TEST REPORT

Test Object:	Cap and pin type glass insulator
Designation:	U120BP
Manufacturer:	**Lviv Insulator Company Ltd.** 79000 Lviv, Zelena Srt. 301 Ukraine
Tested for:	Lviv Insulator Company Ltd.
Date of tests:	1st October 2012 – 20th November 2012
Tested by:	VEIKI-VNL Electric Large Laboratories Ltd.
Project ID:	NFL-30/2012/A1
Order/Contract:	NFL-30/2012, 27th July 2012
Test Specification:	**IEC 60383-1:1993** **IEC 60437:1997** **IEC 60797:1984** **IEC 61211:2004** **IEC 61467:2008** **IEC 60060-1:1989**
Tests Performed:	The test object, constructed in accordance with the description, drawing and photographs incorporated in this report has been subjected to tests.
Test Results:	**The test object passed the test.**

This Type Tests Report has been issued by VEIKI-VNL Ltd. in accordance with above mentioned Specifications.

The Report applies only to the test object tested. The responsibility for conformity of any test object having the same designations with that tested rests with the Manufacturer.

This Report comprises 47 sheets in total (29 numbered pages, 1 drawing; 17 oscillograms).

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VEIKI VILLAMOS NAGYLABORATÓRIUMOK KFT. * VEIKI ELECTRIC LARGE LABORATORIES Ltd.

Budapest, 27th November, 2012	Tamás Forgó responsible for the test	Ildikó Fogarasi supervised by	Dr. László Varga managing director

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TEST CERTIFICATES OR REPORTS ISSUED BY VEIKI-VNL LTD.

Type Test Certificate of Complete Type Test
This certificate provides the verification of all the rated characteristics of the equipment as assigned by the manufacturer, by means of the performance of all type tests specified by the standards.

Type Test Certificate of Dielectric Performance
This certificate provides the verification of all dielectric ratings, by means of the performance of the appropriate type tests specified by the standards.

Type Test Certificate of Temperature-Rise Performance
This certificate provides the verification of temperature-rise limits together with measurement of the main circuit resistance, by means of the performance of the appropriate type tests specified by the standards.

Type Test Certificate of Short-Circuit / Making and Breaking Performance
This certificate provides the verification of rated characteristics with respect short-circuit and/or making and breaking performance, by means of the performance of the appropriate type tests specified by the standards.

Type Test Certificate of Switching Performance
This certificate provides the verification of the switching ratings (e.g. capacitive current), by means of the performance of the appropriate type tests specified by the standards.

Type Test Report
This report provides the verification of the rated characteristics of the equipment as assigned by the manufacturer, by means of the performance of the appropriate type tests specified by the standards, for type tests not indicated above.

Development Test Report
This report is issued when the test is intended only to provide the Client with information about the performance of the equipment. The tests are performed in accordance with relevant standards, but are not intended to verify compliance of the equipment.

Control Test Report
This report is issued for tests performed on equipment in service, or removed from service. Tests are performed, and compliance is evaluated in accordance with relevant standards.

Test Report
Test report is issued in all cases not listed above.

Ratings/characteristics assigned by the manufacturer:

Test Object:	Cap and pin type glass insulator
Designation:	U120BP
Manufacturer:	Lviv Insulator Company Ltd.
Creepage distance:	445 mm
Spacing:	146 mm
Diameter of the insulating part:	280 mm
Dry lightning impulse withstand voltage:	
One unit:	125 kV
5 units:	465 kV
Wet power frequency withstand voltage:	
One unit:	50 kV
5 units:	180 kV
Puncture voltage:	130 kV
Specified mechanical failing load (SML):	120 kN
Residual strength	96 kN

The tests were carried out in accordance with the following standards:

IEC 60383-1:1993	Insulators for overhead lines with a nominal voltage above 1000 V - Part 1: Ceramic or glass insulator units for a.c. systems - Definitions. test methods and acceptance criteria
IEC 61211:2005	Insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1000 V. Impulse puncture testing in air
IEC 60797:1984	Residual strength of string insulator units of glass or ceramic material for overhead lines after mechanical damage of the dielectric
IEC 60437:1997	Radio interference test on high-voltage insulators
IEC 60060-1:1989	High-voltage test techniques. Part 1: General definitions and test requirements
IEC 61467:2008	Insulators for overhead lines – Insulator strings and sets for lines with a nominal voltage greater than 1000 V – AC power arc tests

Requirements of manufacturer or purchaser:

List of manufacturer's drawings attached to this document:

И-675А	U120BP

Present at the test in charge of manufacturer or purchaser:

Mrs. Olena Artamonova	Lviv Insulator Company Ltd.
Mr. Sergiy Oleksandrenko	Lviv Insulator Company Ltd.
Mr. Yuriy Korynevskyy	Lviv Insulator Company Ltd.

TESTS PERFORMED ON THE TEST OBJECT

No.	Description	Relevant clauses of the standard
I.	**Sample tests**	
1	Verification of the dimensions	IEC 60383-1:1993 Clause 17
2	Verification of the displacements	IEC 60383-1:1993 Clause 21
3	Verification of the locking system	IEC 60383-1:1993 Clause 22
4	Thermal shock test	IEC 60383-1:1993 Clause 24
5	Galvanizing test	IEC 60383-1:1993 Clause 26
6	Mechanical failing load test	IEC 60383-1:1993 Clause 19
7	Puncture withstand test	IEC 60383-1:1993 Clause 15
II.	**Type Tests**	
1.1	Dry lightning impulse withstand voltage test on short standard string	IEC 60383-1:1993 Clause 13
1.2	Dry lightning impulse withstand voltage test on one unit	IEC 60383-1:1993 Clause 13
2.1	Wet power frequency withstand voltage test on short standard string	IEC 60383-1:1993 Clause 14
2.2	Wet power frequency withstand voltage test on one unit	IEC 60383-1:1993 Clause 14
3	Mechanical failing load test	IEC 60383-1:1993 Clause 19
4	Thermal mechanical performance test	IEC 60383-1:1993 Clause 20
III.	**Special tests**	
1	R.I.V. test	IEC 60437:1997
2	Residual strength test	IEC 60797:1984
3	Impulse puncture test in air	IEC 61211:2005
4	Power arc test	IEC 61467:2008

DESCRIPTION OF THE TESTS

I. Sample tests

I.1. Verification of dimensions

I.1.1. Test method and parameters

Checking of the dimensions was carried out on samples E1+E2 (7 insulator units). The dimensions of the insulators were checked with manufacturer's drawing. The checked dimensions were within the tolerance.

I.1.2. Test results

The results are summarized in Table 1. The insulators passed the test.

Sample Nos:	Diameter (mm)	Spacing (mm)	Creepage distance (mm)
Specified by IEC 60383 IEC 60305	280±12.7	146±4.7	445±19.3
E1-1	291	143	444
E1-2	290	148	448
E1-3	292	144	447
E1-4	292	145	447
E2-1	291	146	445
E2-2	292	146	444
E2-3	291	145	449

Table 1
Summary of test results of the tests

I.2 Verification of the displacements

I.2.1. Test method and parameters

The axial and radial displacements were checked in accordance with clause Clause 21 of IEC 60383-1:1993. Tests were performed on samples E1+E2 (7 insulator units)

Variation on axial displacement: 11.2 mm
Variation on radial displacement: 8.4 mm

I.2.2. Test results

The results are summarized in Table 2 and the test arrangement can be seen on Photo 2. The insulators passed the test.

Sample No.	Axial displacement 'A' (mm)	Radial displacement 'B' (mm)
1	6	5
2	9	6
3	10	7
4	5	6
5	5	4
6	6	6
7	10	7

Table 2
Summary of test results of the tests

I.3 Verification of the locking system

I.3.1. Test method and parameters

Conformity of the looking device with the requirements of clause 22 of IEC 60383-1 (1993). No uncoupling shall occur during the verification of locking. The load F was applied three times in succession to move the locking device from the locking to the coupling position. The disengagement force shall be between 50 N and 500 N. Tests were performed on samples E2 (3 insulator units).

I.3.2. Test results

The test procedure can be seen on Diagram 1 and on Photo 1. The results are summarized in Table 3. The insulators passed the test.

Sample No.	Load disengagement force (N)		
	1st	2nd	3rd
1	90	87	94
2	111	122	113
3	115	95	106

Table 3
Summary of test results of the tests

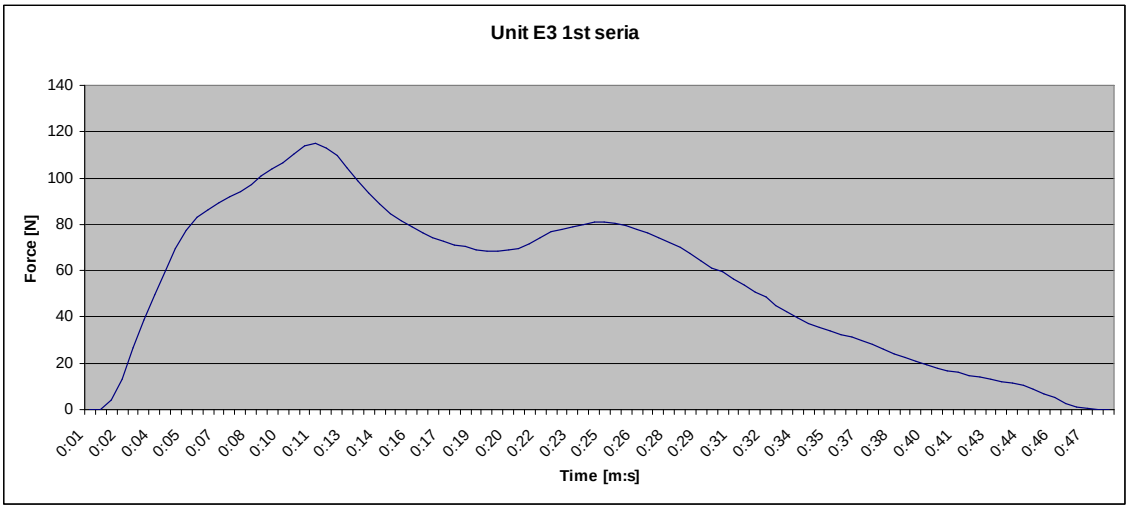

Diagram 1

I.4 Thermal shock test

I.4.1. Test method and parameters

Thermal shock test was carried out in accordance with clause 16 of IEC 60383-1 (1993). Tests were performed on samples E2 (3 insulator units) according to Table 4. Failure of any of the 3 insulators shall not occur.

Sample No:	Temperature of hot oven (°C)	Temperature of water bath (°C)
1-3	120	15

Table 4
Parameters of test results of the tests

I.4.2. Test results

Failure of any of the 3 insulators were not occurred. The insulators passed the test.

I.5 Galvanizing test

I.5.1 Test method and parameters

The appearance of the zinc coating on the sample insulators was visually inspected. The coating thickness on the pin and on the cap of insulators was determined by a magnetic measuring device. Tests were performed on samples E2 (3 insulator units).

I.5.2. Test results

The results are summarized in Table 5. The insulators passed the test.

Sample No.	Thickness of zinc coating (μm)	
	Pin	Cap
	Average value	Average value
1	262.6	203.6
2	317	199.8
3	182.6	244.6
Acceptance criteria	85	

Table 5
Summary of test results of the tests

I.6 Mechanical failing load test

I.6.1. Test method and parameters

The tensile load was increased rapidly but smoothly form zero to app. 75% of SML and then gradually increased in a time between 15 s to 45 s. Finally the tensile load of the insulators was measured.

I.6.2. Test results

Failure was not occurred during the tensile load test at 100% of the SML (120 kN). Test were performed on samples E1 (4 insulator units), the insulators were broken at load between 131 and 151 kN. The test procedure can be seen on Diagram 2 and on Photo 4. The results are summarized in Table 6. The insulators passed the test.

Unit No.	Mechanical failing load (kN)	Fracture pattern
1	151	Broken cap
2	132	Broken cap
3	131	Broken cap
4	133	Broken cap
Average (X)	136.75	Acceptance criteria
Deviation (σ)	9.53	$X \geq SML + C_0\sigma$
Coefficient (C_1)	1	136.75 > 129.53
IEC 383		Passed

Table 6
Summary of test results of the tests

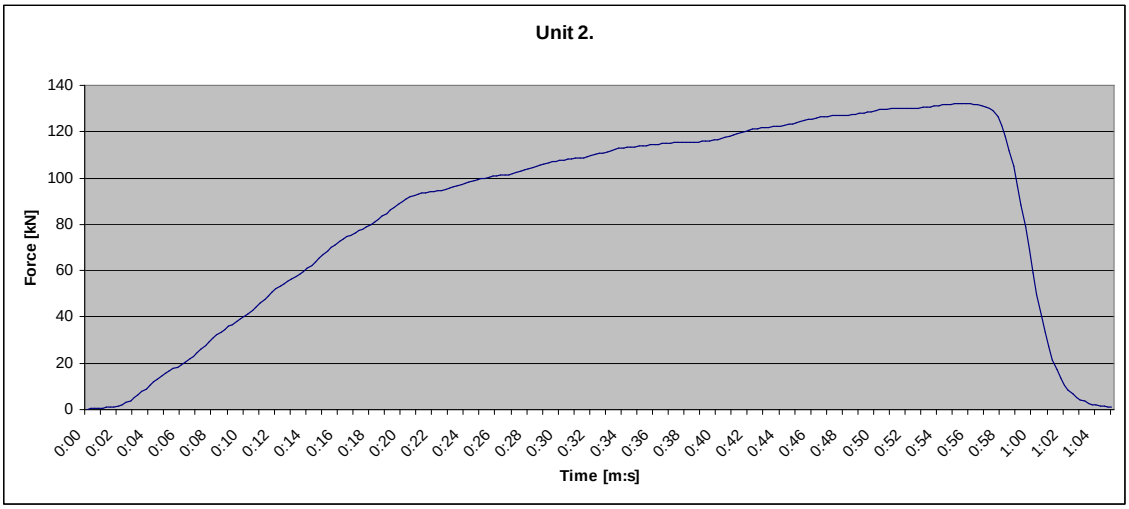

Diagram 2

I.7 Puncture withstand test

I.7.1. Test method and parameters

The test objects were subjected to a puncture test in accordance with clause 15 of IEC 60383-1 (1993). A glass container filled with transformer oil was used for the test.

I.7.2. Test results

The test was carried out on sample E2 (3 insulator units). The results are summarized in Table 7. The insulators passed the test.

Sample Nos:	Measured puncture voltage (kV)	Specified puncture voltage (kV)	Remark
1	150	130	none
2	158	130	none
3	148	130	none

Table 7
Summary of test results of the tests

II. Type tests

II.1. Dry lightning impulse withstand voltage test

During the tests the ambient parameters were: Dry/wet temperature: 19.5/14.0 °C
Air pressure: 101.1 kPa

II.1.1. Test on on short standard insulator string

II.1.1.1. Test method and parameters

The test was carried out on 1 short standard string (5 units) by a test voltage of 465 kV_{peak} with application of the correction factor. During the withstand test 15 positive and negative impulses of 1.18-1.28/50.63-50.98 µs were applied (shown in the attached oscillogram Nos.: 8790, 8805. The test object shall withstand 15 impulses on each polarity without breakdown or with not more than two flashovers according to referred standard.

The correction factor was K=0.9948 during the tests.

II.1.1.2. Test results

The short standard string passed the impulse voltage withstand test without breakdown and without flashover on each polarity.

II.1.2. Test on one unit

II.1.2.1. Test method and parameters

The test was carried out on 3 samples by a test voltage of 125 kV_{peak} with application of the correction factor. During the withstand test 15 positive and negative impulses of 1.18-1.28/52.63-52.92 µs were applied (shown in the attached oscillogram Nos.: 8619, 8634. The test object shall withstand 15 impulses on each polarity without breakdown or with not more than two flashovers according to referred standard.

The correction factor was K=0.9979 during the tests.

II.1.2.2. Test results

The short standard string passed the impulse voltage withstand test without breakdown and without flashover on each polarity.

II.2. Wet power frequency withstand voltage test

During the tests the ambient parameters were: Dry/wet temperature: 19.5/14.0 °C
Air pressure: 101.1 kPa

Characterisation of the artificial rain:

- Vertical and horizontal component of the rain 1.8-2 mm/min
- Resistivity of water 9500 Ωcm
- Direction of the rain to the insulator 45°

II.2.1. Test on short standard insulator string

II.2.1.1. Test method and parameters

The wet power frequency voltage test was carried out on 5 units by a test voltage of 180 kV_{rms} with application of the correction factor for 1 minute in wet condition. The test object shall withstand the test voltage for 1 minute without breakdown and without flashovers.

The sample was pre wetted for 15 minutes before the wet test. The form of the artificial rain was drop. During the test the insulator was continuously wetted.

The correction factor was K=0.9997 during the test.

II.2.1.2. Test results

During the withstand test on short standard string neither flashover nor breakdown occurred at test voltage of 180 kV_{rms} for 1 minute. The insulators passed the test.

II.2.2. Test on one unit

II.2.2.1. Test method and parameters

The wet power frequency voltage test was carried out on 3 samples by a test voltage of 50 kV_{rms} with application of the correction factor for 1 minute in wet condition. The test objects shall withstand the test voltage for 1 minute without breakdown and without flashovers.

The samples was pre wetted for 15 minutes before the wet test. The form of the artificial rain was drop. During the test the insulator was continuously wetted.

The correction factor was K=0.9997 during the test.

II.2.2.2. Test results

During the withstand test on short standard string neither flashover nor breakdown occurred at test voltage of 50 kV_{rms} for 1 minute. The insulators passed the test.

III.3. Mechanical failing load test

II.3.1. Test method and parameters

The tensile load was increased rapidly but smoothly form zero to app. 75% of SML and then gradually increased in a time between 15 s to 45 s. Finally the tensile load of the insulators was measured.

II. 3.2. Test results

Failure was not occurred during the tensile load test at 100% of the SML (120 kN). Test were performed on 10 insulators, the insulators were broken at load between 130 and 151 kN. The test procedure can be seen on Diagram 3 and on Photo 4. The results are summarized in Table 8. The insulators passed the test.

Unit No.	Mechanical failing load (kN)	Fracture pattern
1	131	Broken cap
2	142	Broken cap
3	139	Broken cap
4	130	Broken cap
5	132	Broken cap
6	135	Broken cap
7	146	Broken cap
8	134	Broken cap
9	132	Broken cap
10	130	Broken cap
Average (X)	135.1	Acceptance criteria
Deviation (σ)	5.48	$X \geq SML + C_0\sigma$
Coefficient (C_0)	0.72	135.1 > 123.95
IEC 383		Passed

Table 8
Summary of test results of the tests

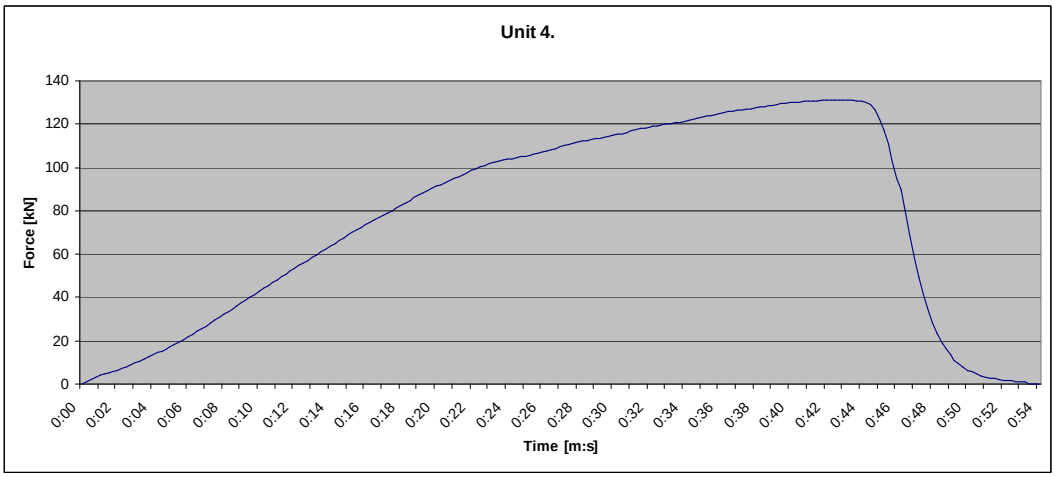

Diagram 3

II.4. Thermal-mechanical test

II.4.1. Test method and parameters

The thermal-mechanical test was performed on 10 insulators. The test consisted of four cycles, where one cycle was 12+12 hours (-30 ±5°C; +40 ±5°C). The applied tensile load was 62.5 % of the SML. The test arrangement can be seen on Photo 3.

II. 4.2. Test results

Failure was not occurred during the thermal-cycle test. After the withstand test the insulators were broken at loads between 132 and 151 kN. The results are summarized in Table 9. The insulators passed the test.

Unit No.	Mechanical failing load (kN)	Fracture pattern
1	141	Broken glass and pin pulled out
2	151	Broken cap
3	147	Broken cap
4	133	Broken cap
5	132	Broken cap
6	142	Broken cap
7	142	Broken cap
8	147	Broken cap
9	141	Broken cap
10	144	Broken cap
Average (X)	142	Acceptance criteria
Deviation (σ)	5.94	$X \geq SML + C_0\sigma$
Coefficient (C_0)	0.72	142>124.27 The test was passed

Table 9
Summary of test results of the tests

III. Special tests

III.1.R.I.V. test

III.1.1. Test method and parameters

The radio interference voltage on the insulator set was tested in accordance with IEC 60437. The tests were carried out on 1 MHz. The condenser was Zs= 10000 pF. The radio interference voltage should be expressed according to the standard referred as dB across a resistance of 300 omhs, therefore R=300 ohms was set on the coupling four pole, in this way a phase angle not exceeding 20° between Zs and R was fulfilled. In accordance with IEC 60437 the radio interference voltage was recorded in course of runs and was plotted versus the applied voltage: the curve obtained was the radio interference characteristic of the insulator set.

III.1.2. Test results

The RIV values were 0 dB on all ten samples and these were measured at the test voltage of 10 kV_{rms}. The RIV values were between 20 dB and 58 dB on all ten samples and these were measured at the test voltage of 20 kV_{rms}. The RIV values were between 65 dB and 82 dB at the test voltage of 30 kV. The values were less than the specified maximum of 86 dB at the test voltage of 30 kV. The insulators passed the test.

The test arrangement is shown on Photo 9.

III.2.Residual strenght test

III.2.1. Test method and parameters

The residual strength test was performed on 25 insulators. The temperature cycle test consisted of three cycles where one cycle was 15 - 15 minutes with 70 K temperature difference (82°C water bath; 12°C cold water bath). After three cycles, the glass of the insulators was broken off. After the preparation of the test pieces the residual strength test was performed on the metal parts of the insulators. The load was increased until failing occurred.

III.2.2. Test results

Failure did not occur during the temperature cycle test. The metal parts of insulators were broken at loads between 120 kN and 139 kN. The test arrangement is shown on Photo 5. The test procedure can be seen on Diagram 4. The results are summarized in Table 10 and can be seen on Photo 6. The insulators passed the test.

Unit No.	Mechanical failing load (kN)		Fracture pattern
	All pieces	Without broken pieces	
1R	135		Broken cap
2R	135	135	Pin pulled out
3R	130	130	Pin pulled out
4R	133	133	Pin pulled out
5R	132	132	Pin pulled out
6R	133	133	Pin pulled out
7R	129	129	Pin pulled out
8R	127		Broken cap
9R	129	129	Pin pulled out
10R	137	137	Pin pulled out
11R	131	131	Pin pulled out
12R	131	131	Pin pulled out
13R	123	123	Pin pulled out
14R	139	139	Pin pulled out
15R	123	123	Pin pulled out
16R	135	135	Pin pulled out
17R	133		Broken cap
18R	133	133	Pin pulled out
19R	120	120	Pin pulled out
20R	139	139	Pin pulled out
21R	136		Broken cap
22R	128	128	Pin pulled out
23R	128	128	Pin pulled out
24R	134	134	Pin pulled out
25R	137	137	Pin pulled out
Average (X)	131.6	131	Acceptance criteria
Deviation (σ)	4.9	5.08	$k \geq 0.65$
Constant (k)	1	0.76	$0.76 > 0.65$
$(X - 1.645\sigma)/SML$			passed

Table 10
Summary of test results of the tests

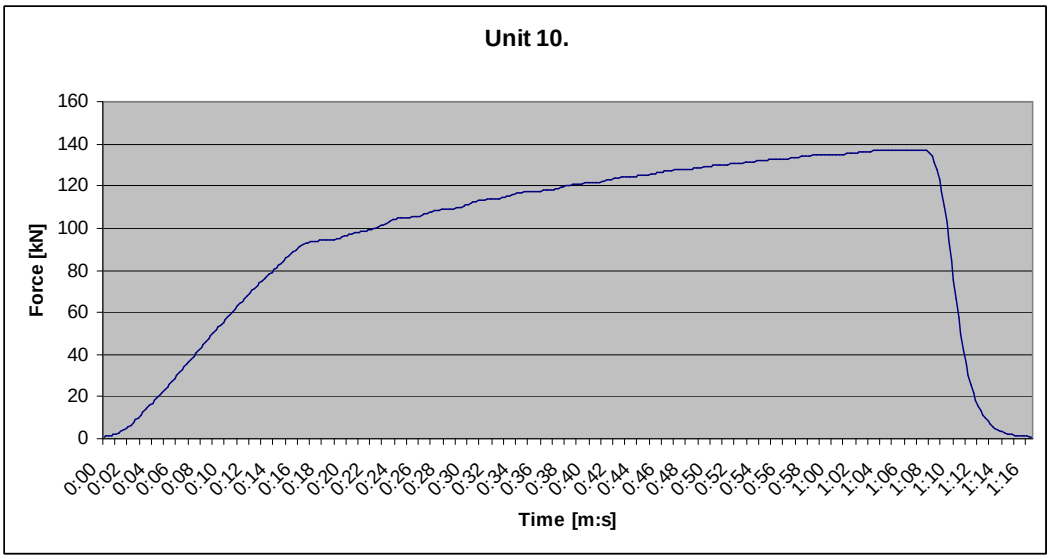

Diagram 4

III.3. Impulse puncture test in air

III.3.1. Test method and parameters

The 50% flashover voltage value on 1 short standard string (5 units) was determined with up and down test method. After the up and down test method the 50% flashover voltage was dividing by the number of units, and the results was multiply with 2.8 p.u. A series of 10 positive and 10 negative impulses were applied on 1 insulators, with a time interval of 1,5 minute (shown in the attached oscillogram No: 9340; 9350; 9360; 9370; 9380; 9390; 9400; 9410; 9420; 9430). Tests were performed on 5 insulators. The steep front of wave test arrangement is shown on Photo 10.

III.3.2. Test results

The test was performed according to the IEC 61211. The test voltage was 2.8 p.u related to 50% flashover voltage, measured for five unit (530 kV/5)*2.8= 397.13 kV. The insulators U120BP were subjected to steep-front impulse of about 2500 kV/µs. Each impulse caused external flashover. No punctures occurred at the specified puncture voltage. All insulators passed this test. The results are summarized in Table 11.

Unit No.	Polarity	Result: Impulses / puncture	No. of oscillogram
1	+ -	10 / no puncture 10 / no puncture	9340-9349 9350-9359
2	+ -	10 / no puncture 10 / no puncture	9360-9369 9370-9379
3	+ -	10 / no puncture 10 / no puncture	9380-9389 9390-9399
4	+ -	10 / no puncture 10 / no puncture	9400-9409 9410-9419
5	+ -	10 / no puncture 10 / no puncture	9420-9429 9430-9439

Table 11
Summary of test results of the tests

III.4.Power arc test

III.4.1 Test circumstances

Three new insulator strings were subjected to power arc tests according to the IEC 61467 standard. One string consisted three cap and pin type glass insulator units. After one power arc test the string was replaced for a new one. The attached drawing is serving the identification of the tested insulator. The test arrangement can be seen on Figure 1.

III.4.2 Test carried out

The tests were carried out in single-phase test circuit supplied from 50 Hz network. Figure 2 shows the connection diagram of the test circuit. The insulator strings prepared for the power arc tests is shown on Photos 11-12. The tests were performed on the insulator strings in the order indicated below:

Name of the tests	Figures, Photos, Diagrams	Results
1. Power arc tests on insulator string (3 glass units / string) with parameters of **6 kA – 0.2 s; 6 kA – 0.2 s; 6 kA – 0.2 s**	Figure 1 Photos 11-15	PASSED (details in Table 12)
2. Visual examination		
3. Mechanical failing load tests were carried out on the tested strings according to the IEC 61467:2008 standard. (70% of SML)	-	PASSED
4. Checking of dimensions	-	PASSED

During the tests oscillograms were taken. Arc current and arc voltage were registered by transient recorder with sampling rate of 50 μs and supplemented with the calculated arc power and energy.

On the oscillograms and in the Figures enclosed to the test report the next notations are applied:

U arc voltage,
I arc current,
P arc power (created by mathematical way),
E arc energy (created by mathematical way).

The measuring circuit is shown in Figure 2. The measuring equipment and devices used for the tests are listed on Page 21 as well as the uncertainty of the measurement of each electrical quantity on.

III.4.3 Result of the tests

During the power arc tests separation of cap and pin could not be observed. The tested cap and pin type porcelain insulator withstood the power arc test with parameters assigned by the manufacturer and passed the mechanical failing load tests with the prescribed load.

The test circumstances, parameters and results are collected in Table 12.
The tested glass insulators fulfilled the requirements of referred IEC standard.

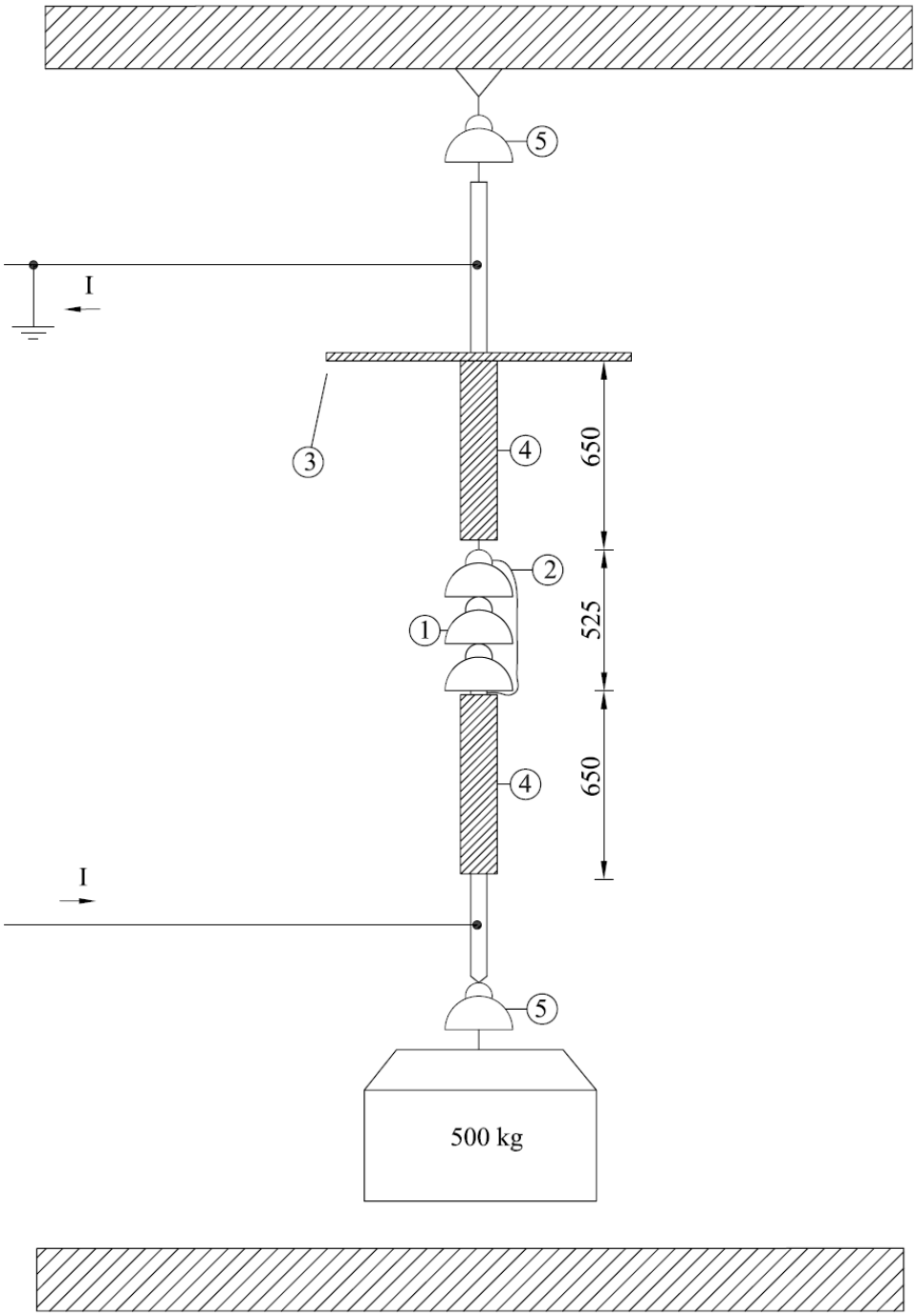

Figure 1
The test arrangement

1. Tested insulators
2. Ignition wire: Ø 0.63 mm (0.31 mm^2) copper
3. Insulating plate (800 x 800 mm)
4. Insulating cylinder (Ø 120 mm)
5. Auxiliary insulators

(All dimension in millimetre)

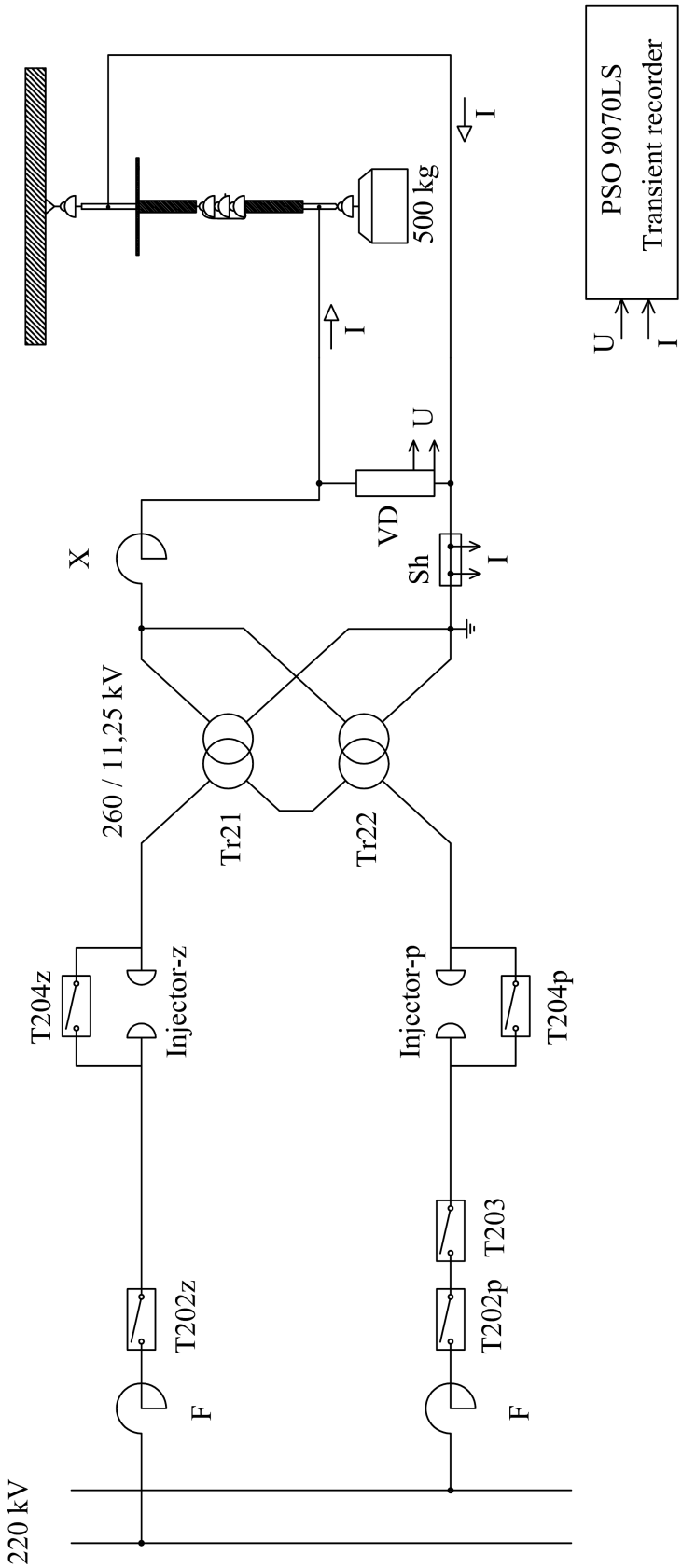

Figure 2

The connection diagram of the test circuit

T203, T202z,p	-	operating circuit-breakers	Tr21, Tr22	-	single phase power transformers (2x500 MVA)
Injector-z, -p	-	plasma injectors	VD	-	voltage divider [14]
T204z, p	-	shunting circuit breakers	Sh	-	resistive short-circuit shunt [15]
X, F	-	reactors	PSO 9070LS	-	transient recorder [16]

Power arc test on cap and pin type glass insulators			
Test arrangement / test circuit:	Figure 1 / 2		
Supply and return conditions:	D (Supply: unbalanced; Return: unbalanced)		
Cross-section of fusible wire:	0.31 mm^2 (copper)		
No. of the tested strings:	1	2	3
Specified arc current (I_n) / arc time (t_n):	6 kA / 200 ms	6 kA / 200 ms	6 kA / 200 ms
Oscillogram No.:	BDK 1002	BDK 1003	BDK 1004
Arc current: peak value [kA]: r.m.s. value [kA]:	 13.9 5.8	 14.4 6.3	 9.8 5.9
Arc time [ms]:	203	203	209
I × t [kAs]: Prescribed value with tolerance of ± 10% Achieved value:	 1.20 1.17	 1.20 1.27	 1.20 1.23
Arc voltage [kV]:	1.68	1.36	1.89
Arc power [MW]:	9.20	7.97	9.56
Arc energy [MJ]:	1.87	1.62	2.01
No-load voltage of the test circuit [kV]:	9.6	9.6	9.6
Photos:	6-8	9	10
High-speed film (2000fps):	-	-	-
Atmospheric conditions:			
wind speed [m/s]:	-	-	-
atmospheric pressure [hPa]:	1014	1014	1014
temperature [°C]:	11.0	11.0	11.0
humidity [%]:	56	56	56
rainfall:	-	-	-

Remarks and results:

- After the power arc test all tested insulator passed the mechanical failing load test with 70% of SML
- Neither breakage of sheds nor separation could be observed after the tests.

Table 12
Summary of test circumstances and results of the tests

Uncertainty of measurements
During the tests the uncertainties of the measurements were the following:

- mechanical load (Amsler): ± 1%
- mechanical load (WPM): ± 0.5
- lightning impulse voltage: ± 0.5%
- power frequency voltage: ± 1%
- conductivity: ± 1%
- Uncertainty of the radio interference level measurement: ± 1dB
- Voltage measurement: ± 0.33%
- Current measurement: ± 0.33%

The uncertainty values given in this report are the standard deviation values multiplied by k=2. Measurement uncertainty was estimated according to the method described in the EA-4/02 document.

Measuring devices used for the tests:

No.	Designation	Manufacturer	Type	S/N:
[1]	Tensile machine	WPM	ZD 10/90	263/1111/DS
[2]	Tensile machine	AMSLER	ZD 100	283/66/9
[3]	Coating Thickness Meter	LIST MAGNETIK	20-ST	20ST-1150
[4]	Impulse generator	MICAFIL	SH 11-24	B1698
[5]	Divider	VEIKI	TA-1	01
[6]	Impulse voltage	TR-AS 100-10	350	TR-AS 100-
[7]	Voltage divider	TUR	KDIS 350/04	32863/1
[8]	Termination	TUR	H 91	852520
[9]	Indoor 50 Hz test	TUR	PEO 1	851181
[10]	Peak voltmeter	SIEMENS	MU-15	880019
[11]	Coupling capacitor	MICAFIL	TEPI-P800	77H734
[12]	Radio interference meter	SIEMENS	B83600-B40	A 10-002
[13]	Impedance adaptor (60-150-300-600Ω)	SIEMENS	B83600-B56	A 10-015
[14]	VD 42 kV / 100 V	VEIKI	R-C-R	19
[15]	Sh 20 kA	VEIKI	--	S20-5
[16]	PSO 9070LS	ECKELMANN	PSO 9070LS	0400001-0400016

PHOTOS

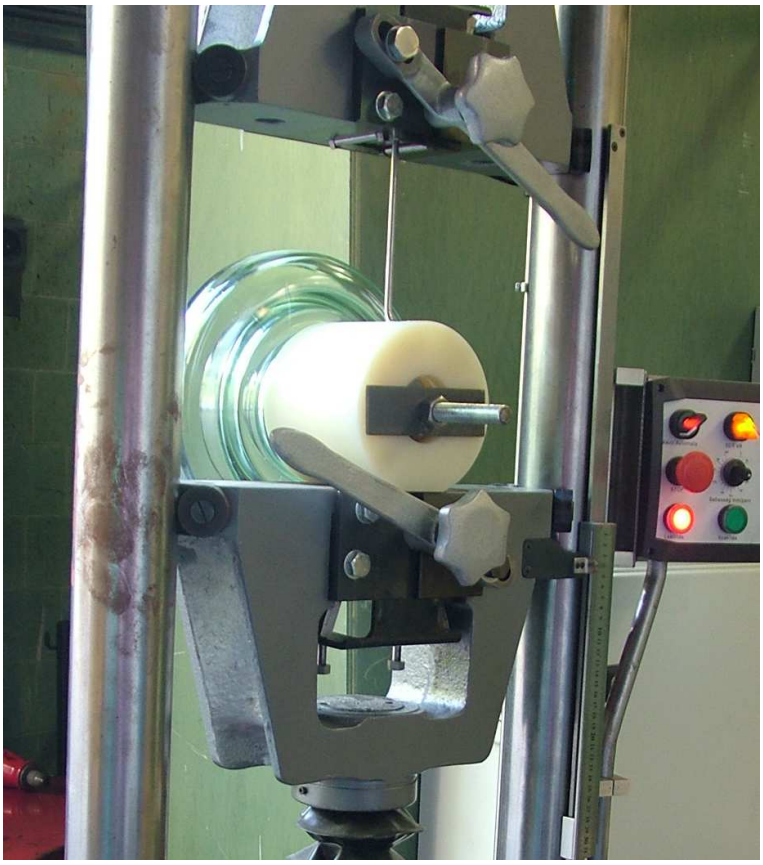

Photo 1
The test arrangement of verification of the locking system

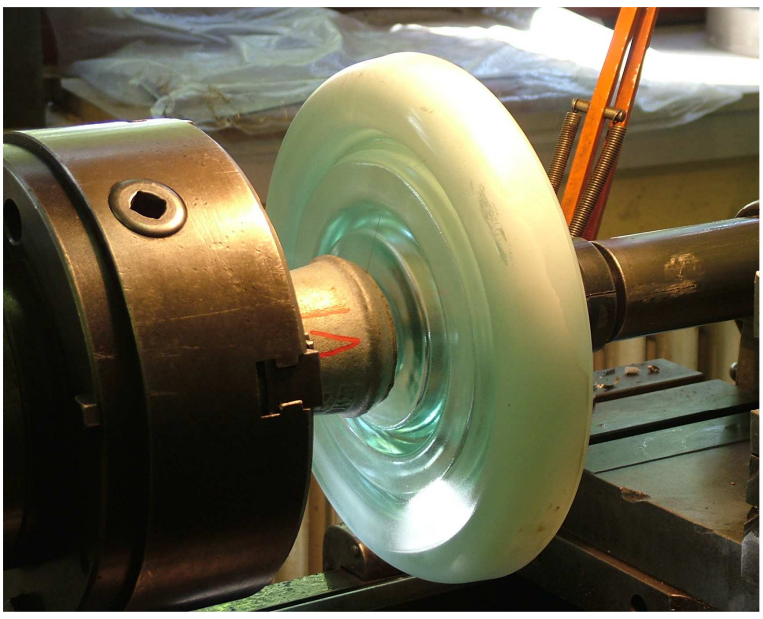

Photo 2
The test arrangement of verification of the axial and radial displacements

Photo 3
The test arrangement of thermal-mechanical test

Photo 4
The test arrangement of failing load tests

Photo 5
The test arrangement of the residual test

Photo 6
The broken insulators after the residual strength test

Photo 7
The test arrangement of dielectric test on one unit insulator

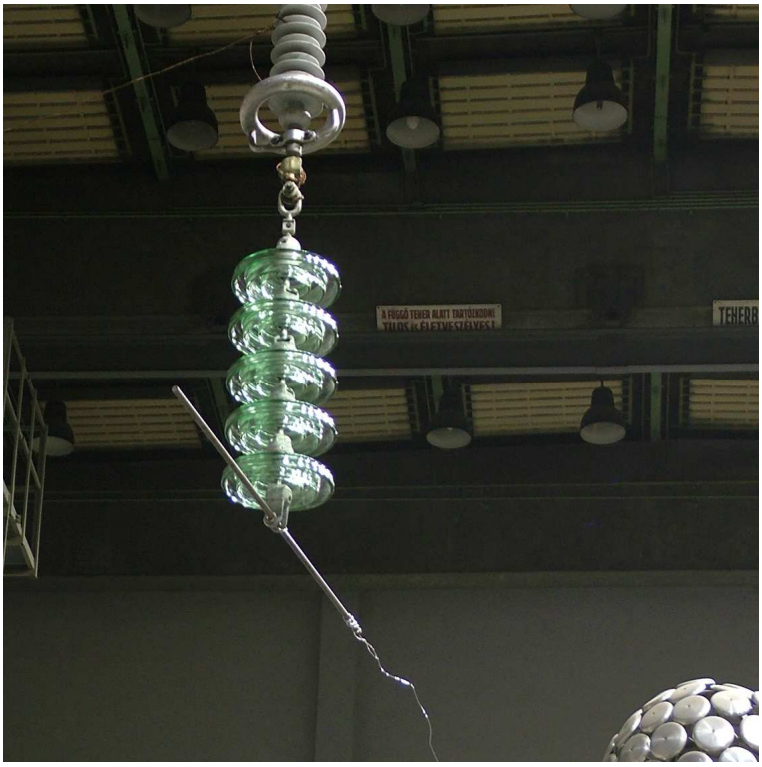

Photo 8
The test arrangement of dielectric test on short standard string

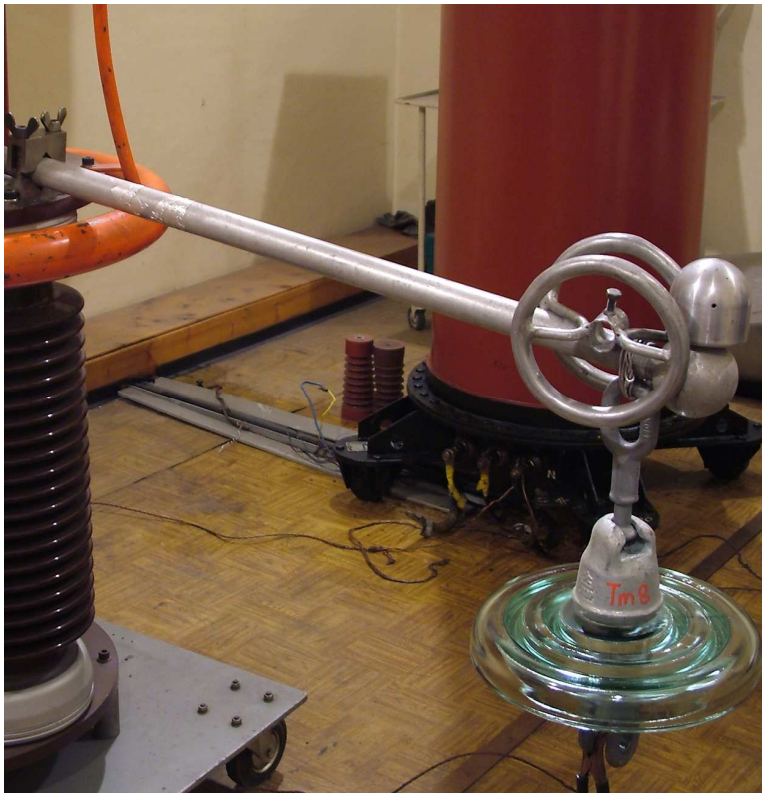

Photo 9
The test arrangement of RIV measurement

Photo 10
The test arrangement of the puncture test in air

Photo 11
The test arrangement of power arc test

Photo 12
The first insulator string prepared for the power arc test

Photo 13
The first insulator string after the power arc test

Photo 14
The second insulator string after the power arc test

Photo 15
The third insulator string after the power arc test