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EGU HV LABORATORY

Accredited testing laboratory No.: 1029 Accredited by Czech Accreditation Institute according to ČSN EN ISO/IEC 17025:2018

	TEST REPORT No.: 11788/W/21
CUSTOMER:	Jiangsu Shemar Electric Co., Ltd. 66 Haiwei Road 226 017 Nantong, Jiangsu China
TEST OBJECT:	69 kV Composite insulator
TYPE SPECIFICATION:	SML 133 kN
TEST STANDARDS:	CSA C411.4-16, CSA C411.1-16, IEC 60060-1 Ed. 3.0:2010

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Date: 2022-05-20



TEST REPORT	No.: 11788/W/21
TEST OBJECT:	69 kV Composite insulator
TYPE SPECIFICATION:	SML 133 kN
DRAWING No.:	21SM510755 Rev. B XL21LS172, Rev. 01
MANUFACTURER:	Jiangsu Shemar Electric Co., Ltd.
DATE OF DELIVERY:	2021-12-09
DATE OF TESTS:	From 2022-01-03 till 2022-04-01
ORDER No.:	Contract 23/21
TESTS WITNESSED BY:	N/A
ANNEX	Test report SYNPO, No. T 375/006 Test report Testpolymer EU, No. 59/2022/EN



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1 TEST SUMMARY

Test title	Test standard	Test result
Tests of core material	CSA C411.4-16, clause 5.2	Passed
Dye penetration test	CSA C411.4-16, clause 5.2.2	Passed
Water diffusion test	CSA C411.4-16, clause 5.2.3	Passed
Water penetration test	CSA C411.4-16, clause 5.3	Passed
Visual inspection of test specimen	CSA C411.4-16, clause 5.3.1	Passed
Visual examination	CSA C411.4-16, clause 5.3.3.1	Passed
Hardness test	CSA C411.4-16, clause 5.3.3.2	Passed
Steep-front impulse voltage test	CSA C411.4-16, clause 5.3.3.3	Passed
Power-frequency voltage test	CSA C411.4-16, clause 5.3.3.4	Passed
Accelerated weathering test 1000h ³⁾ (see SYNPO test report T 375/006)	CSA C411.4-16, clause 5.4	Passed
Tracking and erosion test	CSA C411.4-16, clause 5.5	Passed
Visual inspection of test specimen	CSA C411.4-16, clause 5.5.1	Passed
Steep-front impulse voltage test and Power- frequency voltage test	CSA C411.4-16, clause 5.5.4.2	Passed
Tensile load test	CSA C411.4-16, clause 5.6	Passed
Visual inspection of test specimen	CSA C411.4-16, clause 5.6.1	Passed
Thermal-mechanical test	CSA C411.4-16, clause 5.7	Passed
Visual inspection of test specimen	CSA C411.4-16, clause 5.7.1	Passed
Moisure penetration test	CSA C411.4-16, clause 5.7.3.2	Passed
Assembled core time-load test	CSA C411.4-16, clause 5.8	Passed
Visual inspection of test specimen	CSA C411.4-16, clause 5.8.1	Passed
Determination of the average failing load of the core	CSA C411.4-16, clause 5.8.2.2	Passed
Core time – load test	CSA C411.4-16, clause 5.8.2.3	Passed
Mechanical load-time test	CSA C411.4-16, clause 5.9	Passed
Visual inspection of test specimen	CSA C411.4-16, clause 5.9.1	Passed
Flammability test ³⁾ (see Testpolymer EU test report 59/2022/EN)	CSA C411.4-16, clause 5.10	Passed

Note:

³) The test was done in an external accredited laboratory.



2 TESTS PERFORMED

2.1 Tests of core material

The test was carried out according to CSA C411.4-16, clause 5.2.

2.1.1 Dye penetration test

Test date: 2022-01-03

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

Test specimens

Ten test samples of core rod diameter Ø24 mm, 10 mm in length were prepared and delivered by customer.

Test procedure

Test specimens were placed (with fibres in vertical position) on a layer of glass balls (diameter 2 mm) in a glass vessel. A dye (1 % methyl alcohol solution of Astrazon BR 200) was poured into the vessel, with its level 2,5 mm above the glass balls, see Figure 3. The time taken for the dye to rise (by capillary action) through the specimens was measured.

Testing and measuring equipment:

digital stop-watch Olympia PM-172 slide gauge 150 mm, Kinex CZ, serial No. KN2038

Evaluation:

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

Statement of conformity:

Core rod diameter Ø24 mm, passed the test according to requirements given in CSA C411.4-16, clause 5.2.2.

2.1.2 Water diffusion test

Test date: from 2022-01-03 till 2022-01-07

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

Test specimens

Six test samples of core rod diameter Ø24 mm, 30 mm in length were prepared and delivered by customer.

Pre-stressing

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

After boiling, the specimens 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 described in the following clause was carried out within the next three hours.



Voltage test

Immediately before the voltage test the specimens 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 Figures 4 and 5.

Testing and measuring equipment

voltage source HVI 30 kV, type HPA-305FC1, serial No. 006 + Analog panel meters model 553 slide gauge 150 mm, Kinex CZ, serial No. KN2038 Multimeter UT60E, serial No. 110055936 + shunt PM-160 Digital stop-watch Fastime, PM-251 Measuring cylinder, type 1000 ml, i.n. 2/044/11 Heating water vessel, type LTHS 4000, serial No. 18102 Weight Sartorius, type S210P, serial No. 39010002

Specimen No.	Test voltage (kV)	Leakage current (µA)	Test duration (sec)	Result
1	12,0	30,2	60	passed
2	12,0	31,1	60	passed
3	12,0	30,4	60	passed
4	12,0	30,3	60	passed
5	12,0	30,0	60	passed
6	12,0	30,5	60	passed

Table 1The results of the leakage current measurements

Evaluation:

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

Statement of conformity:

Core rod diameter Ø24 mm, passed the test according to requirements given in CSA C411.4-16, clause 5.2.3.



2.2 Water penetration tests

The test was carried out according to CSA C411.4-16, clause 5.3.

2.2.1 Test specimens

Test was carried out according to CSA C411.4-16, clause 5.3.1. The test was performed on composite insulator samples No.: 1, 2, 3 and 4 REF. No. 1, serial No. 2111150075, No. 2, serial No. 2111150054, No. 3, serial No. 2111150080. No. 4 REF, serial No. 2111150078.

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

Testing and measuring equipment

tape measure 5 m, CXS, PM-241 slide gauge 300 mm, Kinex CZ, serial No.2441/05

Evaluation:

Insulators were without damage and dimensions conform to the drawing.

2.2.2 Test procedure and test results

Tests were carried out according to CSA C411.4-16, clause 5.3.2. The tests were performed on insulator samples No. 1, 2, 3.

2.2.2.1 Hardness test before boiling of the test samples

Test date: 2022-03-23

Tests were carried out according to CSA C411.4-16, clause 5.3.3.2.

The hardness of two sheds of each insulator was measured with a Shore A durometer. Measured values were recorded (see Table 2).

Testing and measuring equipment

durometer Shore A, serial No. 45609010 measuring system for atmospheric conditions Comet, serial No. 10910247

Sample No.	No. Sheds	Average value			
	shed No. 1	68,5			
1	shed No. 2	69,8			
	shed No. 1	70,2			
2	shed No. 2	69,7			
	shed No. 1	65,0			
3	shed No. 2	66,9			
The temperature at the time of hardness measurement: 19,5 °C					

Table 2Hardness before water immersion test



2.2.2.2 Water boiling test

Testing date: from 2022-03-23 till 2022-03-27

Three tested insulators No. 1, 2 and 3 were immersed for 100 hours boiling in tap water adjusted to a conductivity of 0,1 % by weight of NaCl. At the end of boiling, each insulator was allowed to remain in the water until the water cooled to 50 °C and maintained at this temperature until the verification tests started (see Figure 6).

Testing and measuring equipment

Heating water vessel AKV2, inventory No. 2420

2.2.2.3 Visual examination

Testing date: 2022-03-28

Tests were carried out according to CSA C411.4-16, clause 5.3.3.1.

Evaluation:

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

2.2.2.4 Hardness test after boiling of test samples

Tests were carried out according to CSA C411.4-16, clause 5.3.3.2.

The hardness of two sheds of each insulator was measured with a Shore A durometer. Measured values were recorded (see Table 3).

Testing and measuring equipment:

durometer Shore A, serial No. 45609010 measuring system for atmospheric conditions Comet, serial No. 10910247

No. Sheds Sample No. Average value shed No. 1 68,8 1 shed No. 2 70.0 shed No. 1 70,2 2 shed No. 2 69,8 shed No. 1 66,7 3 shed No. 2 68,7 The temperature at the time of hardness measurement: 19,8 °C

Table 3 Hardness after water immersion test

Evaluation:

The hardness of each specimen did not change from the pre-boiled value more than $\pm 20\%$.



2.2.2.5 Steep-front impulse voltage test

Tests were carried out according to CSA C411.4-16, clause 5.3.3.3.

Atmospheric conditions:

air pressure	98,0 kPa
air temperature	16,1 °C
relative humidity	48,2 %

Insulators No. 1, 2, 3 were tested. Insulators were divided by electrode on sections. 25 impulses of both polarities with a steepness of at least 1000 kV/ μ s were applied on each section:

- 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 less than 1 mm thick and an original bottom metal fitting (bottom section).

The test arrangement and the flashover on the insulator are shown in Figure 7.

The wave shape of the test impulse is given in Graph 1.

Testing and measuring equipment



impulse generator TuR Dresden 750 kV, 30 kJ R_{d1}/R_{d2} - resistive divider Haefely, 800 kV, serial No. 554333 measuring system Haefely Trench, type HiAS 743, serial No. 175247 measuring system for atmospheric conditions Comet, serial No. 10910247 tape measure 7,5 m, Assist, PM-242

Evaluation:

No puncture of any part of the insulators occured.



2.2.2.6 Power frequency voltage test

Tests were carried out according to CSA C411.4-16, clause 5.3.3.4. Atmospheric conditions:

air pressure	98,0 kPa
air temperature	16,1 °C
relative humidity	48,2 %

Testing and measuring equipment



G - synchronous generator BEZ Bratislava 6 kV, 1300 kVA, T - test transformer TuR Dresden, 500kV/3 000 kVA, serial No. 870786 Cd1/Cd2 – divider MCF 600, serial No. 863705 universal voltmeter Haefely DMI 551, serial No. 188856 digital stop-watch Fastime, PM-251 measuring system for atmospheric conditions COMET, serial No. 14900363 digital thermometer Fluke 54II, serial No. 41070290WS + probe 80PK-27 tape measure 7,5 m, Assist, PM-242

This test consisted of the following two tests:

a) Dry power frequency flashover test

Samples No. 1, 2, 3 and 4 REF (as a reference sample) were tested, see Figure 8. Before the flashover test begins, the shank reference temperatures of all samples were measured. The flashover voltage was obtained by increasing the voltage linearly from zero within one minute. The average of five flashover voltages on each insulator was corrected to normal standard atmospheric conditions in accordance with IEC 60060-1, clause 4.3.

The test arrangement and the flashover of the insulator are shown in Figure 8.

The value of reference flashover voltage was obtained from insulator 4 REF.

The average value of the flashover voltages of insulators No. 1, 2, 3 shall be greater than or equal to 90 % of flashover voltage of the reference insulator 4 REF. Table 4 and 5 display the results of these measurements.

1 4010 1	Ta	ble	4
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Insulator No.	sulator Uncorrected flashover No. values (kV)				over	Uncorrected flashover average (kV)	Correction factors	Corrected reference flashover voltage (kV)
4 REF	375 379 382 375 373				F 375 379 382 375 373 377	$\begin{array}{c} k_1 \!=\! 0,\!980 \\ k_2 \!=\! 0,\!949 \\ K_t \!=\! 0,\!930 \end{array}$	405	
90 % of corrected reference flashover voltage = 365 kV								
80 % of uncorrected reference flashover voltage = 302 kV								



Insulator No.	Uncorrected flashovers values (kV)				vers	Uncorrected flashover average (kV)	Correction factors	Corrected flashover average (kV)
1	381	378	383	379	380	380		409
2	375	377	376	374	376	376		404
3	375	374	376	377	375	375		403

Table 5

All measured voltages are corrected for the standard reference atmosphere according to IEC 60060-1, clauses 4.3 and 4.4.2.

k 1	air density correction factor,
1_	1

K2	numidity correction factor,
17	

Kt atmospheric correction factor.

Evaluation:

Average corrected flashover voltage values of insulators No. 1, 2, 3 exceed 90 % of the reference flashover voltage.

b) Dry power frequency withstand test

Each of tested insulators No. 1, 2, 3 and 4 REF were individually subjected for 30 minutes to 80 % of the average reference flashover voltage. No puncture of the insulator shall occur and the temperature rise ΔT of the shank of insulator immediately after the test shall be less than 10 K with respect to reference temperature. The results are shown in Table 6.

Table 6

Insulator No.	Test voltage (kV)	Result	ΔT (K)	Result
1	302	no puncture	< 10	passed
2	302	no puncture	< 10	passed
3	302	no puncture	< 10	passed
4 REF	302	no puncture	< 10	passed

Evaluation:

No puncture was occured and increase in temperature of the insulator shank was less than 10 K, with respect to reference temperature.

Statemens of conformity:

69 kV Composite insulator, SML 133 kN, drawing No. 21SM510755 Rev. B, passed the the test according to requirements given in CSA C411.4-16, clause 5.3.



2.3 Accelerated weathering test ³)

Specification of silicone rubber
Manufacturer: Jiangsu Shemar Electric Co., Ltd.
Address: No. 66, Haiwei Road, Sutong Science and Technology Industrial Park, Nantong City, Jiangsu 226017, China
Type: HTV silicone rubber
Color: Light gray
Butch number: N/A

The silicone rubber specification was provided by the customer.

The test was performed according to CSA C411.4-16, clause 5.4.

The test was performed by accredited test laboratory SYNPO a.s.as per test report No. T 375/006.

Evaluation:

No surfaces degradations such as cracks, crumbling or blisters.

Statement of conformity:

Test specimens of HTV silicone rubber passed the test according to requirements given in CSA C411.4-16, clause 5.4.



2.4 Tracking and erosion test

Test was carried out according to CSA C411.4-16, clause 5.5, method 2 (tracking wheel No. 2).

2.4.1 Test specimens

Test was carried out according to CSA C411.4-16, clause 5.5.1. The test was performed on composite insulator samples with reduced length No.: 1, 2, 3 and 4 REF.

No. 1, serial No. 2111150053,

No. 2, serial No. 2111150064,

No. 3, serial No. 2111150086.

No. 4 REF, serial No. 2111150062.

The insulators were examined visually and their dimensions were checked against the manufacturer's drawing (see Figure 2).

Testing and measuring equipment

tape measure 5 m, CXS, PM-241 slide gauge 150 mm, Kinex CZ, serial No. KN2038 slide gauge 1000 mm, Kinex CZ, serial No. C11121

Evaluation:

Insulators were without damage and dimensions conform to the drawing.

2.4.2 Tracking wheel test method 2

Test date: From 2022-01-11 till 2022-04-01

Test procedure and test results

The saline solution in the tank consisted de-ionised water with $1,40 \pm 0,06$ 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 C 411.4-16, 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 during the tracking and erosion test is shown in Figure 10. Test samples after tracking and erosion test are shown in Figure 11, 12, 13 and 14.

Testing and measuring equipment:

Regulation transformer TuR Dresden 54kVA, serial No. 830212 + testtransformer ES Brno 100 kVA, serial No. 150604 measuring Transformer UZGT 30, serial No. 02022 Multimeter UT71D, serial No. 1100420241 Conductivity meter, WTW Cond 3310, serial No. 10410891 Water vessel tracking wheel test "green type" 1,3m³



Table 7

Test voltage:	22,1 kV
Beginning of the test:	2022-01-11
End of the test:	2022-03-31
Salinity:	$1,4 \pm 0,06 \text{ kg/m}^3$
Number of cycles:	31 424
The ambient temperature	20 °C ±5 K
Measured creepage distance	630 mm

Table 8

Start of tested period	End of tested period	Rest period (h)	Quantities of cycles
11.1.	15.1	24	1 964
16.1.	20.1.	24	3 928
21.1.	25.1.	24	5 892
26.1.	30.1.	24	7 856
31.1.	4.2.	24	9 820
5.2.	9.2.	24	11 784
10.2.	14.2.	24	13 748
15.2.	19.2.	24	15 712
20.2.	24.2.	24	17 676
25.2.	1.3.	24	19 640
2.3.	6.3.	24	21 604
7.3.	11.1.	24	23 568
12.3.	16.3.	24	25 532
17.3.	21.3.	24	27 496
22.3.	26.3.	24	29 460
27.3.	31.3.	-	31 424

Evaluation:

No erosion to the core, no shed or housing pucture, no surface tracking occured on tested insulator No. 1, 2 and 3.



2.4.3 Test evaluation

Test date: From 2022-04-01

Tests were carried out according to CSA C411.4-16, clause 5.5.4.

Immediately after completion of the tracking wheel test, each insulator was rinsed in deionized water and was tested in accordance with the steep-front impulse voltage test and the power frequency voltage test. The additional identical insulator No. 4 REF was tested as a reference in the power frequency voltage test.

2.4.3.1 Steep-front impulse voltage test

Tests were carried out according to CSA C411.4-16, clause 5.3.3.3 and 5.5.4.2.

Atmospheric conditions:

air pressure	97,2 kPa
air temperature	15,6 °C
relative humidity	39,2 %

Insulators No. 1, 2, 3 were tested. The test voltage 25 impulses of both polarities with a steepness of at least 1000 kV/ μ s were applied on each tested insulator.

The test arrangement and the flashover on the insulator are shown in Figure 15.

The wave shape of the test impulse is given in Graph 2.

Testing and measuring equipment



impulse generator TuR Dresden 750 kV, 30 kJ R_{d1}/R_{d2} - resistive divider Haefely, 800 kV, serial No. 554333 measuring system Haefely Trench, type HiAS 743, serial No. 175247 measuring system for atmospheric conditions Comet, serial No. 10910247 tape measure 7,5 m, Assist, PM-242

Evaluation:

No puncture of any part of the insulators occured.



2.4.3.2 Power frequency voltage test

Tests were carried out according to CSA C411.4-16, clause 5.3.3.4 and 5.5.4.2. Atmospheric conditions:

air pressure	97,4 kPa
air temperature	16,2 °C
relative humidity	34,9 %

Testing and measuring equipment



G - synchronous generator BEZ Bratislava 6 kV, 1300 kVA, T - test transformer Fischer Köln, 250 kV, serial No. P38879 Cd1/Cd1 – LK-250, serial no. 001-12 universal voltmeter MU 17, serial No. 929218 digital stop-watch Kalenji, PM-259 measuring system for atmospheric conditions COMET, serial No. 10910247 digital thermometer Fluke 54II, serial No. 41070290WS + probe 80PK-27 tape measure 7,5 m, Assist, PM-242

This test consisted of the following two tests:

a) Dry power frequency flashover test

Samples No. 1, 2, 3 and 4 REF (as a reference sample) were tested, see Figure 8. Before the flashover test begins, the shank reference temperatures of all samples were measured. The flashover voltage was obtained by increasing the voltage linearly from zero within one minute. The average of five flashover voltages on each insulator was corrected to normal standard atmospheric conditions in accordance with IEC 60060-1, clause 4.3.

The test arrangement and the flashover of the insulator are shown in Figure 16.

The value of reference flashover voltage was obtained from insulator REF.

The average value of the flashover voltages of insulators No. 1, 2, 3 shall be greater than or equal to 90 % of flashover voltage of the reference insulator 4 REF. Table 9 and 10 display the results of these measurements.

I able 9	Ta	ble	9
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Insulator No.	Uncorrected flashover values (kV)			ver	Uncorrected flashover average (kV)	Correction factors	Corrected reference flashover voltage (kV)	
4 REF	139	131	132	134	131	133		142
90 % of corrected reference flashover voltage = 128 kV								
80 % of uncorrected reference flashover voltage = 106 kV								



Insulator No.	Uncorrected flashovers values (kV)				vers	Uncorrected flashover average (kV)	Correction factors	Corrected flashover average (kV)
1	129	125	129	125	126	127		137
2	121	124	121	128	122	123		133
3	131	124	122	122	129	126		136

Table 10

All measured voltages are corrected for the standard reference atmosphere according to IEC 60060-1, clauses 4.3 and 4.4.2.

- **k**₁ air density correction factor,
- k2 humidity correction factor,
- Kt atmospheric correction factor.

Evaluation:

Average corrected flashover voltage values of insulators No. 1, 2, 3 exceed 90 % of the reference flashover voltage.

b) Dry power frequency withstand test

Each of tested insulators No. 1, 2, 3 and 4 REF were individually subjected for 30 minutes to 80 % of the average reference flashover voltage. No puncture of the insulator shall occur and the temperature rise ΔT of the shank of insulator immediately after the test shall be less than 10 K with respect to reference temperature. The results are shown in Table 11.

Table 11

Insulator No.	Test voltage (kV)	Result	ΔT (K)	Result
1	106	no puncture	< 10	passed
2	106	no puncture	< 10	passed
3	106	no puncture	< 10	passed
4 REF	106	no puncture	< 10	passed

Evaluation:

No puncture was occured and increase in temperature of the insulator shank was less than 10 K, with respect to reference temperature.

Statemens of conformity:

69 kV Composite insulator, SML 133 kN, drawing No. 21SM510755 Rev. B, passed the the test according to requirements given in CSA C411.4-16, clause 5.3.



2.5 Tensile load test

The test was carried out according to CSA C411.4-16, clause 5.6.

2.5.1 Test specimens

Test was carried out according to CSA C411.4-16, clause 5.6.1. The three insulators were examined visually. The tests were performed on composite tension insulators samples No. 1, 2 and 3.

No. 1, serial No. 2111150057, No. 2, serial No. 2111150073, No. 3, serial No. 2111150070.

Testing and measuring equipment:

slide gauge 300 mm, Kinex CZ, serial No. 2441/05 tape measure 5 m, CXS, PM-241

Evaluation:

Insulators were without damage and dimensions conform to the drawing (see Figure 1).

2.5.2 Test procedure and test result

Test date: 2022-03-02

Test was carried out according to CS C411.4.-16, clause 5.6.2. Three insulators No. 1, 2 and 3 were subjected to tensile load applied between couplings. The tensile load was increased rapidly but smoothly from zero to approximately 100 kN (75 % of the SML) and then gradually increased in a time between 30 s to 90 s to 133 kN (100 % of SML). The load was sustained at SML for the 60 s. Then was the load increased up to insulator failure.

Records of measured mechanical loading during the mechanical failing test are given in Graphs 3, 4 and 5.

The samples after mechanical failing load test are shown in Figure 17, 18, 19 and 20.

Testing and measuring equipment

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

Test results

Table 12

Test sample No.	100 % SML	Composite insulator failing load (kN)	Type of failure
1	133 kN/60 s - OK	235,0	Pull out of the core from the end fitting
2	133 kN/60 s - OK	209,5	Pull out of the core from the end fitting
3	133 kN/60 s - OK	234,0	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. 1, 2 and 3.

Statement of conformity:

69 kV Composite insulator, SML 133 kN, drawing No. 21SM510755 Rev. B, passed the test according to requirements given in CSA C411.4-16, clause 5.6.



2.6 Thermal-mechanical test

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

2.6.1 Test specimens

Testing date: 2022-03-24

Test was carried out according to CSA C411.4.-16, clause 5.7.1. The three insulators were examined visually. The tests were performed on composite tension insulators samples No. 1, 2 and 3.

No. 1, serial No. 2111150055, No. 2, serial No. 2111150082, No. 3, serial No. 2111150069.

Testing and measuring equipment: slide gauge 300 mm, Kinex CZ, serial No. 2441/05 tape measure 5 m, CXS, PM-241

Evaluation:

Insulators were without damage and dimensions conform to the drawing (see Figure 1).

2.6.2 Thermal-mechanical tests

Testing date: from 2022-03-24 till 2022-03-28

Tests were carried out according to CSA C411.4-16, clause 5.7.2.

Three insulators No. 1, 2 and 3 were subjected to a tensile mechanical load to 6,7 kN, (5 % of SML, SML = 133 kN) for the duration one minute, the reference total length was measured. Measured values are show in Table 13.

Three insulators No. 1, 2 and 3 were subjected to a mechanical load to 66,5 kN (50% of SML). Each insulator was subjected to four 24-hour cycles with one cooling period of -50 °C \pm 5 °C, followed by one heating period of +50 °C \pm 5 °C.

Following the thermal mechanical cycling, each insulator was permitted to reach ambient temperature and a tension load 6,7 kN was applied and the length again measured. The increased length shall be less than 2 mm (Table 13).

The test arrangement during the thermal-mechanical test on the insulator is shown in Figure 21.

Records of measured temperatures and tensile load during the thermal-mechanical testing are given in Graphs 6, 7 and 8.

Dye penetration test of metal end fittings were carried out according to CSA C411.4-16, clause 5.7.3.1 c). Both ends of insulators were subjected to the dye penetration test. After the penetration test the test specimens were inspected. The insulators after the dye penetration test are shown in Figures 22 and 23.

Testing and measuring equipment:

digital thermometer - datalogger, Comet system S0141, serial No. 18931701 digital thermometer - datalogger, Comet system S0141, serial No. 19270819 thermal mechanical chamber Horkan Klima, inventory No. 2237 loading measuring system Format 1, type EGU – 1V, serial No. Z201128287 thermal mechanical chamber LaborTech. Type Creep test 6.500.C3, serial No. ZA/2018/51 slide gauge 1 500 mm, Filleta, serial No. G10066



2.6.3 Moisture penetration test

Test date: 2022-03-29

Tests were carried out according to CSA C411.4.-16, clause 5.7.3.2.

Each insulator end was submerged to a depth of at least 50 mm above the end fitting in dye composed of 1 g of astrazon in 100 g of methanol for a minimum of 15 min. After that the insulator were removed from the solution and wipe dry.

Each insulator was cut 90° to the axis of the core and about 50 mm from both metal fittings. Both metal fittings were cut on each insulator longitudinally into two halves and removed from the insulator (see Figure 24).

Testing and measuring equipment:

digital stop-watch Fastime PM-251

2.6.4 Test results

Table 13

Insulator No.	1	2	3
Length before test (mm)	1120,5	1127,0	1121,0
Length after test (mm)	1120,6	1127,1	1121,5

Evaluation:

Increase length was not more than 2 mm.

No dye on the core rod or interfaces was observed after moisture penetration test

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

Statement of conformity:

69 kV Composite insulator, SML 133 kN, drawing No. 21SM510755 Rev. B, passed the test according to requirements given in CSA C411.4-16, clause 5.7.



2.7 Assembled core load-time tests

The test was carried out according to CSA C411.4-16, clause 5.8.

2.7.1 Test specimens

Test was carried out according to CSA C411.4-16, clause 5.8.1. The six insulators were examined visually. The tests were performed on composite tension insulators samples No. 1, 2, 3, 4, 5 and 6.

No. 1, serial No. 2111150058,

No. 2, serial No. 2111150051,

No. 3, serial No. 2111150083.

No. 4, serial No. 2111150067,

No. 5, serial No. 2111150060,

No. 6, serial No. 2111150066.

Testing and measuring equipment:

slide gauge 300 mm, Kinex CZ, serial No. 2441/05 tape measure 5 m, CXS, PM-241

Evaluation:

Insulators were without damage and dimensions conform to the drawing (see Figure 1).

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

Test date: 2022-03-03

Test was carried out according to CSA C411.4-16, clause 5.8.2.2. Three insulators No. 1, 2 and 3 were subjected to tensile load applied between couplings. The tensile load was increased rapidly but smoothly from zero to approximately 100 kN (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. The average value of the three failing loads was calculated.

Records of measured mechanical loading during the mechanical failing test are given in Graphs 9, 10 and 11.

The samples after mechanical failing load test are shown in Figure 25, 26, 27 and 28.

Testing and measuring equipment

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

Test results

Table 14

Test sample No.	Type of failure	Composite insulator failing load (kN)
1	Pull out of the core from the end fitting	211,7
2	Pull out of the core from the end fitting	205,7
3	Pull out of the core from the end fitting	196,3
	Average of the failing load	204,6
	60 % of average of the failing load	122,8



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

Test date: from 2022-03-07 till 2022-03-15

Test was carried out according to CSA C411.4-16, clause 5.8.2.3. Three insulators No. 4, 5 and 6 were subjected to a tensile load applied between couplings. The tensile load was increased rapidly but smoothly, from zero up to 122,8 kN (60 % of the average failing load) and then maintained at this value for 96 hours. Test samples during the mechanical 96 hours load test are shown in Figure 29.

Then diagnostic testing of end fittings was performed on the insulators No. 4, 5 and 6. Both ends of each tested insulator were subjected to the dye penetration test. After the penetration test the test specimens were inspected. The insulators after the dye penetration test are shown in Figure 30.

Record of mechanical loading applied during mechanical 96 hours tests are given in Graphs 12, 13 and 14.

Testing and measuring equipment

Thermal-mechanical chamber, inventory No. 1089 Loading system Format 1, type EGU – 2V, serial No. Z201128288 Thermal-mechanical chamber, inventory No. 2237 Loading system Format 1, type EGU – 1V, serial No. Z201128287

Evaluation:

No failure (breakage or complete pull-out of the core or fracture of the metal fittings) occurred during 96 h test on insulators No. 4, 5 and 6.

No fracture or cracking of the metal end fittings were observed after dye penetration test on insulators No. 4, 5 and 6.

Statement of conformity:

69 kV Composite insulator, SML 133 kN, drawing No. 21SM510755 Rev. B, passed the test according to requirements given in CSA C411.4-16, clause 5.8.



2.8 Mechanical load-time test

The test was carried out according to CSA C411.4-16, clause 5.9.

2.8.1 Test specimens

The test was carried out according to CSA C411.4-16, clause 5.9.1.

The insulators No. 1, 2, 3, 4 were examined visually and their dimensions were checked against the drawing.

No. 1, serial No. 2111150061, No. 2, serial No. 2111150068, No. 3, serial No. 2111150085. No. 4, serial No. 2111150076.

Testing and measuring equipment: slide gauge 300 mm, Kinex CZ, serial No. 2441/05 tape measure 5 m, CXS, PM-241

Evaluation:

Insulators were without damage and dimensions conform to the drawing (see Figure 1).

2.8.2 Test procedure and test result

Performance of the test

The test was carried out according to CSA C411.4-16, clause 5.9.1.

This test was performed on the insulators No. 1, 2, 3, 4 at the ambient temperature as described in the following three paragraphs.

a) 96 h withstand test (The test was carried out according to CSA C411.4-16, clause 5.9.2.1.)

All the insulators No. 1, 2, 3, 4 were subjected to a tensile load applied between couplings. The tensile load was increased rapidly but smoothly, from zero up to 93,1 kN (70 % of SML, SML = 133 kN) and then maintained at this value for 96 hours. The insulators under the test are shown in Figure 31. Applied load during testing is shown in Graphs 15, 16 and 17.

b) Dye penetration test (The test was carried out according to CSA C411.4-16, clause 5.9.2.2.)

Both ends of the insulator No. 4 were subjected to the dye penetration test for 20 minutes. After the penetration test the specimens were inspected. The insulator No. 4 after the dye penetration test is shown in Figure 32.

c) SML test (The test was carried out according to CSA C411.4-16, clause 5.9.2.3.)

Three remaining insulators No. 1, 2 and 3 were then again subjected to the tensile load applied between the couplings. The tensile load was increased rapidly but smoothly from zero approximately to 99,8 kN (75 % of SML) and then gradually increased in a time between 30 s to 90 s to 133 kN (100 % of SML). The load was sustained for the 60 s. Then the load was increased up to the failure of the insulator. Record of applied tensile load during testing are shown in Graphs 18, 19 and 20. The insulators after the failing load tests are shown in Figures 33, 34, 35 and 36.



Testing and measuring equipment:

digital stop-watch Fastime PM-251 themal-mechanical chamber LaborTech, type Creep test 6.500.C3, serial ZA/2018/51 themal-mechanical chamber, inventory No. 2237 + loading system Format 1, type EGU – 1V, Z201128287 themal-mechanical chamber, inventory No. 1089 + loading system Format 1, type EGU – 2V, Z201128288 tensile machine LaborTech, type Lab Test 5.600SP1, serial No. 15/12

Test results

a)	96 h	withstand	test

Dates of test:	from 2022-02-25 till 2022-03-01
Insulators:	No. 1, 2, 3, 4.
Apllied load:	93,1 kN (70% of 133 kN).
Result:	No failure.

b) Dye penetration test

Date of test:	2022-03-01
Insulator:	No. 4.
Result:	No cracks.

c) SML test	
Date of test:	2022-03-01
Insulators:	No. 1, 2, 3.
SML:	133 kN.
Result:	No failure during 1-min at SML.
	Measured failing loads are below in the Table .

Table 15 Test results of the failing load tests

Insulator No.	Failing load (kN)	Type of failure
1	183,5	Pull out of end fitting
2	214,7	Pull out of end fitting
3	220,9	Pull out of end fitting

Evaluation:

No failure (breakage or complete pull-out of the core or fracture of the metal fittings) occurred during the 96 h test at 70 % of SML on insulators No. 1, 2, 3 and 4.

No failure occurred during 1 min withstand test at 100 % of SML on insulators No. 1, 2, 3.

No cracks were observed after dye penetration test on insulator No. 4.

Statement of conformity:

69 kV Composite insulator, SML 133 kN, drawing No. 21SM510755 Rev. B, passed the test according to requirements given in CSA C411.4-16, clause 5.9.



2.9 Flammability test ³⁾

Specification of silicone rubber
Manufacturer: Jiangsu Shemar Electric Co., Ltd.
Address: No. 66, Haiwei Road, Sutong Science and Technology Industrial Park, Nantong City, Jiangsu 226017, China
Type: HTV silicone rubber
Color: Light gray
Butch number: N/A
The silicone rubber specification was provided by the customer.

The test was performed according to CSA C411.4-16, clause 5.10.

The test was performed by accredited test Test polymer EU as per report No. 59/2022/EN.

The silicone rubber samples of required dimensions were provided by the customer.

Evaluation:

The silicone material HTV, passed specification V0 and HB.

Statement of conformity:

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



3 UNCERTAINTY OF MEASUREMENTS

QUANTITY	UNCERTAINTY		
Steep front impulse voltage	Um T1	2,2 %	
Power-frequency voltage (divider MCF 600)	-1	7 %	
Power-frequency voltage (divider LK-250)	1,5 %		
Power-frequency voltage (water diffusion test)	0,3 kV		
Power-frequency voltage (wheel test)	1,3 %		
Power-frequency leakage current (water diffusion test)	1,	1,3 %	
Mechanical load (CreepTest)	1,	1,0 %	
Mechanical load (LabTest)	1,	0 %	
Mechanical load (Horkan Klima)	1,3 %		
Temperature (thermal-mechanical chamber)	3,0 %		
Temperature (Fluke + touch probe)	7,5 %		
Slide gauge, length (2-150 mm)	0,4 %		
Slide gauge, length (2-300 mm)	0,5 %		
Slide gauge, length (100-1 500 mm)	0,8 %		
Slide gauge, length (50-1 000 mm)	0,8 %		
Tape measure, length (10-5 000 mm)	1,6 %		
Tape measure, length (10-7 500 mm)	1,6 %		
Temperature	4,0 %		
Air pressure	0,5 %		
Relative humidity	6,3 %		
Time	0,7 %		
Body of water (200 – 1000 ml)	10,0 ml		
Weight (Sartorius)	0,9 %		
Conductivity (0,1 µS/cm – 1000 mS/cm)	5,0 %		
Hardness A (0-100 HAS)	2,	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 %. Details related to the statement of conformity when applied are given in a price quotation submitted to a customer before the testing and on the website of the laboratory.



4 PRODUCT DRAWINGS



Figure 1 69 kV Composite insulator, SML 133 kN, drawing No. 21SM510755 Rev. B





Figure 2 69 kV Composite insulator for tracking end erosion test (tracking wheel), SML 133 kN, drawing No. XL21LS172 Rev. 01







No. 6 Ll tailchopped Upk : 534.397 kV T1 : 494.076 ns SR : 1.084 MV/us



No. 11 LI tailchopped Upk max: -558.606 kV Upk min: 31.336 kV T1 : 509.547 ns SR : -1.098 MV/us

Graph 1 Representative wave shape of steep front impulse (water penetration test)





Graph 2 Representative wave shape of steep front impulse (tracking end erosion test)





Graph 3 Record of mechanical loading test, tensile load test, sample No. 1



Graph 4 Record of mechanical loading test, tensile load test, sample No. 2





Graph 5 Record of mechanical loading test, tensile load test, sample No. 3





Graph 6 Record of temperature during thermal-mechanical cycles, test samples No. 1 and 2





Graph 7 Record of tensile load during thermal-mechanical cycles, test samples No. 1 and 2



Graph 8 Record of tensile load during thermal-mechanical cycles, test sample No. 3





Graph 10 Record of mechanical loading test, assembled core load-time test, sample No. 2





Graph 11 Record of mechanical loading test, assembled core load-time test, sample No. 3



Graph 12 Record of 96 hours mechanical loading test, assembled core load-time test, sample No. 4




Graph 13

Record of 96 hours mechanical loading test, assembled core load-time test, sample No. 5



Graph 14 Record of 96 hours mechanical loading test, assembled core load-time test, sample No. 6





Graph 15 Record of 96 hours mechanical loading test, mechanical load-time test, test samples No. 1 and 2



Record of 96 hours mechanical loading test, mechanical load-time test, test sample No. 3





Graph 17

Record of 96 hours mechanical loading test, mechanical load-time test, test sample No. 4



Record of the mechanical loading applied during the mechanical failing load test, mechanical load-time test, test sample No. 1





Record of the mechanical loading applied during the mechanical failing load test, mechanical load-time test, test sample No. 2



Record of the mechanical loading applied during the mechanical failing load test, mechanical load-time test, test sample No. 3



6 TEST OBJECT AND TEST SETUP PHOTOS



Figure 3 Test specimens after the dye penetration test



Figure 4 Test specimens during the voltage test – water diffusion test





Figure 5 Test specimens after the voltage test – water diffusion test



Figure 6 Test samples No. 1, 2 and 3, water penetration test





Figure 7 Test sample, during the steep-front impulse voltage test, water penetration test



Figure 8 Test sample, during the dry power frequency flashover test, water penetration test





Figure 9 Composite insulator 69kV, SML 133 kN, test samples No. 1, 2 and 3, before start of the tracking end erosion test



Figure 10 Composite insulator 69kV, SML 133 kN, test samples No. 1, 2 and 3, before start of the tracking end erosion test (tested together with test samples 138 kV, SML 222 kN)





Figure 11 Composite insulator 69kV, SML 133 kN, test samples No. 1, 2 and 3, after tracking end erosion test



Figure 12 Test sample No. 1 after the tracking end erosion test





Figure 13 Test sample No. 2 after the tracking end erosion test



Figure 14 Test sample No. 3 after the tracking end erosion test





Figure 15 Test sample, during the steep-front impulse voltage test, tracking end erosion test



Figure 16 Test sample, during the dry power frequency flashover test, tracking end erosion test

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Figure 17 Test sample No. 1, after the mechanical failing load test, tensile load test



Figure 18 Test sample No. 1, after the mechanical failing load test, tensile load test

Test Report No.: 11788/W/21





Figure 19 Test sample No. 1, after the mechanical failing load test, tensile load test



Figure 20 Test samples No. 1, 2 and 3 after the mechanical failing load test, tensile load test





Figure 21 Test samples No. 1, 2 and 3 during thermal-mechanical cycles, thermal-mechanical test



Figure 22 Test samples No. 1, 2 and 3 during diagnostic testing of the fittings, thermal-mechanical test





Figure 23 Test samples No. 1, 2 and 3 after diagnostic testing of the fittings, thermal-mechanical test





Figure 24 Test samples No. 1, 2 and 3 after moisture penetration test, thermal-mechanical test



Figure 25 Test sample No. 1, after the mechanical failing load test, assembled core load-time test





Figure 26

Test sample No. 2, after the mechanical failing load test, assembled core load-time test



Figure 27 Test sample No. 3, after the mechanical failing load test, assembled core load-time test





Figure 28 Test samples No. 1, 2 and 3, after the mechanical failing load test assembled core load-time test



Figure 29 Test samples No. 4, 5 and 6, during the verification of the 96 hours mechanical load test, assembled core load-time test





Figure 30 Test samples No. 4, 5and 6 after diagnostic testing of the fittings, assembled core load-time test





Figure 31 Test samples No. 1, 2, 3 and 4 during the verification of the 96 hours mechanical load test, mechanical load-time test





Figure 32 Test sample No. 4 after the dye penetration test, mechanical load-time test





Figure 33 Test sample No. 1 after the mechanical failing load test, mechanical load-time test



Figure 34 Test sample No. 2 after the mechanical failing load test, mechanical load-time test





Figure 35 Test sample No. 3 after the mechanical failing load test, mechanical load-time test



Figure 36 Test sample No. 1, 2 and 3 after the mechanical failing load test, mechanical load-time test

- end of test report -



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EGU HV LABORATORY

Accredited testing laboratory No.: 1029 Accredited by Czech Accreditation Institute according to ČSN EN ISO/IEC 17025:2018

	TEST REPORT No.: 11788/G/21	TESTING LA BORATO
CUSTOMER:	Jiangsu Shemar Electric 66 Haiwei Road 226 017 Nantong, Jiang China	c Co., Ltd. No. 1029 gsu
TEST OBJECT:	69 kV Composite insulc	ator
TYPE SPECIFICATION:	SML 133 kN	
TEST STANDARDS:	CSA C411.4-16, CSA C4 IEC 60383-1 Ed.4:1993,	411.1-16, NEMA 107:2016
Mawa Michal Novotný Test engineer	Marek Brosch Head of	Jan Lachman, Ph.Đ. Director of

EGU - HV Laboratory a. s.

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EGU HV LABORATORY

Copy: 1

Date: 2022-05-20



TEST REPORT	No.: 11788/G/21
TEST OBJECT:	69 kV Composite insulator
TYPE SPECIFICATION:	SML 133 kN
DRAWING No.:	21SM510755 Rev. B
MANUFACTURER:	Jiangsu Shemar Electric Co., Ltd.
DATE OF DELIVERY:	2021-12-09
DATE OF TESTS:	From 2022-02-28 till 2022-03-04
ORDER No.:	Contract 23/21
TESTS WITNESSED BY:	N/A



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1 TEST SUMMARY

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



2 TESTS PERFORMED

2.1 Corona test

2.1.1 Test procedure

Date of test: 2022-02-28

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 ring, serial No. 2111150079.

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 2.

The test arrangement was set up according to CSA C411.4-16, clause 6.4.2.2 (see Figure 2). The single conductor was simulated using an aluminium tube of 14 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 4,15 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. $V_T = 1.2 \times 72/\sqrt{3} = 50$ kV.

The test object at the specified test voltage is shown in Figure 4. The corona discharges are shown in Figure 5.

Radio interference voltage RIV was measured according to NEMA 107. RIV (expressed in decibels relative to 1 μ V 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 1.

Testing and measuring equipment:

coupling capacitance, 1 000 pF, 800 kV, serial No. 11100108.10.1 measuring impedance Power Diagnostix, NEMA 150 Ω , type CIT4M/V8µ0/RIV, serial No. 12533 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 Trench, type DMI 551, serial No. 150505 RIV meter - measuring receiver Power Diagnostix, type RIV meter, serial No. 035 calibrator Power Diagnostix, type CAL3B, serial No. 3014 measuring system for atmospheric condition COMET, serial No. 10910247 digital stop-watch Kalenji, PM-259 field glasses Nikon Action EX 7x50, serial.No. 320695 measuring telescopic stick 5m, type BMI, serial No. 102



2.1.2 Test results

Table 1	Test results	of the RIV	test
---------	--------------	------------	------

U _m (kV)	72		
Atm. conditions			
p (kPa)		100,4	
t (°C)		15,8	
RH (%)	33,1		
Test voltage (kV)	RIV ↓ (μV)	RIV ↑ (μV)	RIV ↓ (μV)
145	25 119	25 119	25 119
135	10 000	10 000	10 000
125	22	22	22
110	22	22	22
100	22	22	22
65	22	22	22
60	22	22	22
55	22	22	22
50	22	22	22
45	22	22	22
40	22	22	22
0	22	22	22



Um (kV)	72		
Atm. conditions			
p (kPa)	100,4		
t (°C)	15,8		
RH (%)	33,1		
Measurement No.	Ue (kV)		
1	128		
2	131		
3	129		
Average value	129		
Location of corona	Corona ring		
Criteria: $U_e > 50 \text{ kV}$			

Table 2Test results of the corona test

Evaluation:

Measured corona extinction voltages U_e were greater than the specified minimum corona extinction voltage of 50 kV.

Statement of conformity:

69 kV Composite insulator, SML 133 kN, drawing No. 21SM510755 Rev. B, passed the test according to requirements given in CSA C411.4-16, clause 6.4.4.



2.2 Critical impulse flashover test

2.2.1 Test procedure

Date of test: 2022-03-01

The test was carried out according to CSA C411.4-16, clause 6.2 and CSA C411.1, clause 6.5.1 to 6.5.3.

The tests were performed on three insulators:

No. 1, serial No. 2111150079, No. 2, serial No. 2111150072, No. 3, serial No. 2111150077.

The critical impulse voltages of both polarities were 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 and 6.2.6.

The representative wave shape of the lightning impulse $1,2/50 \mu s$ is given Graph 1.

The test arrangement was set up in compliance with IEC 60383-1, clause 34 (see Figure 6).

Testing and measuring devices:

impulse generator HighVolt IGL 180/1800G, serial No. IGG2295141 capacitive/resistive divider HighVolt, type MCR 0,4/2000-1000/1000 H391-41, serial No. MCR2295141/103732 measuring system High Volt, type HiRES S4D, serial No. HIGG2295141 tape measure 7,5 m, Assist, PM-242 measuring system for atmospheric condition COMET, serial No. 14900363



2.2.2 Test results

Test sample No.	1	l	2	2	3	
Impulse polarity	+	-	+	-	+	-
Atm. conditions:						
air pressure (kPa)	100,1	100,1	100,0	100,0	100,1	100,1
air temperature (°C)	16,8	16,8	16,6	16,6	16,9	16,9
relative humidity (%)	38,5	38,5	35,2	35,2	33,2	33,2
Correction factors:						
air density correction factor k ₁	0,999	0,999	0,999	0,999	0,999	0,999
humidity correction factor k ₂	0,958	0,966	0,952	0,963	0,952	0,962
atmospheric correction factor Kt	0,957	0,965	0,951	0,962	0,951	0,961
Critical impulse flashover voltage (kV)	635	667	627	668	633	667
Polarity		+	I		-	1
Average critical impulse flashover value of the three insulators (kV)	632 667					
Measured arcing distance: 980 mm						
Drawing specified critical impulse flashover voltage: 628 kV						

 Table 3
 Test results of the critical impulse flashover test

Evaluation:

The average critical impulse flashover value of the three insulators was equal to or exceed 95% of the rated critical impulse flashover value specified by client drawing 628 kV, i.e. 597 kV.

Statement of conformity:

69 kV Composite insulator, SML 133 kN, drawing No. 21SM510755 Rev. B, passed the test according to requirements given in CSA C411.4-16, clause 6.2. and client requirements.



2.3 Wet power frequency voltage flashover test

2.3.1 Test procedure

Date of test: 2022-03-04

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

The tests were performed on three insulators:

No. 1, serial No. 2111150079, No. 2, serial No. 2111150072, No. 3, serial No. 2111150077.

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

The wet power-frequency flashover voltage 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 in compliance with IEC 60383-1, clause 34 (see Figure 7).

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 measuring system for atmospheric conditions Comet, serial No. 10910247 tape measure 5 m, CXS, PM-241 digital stop-watch Kalenji PM-259 conductivity meter WTW Cond 3310, serial No. 10410891 plastic measuring cylinder 50ml, identification No. 1/153/14 & 2/153/14



2.3.2 Test results

Test sample No.	1	2	3	
Atm. conditions:				
air pressure (kPa)	98,9	98,9	98,9	
air temperature (°C)	15,5	15,5	15,5	
relative humidity (%)	51,2	51,2	51,2	
Rain parameters:				
vertical (mm/min)	1,6	1,6	1,6	
horizontal (mm/min)	1,6	1,6	1,6	
Conductivity (µS/cm)	99	99	99	
Correction factors:				
air density correction factor k ₁	0,992	0,992	0,992	
humidity correction factor k ₂	1,000	1,000	1,000	
atmospheric correction factor K _t	0,992	0,992	0,992	
Flashover voltage	320 kV	327 kV	332 kV	
The average wet flashover voltage of the three insulators326 kV				
Measured arcing distance: 980 mm				
Drawing specified wet power frequency flashover voltage: 320 kV				

Table 4Test results of the wet power frequency flashover voltage test



3 LIST OF SYMBOLS

RIV	radio interference voltage (µV)
Vt	test voltage specified by client (kV)
Um	maximum design phase-to-phase service voltage
Ue	extinction corona voltage (kV), corresponding to actual atmosphere
р	air pressure (kPa)
t	air temperature (°C)
RH	relative humidity (%)
k 1	air density correction factor
k ₂	humidity correction factor
Kt	atmospheric correction factor
Upk	maximum voltage of recorded curve (kV)
β'	relative overshoot (%)
T1	front time of recorded curve (µs)
T ₂	time to half-value of recorded curve (µs)
vertical c.	average value of rainfall intensity - vertical component (mm/min)
horizontal c.	average value of rainfall intensity – horizontal component (mm/min)
conductivity	water conductivity (µS/cm)



4 UNCERTAINTY OF MEASUREMENTS

QUANTITY	UNCERTAINTY (k=2)	
	U _{pk}	1,7 %
Lightning impulse voltage	T_1	8,0 %
	T ₂	3,1 %
Radio interference voltage	1,	0 dB
Power-frequency voltage	1	,7 %
Air pressure	0,5 %	
Temperature	4,0 %	
Relative humidity	6,3 %	
Time	0,7 %	
Telescopic stick	0,8 %	
Length (tape measure)	1,6 %	
Rainfall intensity	10 %	
Conductivity	5,0 %	

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 %. Details related to the statement of conformity when applied are given in a price quotation submitted to a customer before the testing and on the website of the laboratory.


5 PRODUCT DRAWING



Figure 1 69 kV Composite insulator, SML 133 kN, drawing No. 21SM510755 Rev. B



6 TEST SETUP PHOTOS



Figure 2 Test arrangement for RIV and corona tests



Figure 3 Test arrangement for RIV and corona tests

Test Report No.: 11788/G/21





Figure 4 Test object at the test voltage of 50 kV – no positive corona



Figure 5 Test object at the test voltage of 145 kV

Test Report No.: 11788/G/21





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



7 GRAPHS



- end of test report -

Testpolymer EU 17025-F-05_15





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



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

Customor	EGU - HV Laboratory a.s., Podnikatelská 267, 190 11 Praha 9, Běchovice					
customer.	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 barand testing - beninental and ventical flame tests	UL 94: 2013 revision 05/2021		
Fire nazard testing - nonzontal and vertical name tests	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. 15Fire hazard testing - Horizontal and vertical flame tests - methodA - horizontal burning test

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



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				00/		1	
	Test re	port No	b. 59/20	022/EN			
Test standard:	ČSN EN 6069	95-11-10 ed	. 2: 2014				
Test equipment:	Chamber At	amber Atlas HVUL2					
Ignition course:	Burner with	an inner dia	ameter 9.5 m	m			
ignition source.	The gas used	d: Methane	2.5				
	Blue flame h	eight 20 m	m, the expos	ure time 30s	5		
Test conditions:	No forced ve	entilation w	as used durir	ng the test			
	Temperatur	e:	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 specim	est specimens of grey color 125x13x3mm, 3 pieces					
Conditioning of samples:	48 hours at	23±2°C and	50±5% relati	ive humidity			
Conditioning of cotton indicator:	24 hours in	desiccator 2	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 stop	oped before	25 mm				
Test specimen No.2	burning stop	oped before	25 mm				
Test specimen No.3	burning stop	oped before	25 mm				
No. of test specimen	Damaged length L (mm)	Burning time t (s)	Linear burn rate (mm/min)	Linear burn va (mm	rate average Ilue /min)	Sample standard deviation (mm/min)	
1	0	0	0				
2	0	0	0		0	0	
3	0	0	0				
Statement of conformity to specification	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 N	avrátil		Date:	13.1.2022		

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	Test report No. 59/2022/EN					
Test No. 15	Fire hazard testing - horizontal and ver B - vertical burning test	rtical flame tests - method				
Photo of the position of the test spe	ecimen during the test:					
Test standard:	ČSN EN 60695-11-10 ed. 2: 2014					
Test equipment:	Chamber Atlas HVUL2					
	Burner with an inner diameter 9.5 mm					
Ignition source:	The gas used: Methane 2.5					
	Blue flame height 20 mm, the exposure time 2 x 1	.0s				
Test conditions:	No forced ventilation was used during the test					
	Temperature: $22.0 - 23.0^{\circ}$ C Humidity: $48.0 - 49.0^{\circ}$					
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 pic	eces				
Conditioning of samples:	5 pieces - 48 hours in the climate chamber at 23±2 5 pieces -168 ±2 hours in the hot air oven at 70±2 hours at room temperature	2°C and 50±5% relative humidity; °C and cooled in desiccator min. 4				
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 a flame. The material does not drip or ignite absorb	fter the second application of the ent cotton.				

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		17025	5-F-05_15				
	Test re	eport No	o. 59/20)22/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 c	onditioned in clin	nate 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	
· · · · · · · · · · · · · · · · · · ·	Specimen	s conditioned in h	not 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 specification	The measu indicators This statem	on the ten c) on the ten V-0 acco nent of confo decision ru	burning and samples tes ording to arti ormity to spe ile; without i	afterglow ti ted meet all icle 9.4 ČSN cifications is ncluding me	mes and the the requirer EN 60695-11 given in the asurement u	condition of ments for clas -10 ed. 2. sense of the uncertainty.	the cotton ssification shared risk
Tested and evaluated by:	Ing. Lukáš N	lavrátil		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

Test report was approved by:

In Bohuslavice:

19.1.2022

Eva Kovářová Laboratory manager TKUS

č. 1595

End of test report



SYNPO, akciová společnostS. K. Neumanna 1316532 07 Pardubice - Zelené PředměstíThe 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.



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Digitálně podepsal Ing. Vladimír Špaček, CSc.

Dr. Vladimír Špaček Head of testing laboratory

In Pardubice on March 29, 2022

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. The test report shall not be reproduced except in full, without written approval of the 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

¹The 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 $0.35 \text{ W/m}^2/\text{nm}$ 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 \check{CSN} 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,						
	Type . III v						
Data delivered by the customer ¹ :	-						
Internal lab number:	22 0066						

¹The 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° .

TEST REPORT T 375/006 Page/Total pages: 4/6 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)

(The test was meride	iea in the flent	ete seope of acet cattait	011)		
	Internal	Surface failure	Cracking	Flaking	
Sample	Lab	ČSN EN	ČSN EN	ČSN EN	
name	Lau Numbor	ISO 4628-1	ISO 4628-4	ISO 4628-5	
	Number	degree + verbal	degree	degree	
250 hours					
	22 0066/1	0, no visual changes	0 (80)	0 (80)	
HTV	22 0066/2	0, no visual changes	0 (80)	0 (80)	
	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 (80)	0 (S0)	
	22 0066/3	0, no visual changes	0 (S0)	0 (S0)	
750 hours					
	22 0066/1	0, no visual changes	0 (80)	0 (S0)	
HTV	22 0066/2	0, no visual changes	0 (80)	0 (80)	
	22 0066/3	0, no visual changes	0 (80)	0 (S0)	
1000 hours					
	22 0066/1	0, no visual changes	0 (80)	0 (80)	
HTV	22 0066/2	0, no visual changes	0 (80)	0 (S0)	
	22 0066/3	0, no visual changes	0 (80)	0 (80)	

TEST REPORT T 375/006 Page/Total pages: 5/6

Annexes: 1



MEASUREMENT OF SURFACE ROUGHNESS ACCORDING TO ČSN EN ISO 4287, 4288 (January 7, 2022 – February 18, 2022)

_	(January 7, 2022 - rcoruary)	10, 2022)						
Sample	Internal	Arithmetical mean deviation of the assessed roughness <u>Ra</u>			Maximum height of profile (roughness) <u>Rz</u>			
	name Lab Number		Measuring range [µm]			Measuring range [µm]		
			Mean	Max.	Min.	Mean	Max.	Min.
	Before exposure							
Г		22.00((1	0.67	0.00	0.64		4.00	4.50

	22 0066/1	0,67	0,69	0,64	4,74	4,92	4,53
HTV	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

	22 0066/1	0,67	0,70	0,63	4,84	5,11	4,56
HTV	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

НТV	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

НТV	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





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				

¹The 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		Parameter no surface defects such as cracks, crumbling or blisters	Fulfillment of parameters	
	test	result according to CSA C411.416 article 5.4.3		
НТУ	ASTM D2565-16	no cracks, crumbling or blisters	Yes	

-End-

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

¹The 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)



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