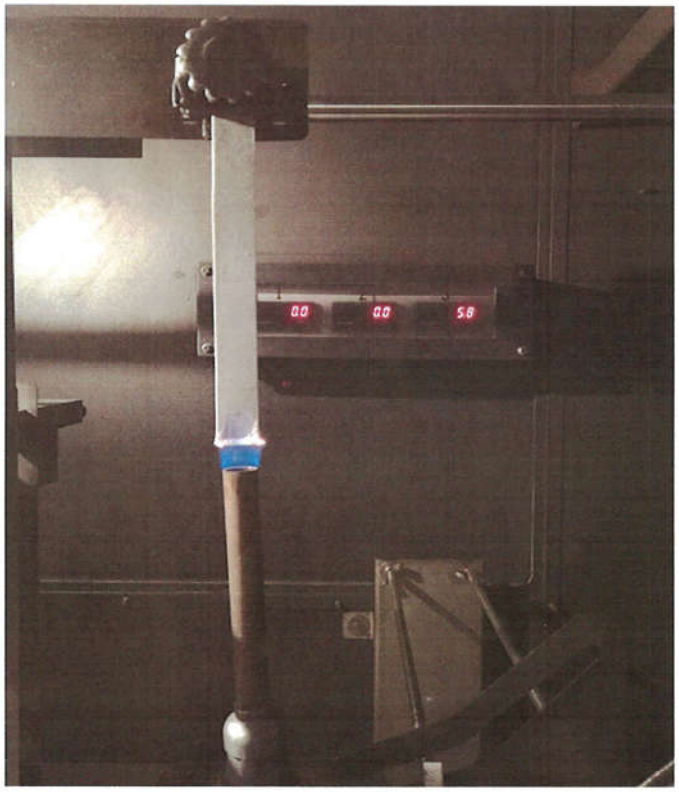
Statement of conformity to specifications - classification	Measured results (burning rate, damaged length) on tested three samples meet all requirements for classification **HB** according to article 8.4 ČSN EN 60695-11-10 ed.2 This statement of conformity to specifications is given in the sense of the shared risk decision rule; without including measurement uncertainty.

Tested and evaluated by:	Ing. Lukáš Navrátil	Date:	13.1.2022

Test report No. 59/2022/EN

Test No. 15	**Fire hazard testing - horizontal and vertical flame tests - method B - vertical burning test**

Photo of the position of the test specimen during the test:



Test standard:	ČSN EN 60695-11-10 ed. 2: 2014	
Test equipment:	Chamber Atlas HVUL2	
Ignition source:	Burner with an inner diameter 9.5 mm	
	The gas used: Methane 2.5	
Test conditions:	Blue flame height 20 mm, the exposure time 2 x 10s	
	No forced ventilation was used during the test	
	Temperature: 22,0 - 23,0°C	Humidity: 48,0 - 49,0%
Description of the sample (sample type, the color, the location in the product, the number of samples tested):	Test specimens of grey color 125x13x3mm, 10 pieces	
Conditioning of samples:	5 pieces - 48 hours in the climate chamber at 23±2°C and 50±5% relative humidity; 5 pieces -168 ±2 hours in the hot air oven at 70±2°C and cooled in desiccator min. 4 hours at room temperature	
Conditioning of cotton indicator:	24 hours in desiccator 23±2°C	
Deviations from the standard:	Not detected	
Test progress:	The test specimens do not burn after the first or after the second application of the flame. The material does not drip or ignite absorbent cotton.	

Test report No. 59/2022/EN

No. of test specimen:	Afterflame time after the first flame application t_1 (s)	Afterflame time after the second flame application t_2 (s)	Afterflame plus afterglow time after the second flame application t_2+t_3 (s)	Afterflame up to the holding clamp: YES - NO	Flaming particles or drops: YES - NO	Cotton indicator ignited by flaming particles or drops: YES - NO
Specimens conditioned in climate chamber						
1	0	0	0	NO	NO	NO
2	0	0	0	NO	NO	NO
3	0	0	0	NO	NO	NO
4	0	0	0	NO	NO	NO
5	0	0	0	NO	NO	NO
Specimens conditioned in hot air oven						
1	0	0	0	NO	NO	NO
2	0	0	0	NO	NO	NO
3	0	0	0	NO	NO	NO
4	0	0	0	NO	NO	NO
5	0	0	0	NO	NO	NO

Statement of conformity to specifications - classification	The measured results (burning and afterglow times and the condition of the cotton indicators) on the ten samples tested meet all the requirements for classification **V-0** according to article 9.4 ČSN EN 60695-11-10 ed. 2. This statement of conformity to specifications is given in the sense of the shared risk decision rule; without including measurement uncertainty.

Tested and evaluated by:	Ing. Lukáš Navrátil	Date:	13.1.2022, 18.1.2022

Declaration:

Test results relates only to the test subject and refer to the sample as received
Laboratory is not responsible for sampling and specimen preparations done by customer.
Without the written consent of the Head of Laboratory, the protocol cannot be reproduced other than the entire.
All results are metrologically traceable.

Test report was created by:

Jana Trbušková
Chief laboratory technician

AKREDITOVANÁ ZKUŠEBNÍ LABORATOŘ Testpolymer EU s.r.o. č. 1595

Test report was approved by:

Eva Kovářová
Laboratory manager

In Bohuslavice: 19.1.2022

End of test report

SYNPO, akciová společnost
S. K. Neumanna 1316
532 07 Pardubice - Zelené Předměstí
The 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 375/006

Name and contact information of the customer	**EGU – HV Laboratory a.s.** Podnikatelská 267, 190 11 Praha 9 – Běchovice The Czech Republic
Test item(s)	**Manufacturer: Jiangsu Shemar Electric Co., Ltd.** **Address : No. 66, Haiwei Road, Sutong Science and Technology Industrial Park, Nantong City, Jiangsu 226017, China** **Type : HTV**
Test procedure/method	Test No. 35: **Standard Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications** ASTM D2565-16 *(The test was included in the flexible scope of accreditation)* Test No. 1 : **Determination of the degree of degradation of coatings** APP 1 (*ČSN EN ISO 4628 -1, 4, 5)* Test No. 33 : **Surface roughness measurement (Ra, Rz, Ry, Rq)** (*ČSN EN ISO 4287, ČSN EN ISO 4288)*
Date of receipt of item(s)	January 7, 2022
Internal laboratory number	22 0066
Date of the test	January 7, 2022– February 18, 2022
Tested by	Gabriela Štěpánková
The report made by	Gabriela Štěpánková, Ondřej Janča

This report contains 6 pages and 1 annex.

In Pardubice on March 29, 2022

Digitálně podepsal Ing. Vladimír Špaček, CSc.

Dr. Vladimír Špaček
Head of testing laboratory

TEST REPORT T 375/006
Page/Total pages: 2/6
Annexes: 1

DESCRRIPTION OF THE TEST ITEM

Test item:	**Manufacturer: Jiangsu Shemar Electric Co., Ltd.** **Address : No. 66, Haiwei Road, Sutong Science and Technology Industrial Park, Nantong City, Jiangsu 226017, China** **Type : HTV**
Data delivered by the customer[1] :	-
Internal lab number:	**22 0066**

[1]The laboratory is not responsible for the data delivered by customer.

FURTHER SPECIFICATION OF THE TEST PERFORMANCE

The samples of testing were received from the contractor (3 pieces) and submitted to the test without any treatment of surface protection or heat storage.

Test No. 35: Standard Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications ASTM D2565-16
(The test was included in the flexible scope of accreditation)

Test was performed according to ASTM D2565-16
Testing device: Q-SUN Xe-3HS (Q-Lab Corporation, GB). Cycle number 1^{H}.
Exposure cycling: regular switching of drying period for 102 minutes at (63 ± 2) °C light followed by 18 minutes of light and front spray.
Light source: Xenon lamps with irradiance energy of 0.35 W/m^2/nm at 340 nm. Used UBP placed horizontally at the site of sample exposure was fasten by anticorrosion screw.
The test samples were putted in testing area and the position of samples during the test was not changed – for measurements only.

Test No. 33: Surface roughness measurement
Test was performed according to ČSN EN ISO 4288 - Geometrical product specifications (GPS) - Surface texture: Profile method – Rules and procedures for the assessment of surface texture. Parameters of surface texture were measured according to *ČSN EN ISO* 4287- Geometrical product specifications (GPS) - Surface texture: Profile method - Terms, definitions and surface texture parameters.

Testing device: SURFTEST SJ-201 (Mitutoyo, Ltd., Japan).
Ra - arithmetical mean deviation of the assessed profile (roughness)
Rz - maximum height of profile (roughness).

Measurements were performed six times on each sample.

Measurement conditions: basic roughness length 0,8 mm

TEST REPORT T 375/006
Page/Total pages: 3/6
Annexes: 1

DESCRRIPTION OF THE TEST ITEM

Test item:	**Manufacturer: Jiangsu Shemar Electric Co., Ltd.** **Address : No. 66, Haiwei Road, Sutong Science and Technology Industrial Park, Nantong City, Jiangsu 226017, China** **Type : HTV**
Data delivered by the customer[1] :	-
Internal lab number:	**22 0066**

[1]The laboratory is not responsible for the data delivered by customer.

APP 1 - Determination of the degree of degradation of coatings

The evaluation of surface failure (defects) was performed according standard 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 1: General introduction and designation system; Part 4: Assessment of degree of cracking; Part 5: Assessment of degree of flaking

Lighting used in the evaluation of defect on the surface finish: the fluorescent tube, standard observation: the observation angle 0° / light incidence of angle 45°.

SYNPO, akciová společnost, S. K. Neumanna 1316, 532 07 Pardubice – Zelené Předměstí, 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 375/006

Annexes: 1

VISUAL EVALUATION OF SURFACE DEFFECTS ACCORDING TO ČSN EN ISO 4628 DURING THE EXPOSURE AFTER XENON TEST ACCORDING TO ASTM D2565-16

(January 7, 2022 – February 18, 2022)

(The test was included in the flexible scope of accreditation)

Sample name	Internal Lab Number	Surface failure	Cracking	Flaking
		ČSN EN ISO 4628-1	*ČSN EN ISO 4628-4*	*ČSN EN ISO 4628-5*
		degree + verbal	*degree*	*degree*
250 hours				
HTV	22 0066/1	**0, no visual changes**	**0 (S0)**	**0 (S0)**
	22 0066/2	**0, no visual changes**	**0 (S0)**	**0 (S0)**
	22 0066/3	**0, no visual changes**	**0 (S0)**	**0 (S0)**
500 hours				
HTV	22 0066/1	**0, no visual changes**	**0 (S0)**	**0 (S0)**
	22 0066/2	**0, no visual changes**	**0 (S0)**	**0 (S0)**
	22 0066/3	**0, no visual changes**	**0 (S0)**	**0 (S0)**
750 hours				
HTV	22 0066/1	**0, no visual changes**	**0 (S0)**	**0 (S0)**
	22 0066/2	**0, no visual changes**	**0 (S0)**	**0 (S0)**
	22 0066/3	**0, no visual changes**	**0 (S0)**	**0 (S0)**
1000 hours				
HTV	22 0066/1	**0, no visual changes**	**0 (S0)**	**0 (S0)**
	22 0066/2	**0, no visual changes**	**0 (S0)**	**0 (S0)**
	22 0066/3	**0, no visual changes**	**0 (S0)**	**0 (S0)**

SYNPO, akciová společnost, S. K. Neumanna 1316, 532 07 Pardubice – Zelené Předměstí, 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 375/006

Annexes: 1

MEASUREMENT OF SURFACE ROUGHNESS ACCORDING TO ČSN EN ISO 4287, 4288

(January 7, 2022 – February 18, 2022)

Sample name	Internal Lab Number	Arithmetical mean deviation of the assessed roughness Ra			Maximum height of profile (roughness) Rz		
		Measuring range [µm]			Measuring range [µm]		
		Mean	Max.	Min.	Mean	Max.	Min.
Before exposure							
HTV	22 0066/1	**0,67**	0,69	0,64	**4,74**	4,92	4,53
	22 0066/2	**0,66**	0,73	0,60	**4,99**	5,25	4,82
	22 0066/3	**0,71**	0,75	0,67	**5,28**	5,64	4,87
250 hours							
HTV	22 0066/1	**0,67**	0,70	0,63	**4,84**	5,11	4,56
	22 0066/2	**0,69**	0,75	0,65	**5,06**	5,47	4,52
	22 0066/3	**0,72**	0,76	0,65	**5,24**	5,78	4,25
500 hours							
HTV	22 0066/1	**0,64**	0,67	0,60	**5,01**	5,36	4,60
	22 0066/2	**0,72**	0,77	0,60	**5,33**	6,11	4,70
	22 0066/3	**0,76**	0,80	0,70	**5,65**	6,27	4,90
750 hours							
HTV	22 0066/1	**0,67**	0,70	0,64	**5,18**	5,56	4,88
	22 0066/2	**0,77**	0,80	0,74	**5,64**	5,96	5,32
	22 0066/3	**0,78**	0,80	0,75	**5,76**	6,22	5,29
1000 hours							
HTV	22 0066/1	**0,74**	0,78	0,68	**5,81**	6,09	5,22
	22 0066/2	**0,79**	0,81	0,77	**5,95**	6,22	5,69
	22 0066/3	**0,79**	0,83	0,76	**6,14**	6,55	5,78

TEST REPORT T 375/006
Page/Total pages: 6/6
Annexes: 1

DESCRRIPTION OF THE TEST ITEM

Test item:	**Manufacturer: Jiangsu Shemar Electric Co., Ltd.** **Address : No. 66, Haiwei Road, Sutong Science and Technology Industrial Park, Nantong City, Jiangsu 226017, China** **Type : HTV**
Data delivered by the customer[1] :	-
Internal lab number:	**22 0066**

[1]The laboratory is not responsible for the data delivered by customer.

Statement of conformity

The laboratory uses a binary decision rule according to ILAC-G08: 09/2019, article 4.2.1

Test items	**Prescribed test**	**Parameter** no surface defects such as cracks, crumbling or blisters result according to CSA C411.4.-16 article 5.4.3	**Fulfillment of parameters**
HTV	ASTM D2565-16	no cracks, crumbling or blisters	**Yes**

-End-

SYNPO, akciová společnost, S. K. Neumanna 1316, 532 07 Pardubice – Zelené Předměstí, 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 375/006
Annexes: 1/1

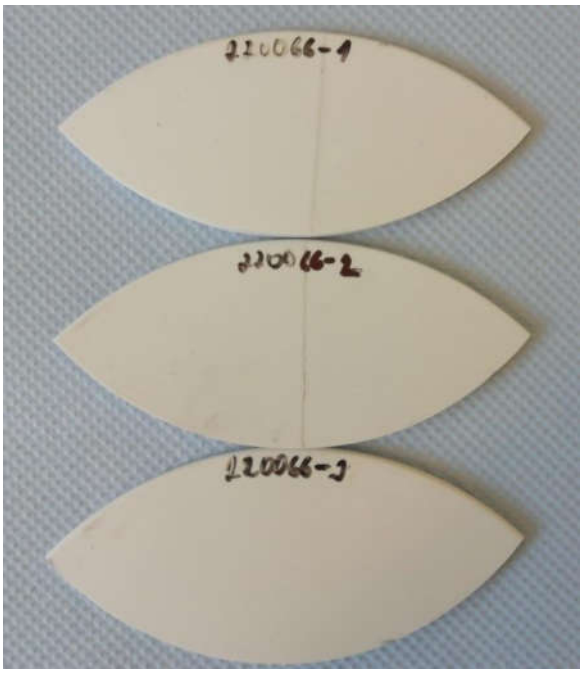
DESCRRIPTION OF THE TEST ITEM

Test item:	**Manufacturer: Jiangsu Shemar Electric Co., Ltd.** **Address : No. 66, Haiwei Road, Sutong Science and Technology Industrial Park, Nantong City, Jiangsu 226017, China** **Type : HTV**
Data delivered by the customer[1] :	-
Internal lab number:	**22 0066**

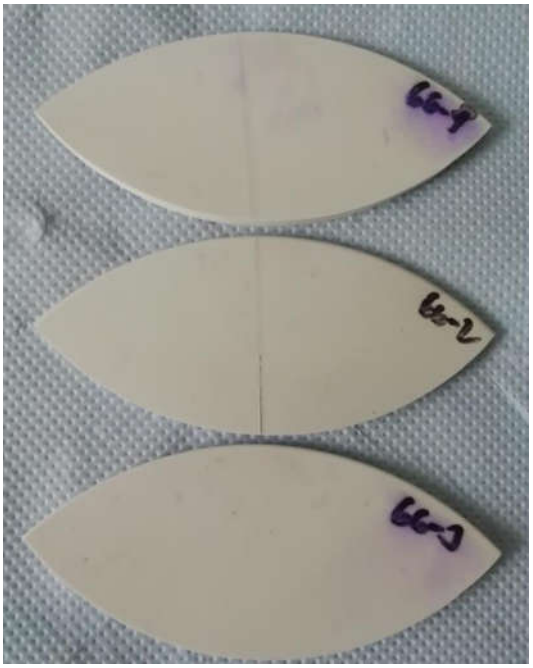
[1]The laboratory is not responsible for the data delivered by customer.

THE PHOTOS OF TEST SAMPLES AFTER 1000 HOURS OF EXPOSURE UNDER XENON LAMPS ACCORDING TO ASTM D2565-16
(The test was included in the flexible scope of accreditation)

1



2



Pic 1 : Exposure after 1000hrs (top face)
Pic 2 : Exposure after 1000hrs (lower face)