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Testing center of high-voltage electrical equipment
Joint Stock Company "Research Institute for the Transfer
high voltage direct current
(ITS VE JSC "NIIPT")

Accreditation certificate: No. ROSS RU.0001.213T71
Date of entry in the register of information on an accredited company: January 27, 2014 Legal address: 194233, St. Petersburg, ul. Kurchatov, d. 14, lit. A

Arch. No. 0-123
Registration date: 07/17/2017

TEST REPORT No. 145-2-17/4

Test object	Nonlinear surge arrester produced by JSC "Polymer-Apparat", equipped with varistors of the types SIOV-E48NR, SIOV-E58NR, SIOV-E70NR, SIOV-E78NR, SIOV-E99NR manufactured by EPCOS
Customer	JSC "Polymer-Apparat", address: 190068, Russia, St. Petersburg, B. Podyacheskaya Str., lit. A
Type of test, the document for compliance with which the tests were conducted	Operating duty tests of surge arresters. To verify compliance with the requirements of GOST R 52725-07, TU 3414-002-15207362-03, TU 3414-003-15207362-03 and TU 3414-004-15207362-03 ITs VE
Place of tests	JSC "NIIPT"
Date of tests	June 20 to July 14, 2017

PROTOCOL CONTAINS:
1. Test object
2. Purpose, program and test methods
3. Test conditions
4. Testing equipment and measuring instruments
5. Test results
6. Conclusions

CONCLUSION: Surge arresters manufactured by JSC "Polymer-Apparat", equipped with varistors of the type SIOV-E48NR, SIOV-E58NR, SIOV-E70NR, SIOV-E78NR, SIOV-E99NR manufactured by EPCOS, passed the working tests.
Surge arresters manufactured by JSC "Polymer-Apparat", equipped with varistors SIOV-E48NR, SIOV-E58NR, SIOV-E70NR, SIOV-E78NR, SIOV-E99NR manufactured by EPCOS, meet the requirements of TU 3414¬002-15207362-03, TU 3414 -003-15207362-03, TU 3414-004-15207362-03 in terms of operating duty tests.

Date of signing the test report: July 17, 2017

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1. TEST OBJECT

1.1. Name of the product, type: non-linear surge arresters equipped with varistors of the types SIOV-E48NR, SIOV-E58NR, SIOV-E70NR, SIOV-E78NR.

1.2. OKPD2 code: 27.12.10.130.

1.3. EEU TN VED code: 8535 40 000 0.

1.4. Serial number: varistors of types SIOV-E48NR, SIOV-E58NR, SIOV-E70NR, SIOV-E78NR, SIOV-E99NR are selected from lots No. 115555786, No. 112014140, No. 110839312, No. 905179953, No. 111283214, respectively. Sections of surge arresters are made from selected varistors. Prior to the start of work, the test sections were marked with the purpose of their identification in the process of testing (the section numbers of the same type 1, 2 and 3 used).

1.5. Product Description: The varistors of the NR series of the EPCOS company, used by JSC "Polymer-Apparat" to complete the arrester, are zinc oxide cylinders with vitrified lateral surface. The geometrical dimensions of the varistors are shown in table 1.

Table 1

Varistor type	Diameter, mm	Height, mm
SIOV-E48NR	48,0±1	35,4±0,6
SIOV-E58NR	59,7±1	35,4±0,6
SIOV-E70NR	70,0±1	35,4±0,6
SIOV-E78NR	78,0±1	35,4±0,6
SIOV-E99NR	99,0±1	21,4±0,6

For working tests, 3 proportional models (hereinafter - sections) were made from unit varistors, the radial dimensions of which and the materials used in the design corresponded to the simulated arrester. The sections were made as follows: the varistor was placed in a mesh fiberglass housing, covered with two aluminum flanges of the original form. The ribbed shell of a two-component electrical silicone was applied to the side surface of the housing, flanges, and the varistor, so that all the free space between the GRP case and the varistor was filled. Studs are used as contact points, screwed into the flanges of the sections.

To prevent heat transfer in the axial direction, polyurethane foam disks with a thickness of 60 mm with a diameter equal to the diameter of the shell ribs were fixed on the end surfaces of the section.

A separator for over-voltage suppressors of the OPNp series was included in the ground circuit of each section. Separators are used by JSC "Polymer-Apparat" to prevent stable short-circuits, complete with OPNp series limit switches, and can be installed both in the ground circuit and in the connecting loop.

Declared throughput current on a rectangular pulse with a duration of 2000 μs (according to the data of the company EPCOS):

- 680 A for varistors SIOV-E48NR;
- 1000 A for varistors SIOV-E58NR;
- 1450 A for varistors SIOV-E70NR;
- 1800 A for varistors SIOV-E78NR;
- 3200 A for varistors (sections) SIOV-E99NR.

Rated current of a lightning impulse current 8/20 μs:

- 10 kA for varistors (sections) SIOV-E48NR;
- 20 kA for varistors (sections) SIOV-E58NR; \\ t% * Documents j
- 20 kA for varistors (sections) SIOV-E70NR;
- 20 kA for varistors (sections) SIOV-E78NR;

20 kA for varistors (sections) SIOV-E99NR.

The high current value of 4/10 μs is 100 kA for sections (varistors) of all types. Test frequency of industrial frequency applied to the sections in the process of working tests:

- for varistors (sections) of the types SIOV-E48NR and SIOV-E58NR - 1 / used dd = # MKA / 3,2 * 1,1; Eisp.nom = otter * 1.25 * 1.1;
- for varistors (sections) of types SIOV-E70NR and SIOV-E78NR - Eisp.indr = EWA / 2.9 * 1.1; Eisp.nom = End * 1.25 * 1.1.

1.6. Manufacturer: Polymer-Apparat Joint-Stock Company (legal address: 190068, Russian Federation, St. Petersburg, B. Podyachnaya str., 1/3, letter A).

1.7. Regulatory document (ND) according to which the product is manufactured: TU 3414-002-15207362-03 "Surge arresters non-linear series OPNp for alternating current 3-35 kV", TU 3414-003-

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15207362-03 "Surge arresters non-linear series OPNp for 110-330 kV AC networks, "TU 3414-004-15207362-03" Overvoltage limiters OPNp non-linear series for 500-750 kV AC networks. "
1.8. Information on the act of sampling (organization, number, date): act (no number) of JSC "Polymer-Apparat", dated 12.06.2017
1.9. Date of receipt of samples: 06/19/2017
1.10. Date of testing: from June 20 to July 14, 2017

2. PURPOSE, PROGRAM AND TEST METHODS

2.1. The purpose of the tests: confirmation of the compliance of the real characteristics of the arrester with the requirements of TU 3414-002-15207362-03, TU 3414-003-15207362-03, TU 3414-004-15207362-03 in terms of operational tests.
2.2. Test program:
In the process of testing for each section of all types:
- the maximum long-term working voltage (Evdr) was determined;
- the remaining voltages are determined when exposed to a nominal thunderstorm current impulse of 8/20 μs before and after working tests (£ / d0 and C / after);
- preparatory tests were carried out (with current pulses of 8/20 μs and 4/10 μs);
- conducted working tests.
2.3. Method (method) of testing: tests conducted according to GOST R 52725 (clause 9.5). Current pulses with the required parameters were applied to varistors using the circuit shown in Fig. 1. The diagram shows: the source of pulse currents GIN-4; inductance L, which ensures the formation of the necessary current pulse shape; charger charger; measuring shunt RIU; voltage divider.
GIN-4

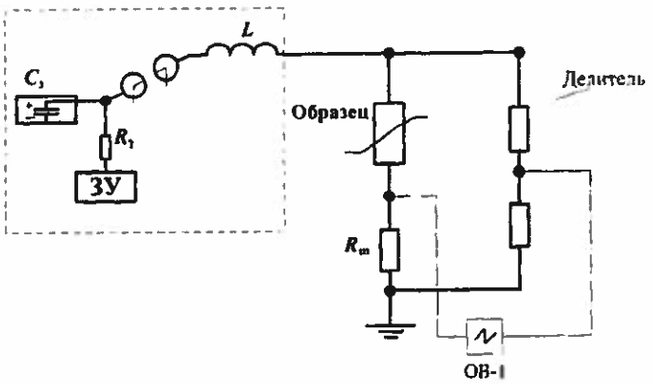

Рис. 1. Принципиальная схема установки для определения вольтамперных характеристик при импульсных токах

Для документов

Measurement of the amplitudes of the remaining voltage and the test current pulse, as well as the duration of the pulses and their fronts, was carried out according to oscillograms taken using the method of GOST 17512-82.
2.3.1. Determination of the maximum long-term allowable voltage sections.
To determine the values of C / ddr and E / com sections, the remaining voltage was determined at a current pulse of 8/20 μs with an amplitude of 10 kA (E / ЦЖА) - Test method according to GOST R 52725 (clause 9.3.3).
2.3.2. Determination of correction factors.
The values of the correction factors during the performance tests for the nominal (.Kn) and the highest allowable operating voltages (QRsD) were assumed to be 1.0 based on the analysis of information on aging varistors of the types SIOV-E48NR, SIOV-E58NR, SIOV-E70NR, SIOV-E78NR of EPCOS company, presented by CJSC Polymer-Apparat, and test results of varistors of type SIOV-E48KV, conducted at JSC NIIPT. Tests to determine the correction factors were conducted in July - August 2007, upon the request of JSC Polymer-Apparat (Contract No. 110-04-2-07). The test results are presented in

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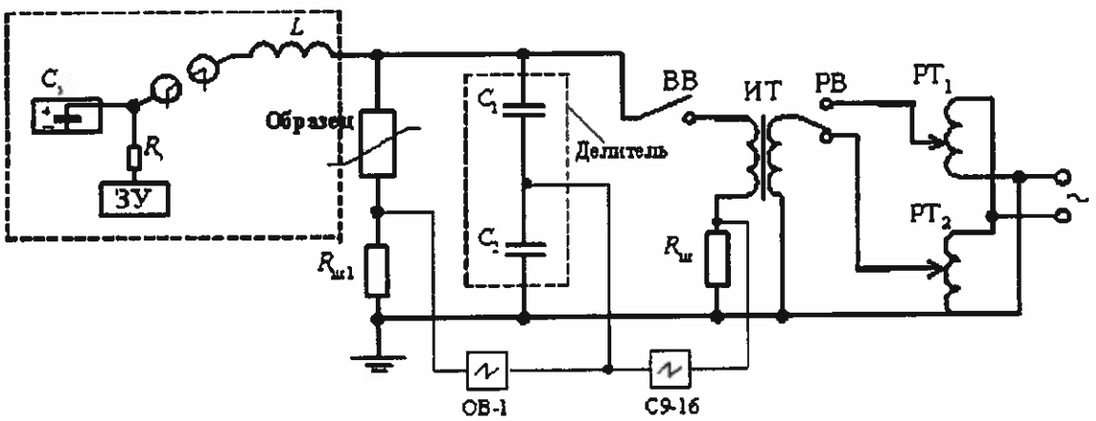
the working test report of varistors of type SIOV-E48KV, manufactured by EPCOS (# 110-04-2-07 / 7).
2.3.3. Confirmation of thermal equivalence of sections and arrester.
To confirm the thermal equivalence of the test section and the fully assembled arrester, an estimated calculation of the section thermal conductivity in the axial and radial directions was carried out. For the calculation, the following coefficients of thermal conductivity of materials were used:
- silicone rubber (tire material) -1.2 W / (mK);
- fiberglass (pipe in which varistors are placed) - 0.6 W / (mK);
- polyurethane foam (the material with which the flanges of the section were closed during the tests) - 0.05 W / (m-K).
During the tests, the thickness of the polyurethane foam was chosen such that the thermal conductivity of the section in the radial direction was significantly greater (30 ^ 10 times) than in the axial one.
2.3.4. Preparatory tests.
The tests were carried out according to GOST R 52725 (clause 9.5.5.2).
2.3.5. Work tests.
The tests were carried out according to GOST R 52725 (clause 9.5.5.3).
Working tests were carried out using the scheme shown in Fig. 2



The diagram shows the source of GIN-4 impulse currents; inductive formation of the necessary current pulse shape; test IT; adjusting transformers RT) and RTg, allowing in advance: the values of test voltages; time relay RV, providing the required time of exposure of high voltage industrial frequency on the section; high-voltage switch BB; capacitive voltage divider; measuring shunts - pulsed Rm \, high-resistance Ra, (measurement of current of industrial frequency). Shunt LSh is included in the transformer earthing circuit.

Using oscillograms of current and voltage affecting a section of rectangular current pulses with a duration of 2000 μs (first current pulses), the energy of the acting current pulses (P, wn) was determined and the specific energy Rud = Rp I / ndr- was calculated. Symp).
2.3.6. Final measurements and inspection.
Sections were considered to pass the test if for all sections:
- there was a decrease in the amplitude of the active component of the current under the action of the voltage £ / * isp.dr after the application of test influences;
- on the oscillograms of current pulses and the remaining voltage there were no distortion of the form, indicating the presence of damage in the sections;
- the difference between the values of the remaining voltages measured under the influence of a nominal current pulse of 8/20 μs before and after the preparatory and operational tests, did not exceed 5%;
- visual examination of the sections after the tests revealed no signs of breakdown, overlap, cracking or other significant damage to the varistors.
2.4. Regulatory document on the product, for compliance with the requirements of which tests were conducted:
- GOST R 52725 "Non-linear surge suppressors for electrical installations of alternating current with voltage from 3 to 750 kV. General technical conditions";

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- TU 3414-002-15207362-03 "Surge suppressors non-linear series OPNp for AC networks 3-35 kV";
- TU 3414-003-15207362-03 "Surge suppressors non-linear OPNp series for 110-330 kV AC networks";
- TU 3414-004-15207362-03 "Surge suppressors non-linear series OPNp for AC networks 500-750 kV".

3. CONDITIONS FOR TESTING

Climatic test conditions: the tests were conducted indoors under the following atmospheric conditions:
- ambient temperature: + (10.1-19.7) ° C;
- relative humidity: (72-87)%;
- atmospheric pressure: (98.2-102.3) kPa.

4. TEST EQUIPMENT AND MEASUREMENT TOOLS

The list of applied test equipment (EUT) and measuring instruments (SI) is given in Appendix 1.

5. TEST RESULTS

5.1. Work tests

Test impacts for the sections are given in table. 2-6.

Table 2
Test influences for a section with a varistor type SIOY-E48NR

	Section № 1	Section № 2	Section № 3
^10кА> кВ	13,8	13,8	13,8
*Uи*др= Нижа/3,2, кВ	4,31	4,31	4,31
£/исп.ндр= *U*ыка/3 ,2 * 1,1, кВ	4,74	4,74	4,74
*U*исп.ном £/вдр* 1,25*1,1, кВ	5,93	5,93	5,93
А'ндр	1	1	1
к„	1	1	1
t/ исп.ндр, кВ (действ .зн.)	4,74	4,74	4,74
#*исп.ном, кВ (действ .зн.)	5,93	5,93	5,93

Table 3
Test influences for section with varistor type SIOV-E58NR

	Section № 1	Section № 2	Section № 3
Е)окл, кВ	13,2	13,2	13,2
Ендр= Т)окл/3,2	4,13	4,13	4,13
1/исп.ндр £W3,2*1,1, кВ	4,54	4,54	4,54
*U*исп.ном- г/ндр*1,25*1,1, кВ	5,67	5,67	5,67
Т^пдр	1	1	1
к»	1	1	1
Т^исплдр, кВ (действ .зн.)	4,54	4,54	4,54
^"исплом, кВ (действ .зн.)	5,67	5,67	5,67

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Table 4
Test influences for section with varistor type SIOV-E70NR

	Section № 1	Section № 2	Section № 3
tIOKA, кВ	12,4	12,4	12,3
Е/ид р= tW3,2	4,28	4,28	4,24
Ь'игп.нлр= £^10КА/3,2*1,1, кВ	4,70	4,70	4,67
*U*исп.ном= Е/ндр* 1,25 *1,1, кВ	5,88	5,88	5,83
^НДР	1	1	1
Ки	1	1	1
U\сп.тр, кВ (действ .зн.)	4,70	4,70	4,67
Е/исплом, кВ (действ .зн.)	5,88	5,88	5,83

Table 5
Test influences for section with varistor type SIOV-E78NR

	Section № 1	Section № 2	Section № 3
£/IOKA, кВ	13,1	12,9	12,9
Сндр- Сн)кл/3,2	4,52	4,45	4,45
Сисп.ндр= £7юка/3,2*1,1, кВ	4,97	4,89	
U исп.ном= *U*ндр* 1,25 * 1,1, кВ	6,21	6,12	
Kwjiy	1	1	// O C'iy'
Ки	1	1	-It/1 Длй
Е/*исп.ндр, кВ (действ .зн.)	4,97	4,89	п' 7 е
u"исп.ном, кВ (действ .зн.)	6,21	6,12	--

Table 6
Test influences for section with varistor type SIOV-E79NR

	Section № 1	Section № 2	Section № 3
Е/ц)кА, кВ	7,5	7,5	7,5
Сндр= ***UIQ*** КА/3,2	2,59	2,59	2,59
Сисп.ндр= Е/юка/3,2*1,1, кВ	2,84	2,84	2,84
*U*исп.ном= Е/ндр* 1,25 * 1,1, кВ	3,56	3,56	3,56
^НДР	1	1	1
Ка	1	1	1
ЕЛкжндр, кВ (действ ,зн.)	2,84	2,84	2,84
Е/*исп.ном, кВ (действ .зн.)	3,56	3,56	3,56

When conducting preparatory tests in accordance with the methodology, 20 pulses of nominal discharge current of 8/20 μs were applied to the sections.
After the sections cooled down to ambient temperature, two current pulses of 4/10 μs were applied to them with recorded amplitudes in the range 92–95 kA. The results of the working tests are given in Table. 7-11.

Table 7
Currents and voltages acting on sections with varistor type SIOV-E48NR

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Name of influence		Section № 1	Section № 2	Section № 3
Amplitude of the 1st current impulse 2000 µs, A	Norm	680		
	Applied	**700**	**700**	**690**
***U*ост 1 го импульса, кВ**		9,6	9,6	9,6
Amplitude of the 2nd current impulse of 2000 µs, A	Norm	680		
	Applied	**700**	**700**	**700**
***U₀*ст 2'го импульса, кВ**		9,7	9,7	9,8
***U* исп.ном, кВ (действ, зн.)**	Norm	5,93	5,93	5,93
	Applied	5,95	5,95	5,95
Е7 ИСП.НДР, **кВ (действ, зн.)**	Norm	4,74	4,74	4,74
	Applied	4,75	4,75	4,75
Е'имп 1го импульса, кДж		17,5	17,5	17,4
***Руд — Рm\n IU*НДР, кДж/кВ**		**4,07**	**4,07**	**4,04**
Симп 1го импульса, Кл		1,62	1,62	1,60

Table 8

Currents and voltages acting on sections with varistor type SIOV-E58NR

Name of influence		Section № 1	Section № 2	Section № 3
Amplitude of the 1st current impulse 2000 µs, A	Norm	1000		
	Applied	**1020**	**1030**	**1030**
***U₀ст* 1го импульса, кВ**		10,3	10,3	10,2
Amplitude of the 2nd current impulse of 2000 µs, A	Norm	1000		
	Applied	**1020**	**1020**	**1020**
Сое **2'го импульса, кВ**		10,3	10,3	10,3
***U* исп.ном, кВ (действ, зн.)**	Norm	5,67	5,67	5.67
	Applied	5,7	5,7	
С*исп.ндр, **кВ (действ, зн.)**	Norm	4,54	4,54 */А*	
	Applied	4,55	4,55 *к*	
Рампу КДЖ		24,7	25,1	= v7 *1Ш* $_n$ *й с*
***Руд — Р*имп /Сидр, кДж/кВ**		**5,98**	**6,08**	
Симп **1 го импульса, Кл**		2,24	*ш х*	

Currents and voltages acting on sections with varistor type SIOV-E70NR

Table 9

Name of influence		Section № 1	Section № 2	Section № 3
Amplitude of the 1st current impulse 2000 µs, A	Norm	1450		
	Applied	**1500**	**1500**	**1500**
Пост 1г0 импульса, кВ		10,1	10,2	10,1
Amplitude of the 2nd current impulse of 2000 µs, A	Norm	1450		
	Applied	**1510**	**1510**	**1500**
Пост 2 го импульса, кВ		10,2	10,2	10,2
Н*исп.ном, **кВ (действ, зн.)**	Norm	5,88	5,88	5,83
	Applied	5,4	5,4	5,3
Н"исп.ндр, **кВ (действ, зн.)**	Norm	4,70	4,70	4,67
	Applied	4,3	4,3	4,25
Римт **кДж**		33,5	33,7	33,4
*Руц ~ Р***имп** *! U*ндр, **кДж/кВ**		**7,83**	**7,89**	**7,88**
Пимп 1 го импульса, Кл		3,15	3,15	3,15

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Currents and voltages acting on sections with varistor type SIOV-E78NR

Table 10

Name of influence		Section № 1	Section № 2	Section № 3
Amplitude of the 1st current impulse 2000 μs, A	Norm	1800		
	Applied	**1840**	**1810**	**1810**
Пост 1[r0] импульса, кВ		11,3	**11Д**	**ПД**
Amplitude of the 2nd current impulse of 2000 μs, A	Norm	1800		
	Applied	**1810**	**1810**	**1810**
Пост 2"[ro] импульса, кВ		п,з	11,3	11,2
П ИСП.НОМ) **кВ (действ, зн.)**	Norm	6,21	6,12	6,12
	Applied	5,65	5,6	5,6
Н*исп.ндр, кВ (действ, зн.)	Norm	4,97	4,89	4,89
	Applied	4,5	4,5	4,5
***Р*имп, кДж**		43,6	42,2	42,2
***Р*\д *Р*имп! Ндр, кДж/кВ**		**9,7**	**9,5**	**9,5**
Симп 1[ro] импульса, Кл		3,86	3,80	3,80

Table 11

Currents and voltages affecting sections with varistor type SIOV-E99NR

Name of influence		Section № 1	Section № 2	Section № 3
Amplitude of the 1st current impulse 2000 μs, A	Norm	3200		
	Applied	**3220**	**3220**	**3200**
Пост 1[ro] **импульса, кВ**		7,0	7,1	7Д
Amplitude of the 2nd current impulse of 2000 μs, A	Norm	3200		
	Applied	**3220**	**3220**	**3220**
Пост **2 [ro] импульса, кВ**		7,1	7,2	7,2
П исп-ном, **кВ (действ, зн.)**	Norm	3,56	3,56	3,56
	Applied	3,56	3,56 ,,	
П исп.ндр, **кВ (действ, зн.)**	Norm	2,84	2,84	
	Applied	2,85	2,85 ///i	*% ь* \\
***Р*имп, КДж**		45,1	45,7 j|£fj.	?/ шчи ^ 1
***Р*уд ~ Пимп/Пндр, кДж/кВ**		**17,4**	**6,7** О	c:
С„мп 1[ro] импульса, Кл		6,44	6,44	*«Syj*

6. CONCLUSIONS

The sections of surge arresters manufactured by JSC "Polymer-Apparat", equipped with varistors of types SIOV-E48NR, SIOV-E58NR, SIOV-E70NR, SIOV-E78NR, SIOV-E99NR, manufactured by EPCOS, passed the working tests.

Test results can be extended to surge arresters equipped with varistors of the types SIOV-E48NR, SIOV-E58NR, SIOV-E70NR, SIOV-E78NR, SIOV-E99NR manufactured by EPCOS, manufactured by TU 3414-002-15207362- 03, TU 3414-003-15207362-03 and TU 3414-004-15207362-03.

Surge suppressors manufactured by CJSC Polymer-Apparat, equipped with varistors of types SIOV-E48NR, SIOV-E58NR, SIOV-E70NR, SIOV-E78NR, SIOV-E99NR, manufactured by EPCOS, meet the requirements of:

- TU 3414-002-15207362-03 "Surge arresters nonlinear series OPNp for AC networks 3-35 kV ",
- TU 3414-003-15207362-03 "Surge arresters nonlinear series OPNp for 110-330 kV AC networks "

List of applied test equipment (IO) and measuring instruments (SI)

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№ п/п	Name of IO / SI	Certificate, date of verification, validity
1	The pulse voltage generator Sp 640/4000, head. № 860622 02	Certificate VNIIM number 2203-150-20027. Protocol of periodic certification from 10.10.2014, to 10.10.2017
2	Ohmic voltage divider 50 kV, head. № 01 Capacitive voltage divider 40 kV, head. №	Sert K. VNIIMS number RU-04-206.1-2103-15 from 12/08/2015, to 12/08/2017
3	Capacitive voltage divider 40 kV, head. № 02	Sert K. VNIIMS number RU-04-206.1-2102-15 from 12/08/2015, to 12/08/2017
4	Digital oscilloscope TDS2014, head. № C035988	Sv-in FBU "Test-S.-Pb" No. 0011945 from January 31, 2017, until June 30, 2017
5	Set of measuring shunts (8 pcs.)	Sert K. VNIIMS No. RU-04-206.1-2104-15 from 12/08/2015, until 08/12/2017
6	Voltmeter B 7-5 8/2, head. No. 017602	Sv-in FBU "Test-S.-Pb" No. 0024847 from 02.03.2017, until 01.03.2018.
7	Hygrometer psychometric VIT-1, head. No. of WHOP	Sv-in FBU "Test-S.-Pb" No. 0011558 from 01.30.2017, until 01.29.2018
8	Aneroid barometer BAMM-1, head. No. 129	Sv-in FBU "Test-S.-Pb" No. 0010608 from 01.27.2017, until 01.26.2018

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Аккредитованный Федеральной службой по аккредитации на техническую компетентность и независимость
Испытательный центр высоковольтного электрооборудования
Открытого акционерного общества "Научно-технический центр Единой энергетической системы"
(ИЦ ВЭ ОАО "НТЦ ЕЭС")

Аттестат аккредитации: № РОСС RU.0001.21МВ14
Зарегистрирован в Едином реестре: 30 октября 2012 г.
Действителен до: 16 января 2017 г.
Юридический адрес: 194233, г. Санкт-Петербург, ул. Курчатова, д. 1, лит. А

Арх. № О-8075
Дата регистрации: 15.03.2013 г.

УТВЕРЖДАЮ
Руководитель ИЦ ВЭ ОАО "НТЦ ЕЭС"

_____ П.Л. Владимирский

М.П.

ПРОТОКОЛ ИСПЫТАНИЙ № 634-04-2-13/2

Объект испытаний	ОПНп 35 кВ производства ЗАО "Полимер-Аппарат" (Санкт-Петербург)
Заказчик	ЗАО "Полимер-Аппарат" (юр. адрес: 190068, Россия, г. Санкт-Петербург, ул. Б. Подъяческая, дом 1/3 литер А)
Вид испытаний, документ на соответствие которому проводились испытания	Испытания воздействием соляного тумана при приложении переменного напряжения промышленной частоты ОПНп 35 кВ производства ЗАО "Полимер-Аппарат" на проверку соответствия требованиям п. 9.18 ГОСТ Р 52725-2007
Место проведения работ	ИЦ ВЭ ОАО "НТЦ ЕЭС"
Дата проведения испытаний	01 февраля по 14 марта 2013 г.

ПРОТОКОЛ СОДЕРЖИТ:

1. **Объект испытаний** лист 2
2. **Цель, программа и методы испытаний** лист 2
3. **Условия проведения испытаний** лист 3
4. **Испытательное оборудование и средства измерений** лист 3
5. **Результаты испытаний** лист 3
6. **Выводы** лист 3

ВСЕГО ЛИСТОВ: 10

ЗАКЛЮЧЕНИЕ: ОПНп 35 кВ, изготовленный в ЗАО "Полимер-Аппарат" (г. Санкт-Петербург) по ТУ 3414-002-15207362-03, соответствует требованиям п. 9.18 ГОСТ Р 52725-2007.
Результаты испытаний образца ограничителей перенапряжения распространяются на ограничители перенапряжений, производства ЗАО "Полимер-Аппарат" выполненные по аналогичной технологии (LSR) и имеющими удельные длину пути утечки и изоляционную высоту большую, чем у образца.
Ограничителей перенапряжений опорного и подвесного исполнений, на которые можно распространить результаты испытаний:
ОПНп-6/680/(6,0…8,5)-10-IV-УХЛ1; ОПНп-10/680/(10…14)-10-IV-УХЛ1;
ОПНп-15/680/(17…19)-10-IV-УХЛ1; ОПНп-20/680/(24…29)-10-IV-УХЛ1;
ОПНп-35/680/(36…45)-10-III(IV)-УХЛ1; ОПНп-110/680/(56…60)-10-III(IV)-УХЛ1;
ОПНп-110/680/(73…100)-10-III(IV)-УХЛ1; ОПНп-110/1000/(73…100)-10-III(IV)-УХЛ1;
ОПНп-110/1450/(73…100)-10-III(IV)-УХЛ1; ОПНп-110/1800/(73…100)-10-III(IV)-УХЛ1;
ОПНп-150/680/(100…130)-10-III(IV)-УХЛ1; ОПНп-150/1000/(100…130)-10-III(IV)-УХЛ1;
ОПНп-220/680/(146…190)-10-III(IV)-УХЛ1; ОПНп-220/1000/(146…190)-10-III(IV)-УХЛ1;
ОПНп-220/1450/(146…190)-10-III(IV)-УХЛ1; ОПНп-220/1800/(146…190)-10-III(IV)-УХЛ1;
ОПНп-330/1000/(210…250)-10-III(IV)-УХЛ1; ОПНп-330/1450/(210…250)-10-III(IV)-УХЛ1;
ОПНп-330/1800/(210…250)-10-III(IV)-УХЛ1; ОПНп-500/1000/(303…360)-10-III(IV)-УХЛ1;
ОПНп-500/1450/(303…360)-10-III(IV)-УХЛ1; ОПНп-500/1800/(303…360)-10-III(IV)-УХЛ1;
ОПНп-500/2100/(303…360)-10-III(IV)-УХЛ1; ОПНп-500/3000/(303…360)-10-III(IV)-УХЛ1;
ОПНп-750/2100/(450…490)-10-III(IV)-УХЛ1; ОПНп-500/3000/(303…360)-10-III(IV)-УХЛ1.
Допускается распространение результатов испытаний на нестандартные типы ОПН если они выполнены по технологии LSR и имеют удельные длину пути утечки и изоляционную высоту большую, чем у испытуемого образца

Дата подписания протокола испытаний: 15 марта 2013 г.

Протокол испытаний не может быть частично или полностью перепечатан или размножен без разрешения Заказчика или Испытательного центра

Lic. Abelardo Brugada
Representante Legal
Piro'y S.A.

1. ОБЪЕКТ ИСПЫТАНИЙ

1.1. Наименование и название изделия, тип: ограничитель перенапряжений нелинейный класса напряжения 35 кВ (ОПНп 35 кВ).

1.2. Код ОКП:

1.3. Код ТН ВЭД:

1.4. Заводской номер: ОПНп 35 кВ отобран из партии № 360, изготовленной в ЗАО "Полимер-Аппарат" 12.2012 г.

1.5. Описание изделия: ограничитель перенапряжений нелинейный на номинальное напряжение 35 кВ укомплектован оксидно-цинковыми варисторами серии NR фирмы EPCOS и изготовлен по технологии LSR (liquid silicone rubber).

1.6. Фото: фотография испытуемого ОПНп 35 кВ приведена в Приложении 4.

1.7. Предприятие-изготовитель: ЗАО "Полимер-Аппарат" (юр. адрес: 190068, Россия, г. Санкт-Петербург, ул. Б. Подъяческая, дом 1/3 литер А).

1.8. Нормативный документ (НД), по которому изготавливается изделие: ТУ 3414-002-15207362-03 "Ограничители перенапряжений нелинейные серии ОПНп для сетей переменного тока 3–35 кВ".

1.9. Сведения об акте отбора образцов (организация, номер, дата): ИЦ ВЭ ОАО "НТЦ ЕЭС", № 1/13 от 10.01.2013 г.

1.10. Дата получения образца: 25.01.2013 г.

1.11. Дата проведения испытаний: с 01 февраля по 14 марта 2013 г.

2. ЦЕЛЬ, ПРОГРАММА И МЕТОДЫ ИСПЫТАНИЙ

2.1. Цель испытаний: проверка соответствия предъявленного образца ОПНп 35 кВ производства ЗАО "Полимер-Аппарат" требованиям п. 9.18 ГОСТ Р 52725-2007 для сертификации продукции ЗАО "Полимер-Аппарат".

2.2. Программа испытаний: испытания проведены в соответствии с требованиями п. 9.18 ГОСТ Р 52725-2007.

2.3. Метод (методика) испытаний: испытания проведены по ГОСТ Р 52725-2007 (п. 9.18) и ГОСТ Р 52082-2003 (п. 8.2.5).

2.4. Нормативный документ на изделие, на соответствие требованиям которого проведены испытания: ГОСТ Р 52725-2007 "Ограничители перенапряжений нелинейные для электроустановок переменного тока напряжением от 3 до 750 кВ. Общие технические условия".

3. УСЛОВИЯ ПРОВЕДЕНИЯ ИСПЫТАНИЙ

3.1. Климатические условия проведения испытаний: испытания проводились в закрытом помещении при следующих атмосферных условиях:

температура окружающей среды: +(19–22)°С;

относительная влажность – 40–70 %;

атмосферное давление – 99–102 кПа.

4. ИСПЫТАТЕЛЬНОЕ ОБОРУДОВАНИЕ И СРЕДСТВА ИЗМЕРЕНИЙ

Перечень применяемого испытательного оборудования (ИО) и средств измерений (СИ) приведен в Приложении 1.

5. РЕЗУЛЬТАТЫ ИСПЫТАНИЙ

5.1. Результаты испытаний приведены в Приложении 2.

5.2. Конструкция испытуемого образца приведена в Приложении 3.

5.3. Фотографии испытуемого образца в испытательной камере приведены в Приложении 4.

5.4. Схема проведения испытаний приведена в Приложении 5.

Протокол испытаний не может быть частично или полностью перепечатан или размножен без разрешения Заказчика или Испытательного центра

Lic. Abelardo Brugada
Representante Legal
Piro'v S.A.

5.5. Фотографии испытуемого образца до и после испытаний приведены в Приложении 6.

6. ВЫВОДЫ

ОПНп 35 кВ, изготовленный в ЗАО "Полимер-Аппарат" (г. Санкт-Петербург) по ТУ 3414-002-15207362-03, соответствует требованиям п. 9.18 ГОСТ Р 52725-2007.

Результаты испытаний образца ограничителей перенапряжения распространяются на ограничители перенапряжений, производства ЗАО "Полимер-Аппарат" выполненные по аналогичной технологии (LSR) и имеющими удельные длину пути утечки и изоляционную высоту большую, чем у образца.

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ОПНп-10/680/(10…14)-10-IV-УХЛ1;
ОПНп-15/680/(17…19)-10-IV-УХЛ1;
ОПНп-20/680/(24…29)-10-IV-УХЛ1;
ОПНп-35/680/(36…45)-10-III(IV)-УХЛ1;
ОПНп-110/680/(56…60)-10-III(IV)-УХЛ1;
ОПНп-110/680/(73…100)-10-III(IV)-УХЛ1;
ОПНп-110/1000/(73…100)-10-III(IV)-УХЛ1;
ОПНп-110/1450/(73…100)-10-III(IV)-УХЛ1;
ОПНп-110/1800/(73…100)-10-III(IV)-УХЛ1;
ОПНп-150/680/(100…130)-10-III(IV)-УХЛ1;
ОПНп-150/1000/(100…130)-10-III(IV)-УХЛ1;
ОПНп-220/680/(146…190)-10-III(IV)-УХЛ1;
ОПНп-220/1000/(146…190)-10-III(IV)-УХЛ1;
ОПНп-220/1450/(146…190)-10-III(IV)-УХЛ1;
ОПНп-220/1800/(146…190)-10-III(IV)-УХЛ1;
ОПНп-330/1000/(210…250)-10-III(IV)-УХЛ1;
ОПНп-330/1450/(210…250)-10-III(IV)-УХЛ1;
ОПНп-330/1800/(210…250)-10-III(IV)-УХЛ1;
ОПНп-500/1000/(303…360)-10-III(IV)-УХЛ1;
ОПНп-500/1450/(303…360)-10-III(IV)-УХЛ1;
ОПНп-500/1800/(303…360)-10-III(IV)-УХЛ1;
ОПНп-500/2100/(303…360)-10-III(IV)-УХЛ1;
ОПНп-500/3000/(303…360)-10-III(IV)-УХЛ1;
ОПНп-750/2100/(450…490)-10-III(IV)-УХЛ1;
ОПНп-500/3000/(303…360)-10-III(IV)-УХЛ1.

Допускается распространение результатов испытаний на нестандартные типы ОПН если они выполнены по технологии LSR и имеют удельные длину пути утечки и изоляционную высоту большую, чем у испытуемого образца.

Руководитель ИЦ
высоковольтного электрооборудования
ОАО "НТЦ ЕЭС", к.т.н. — Л.Л. Владимирский

Заместитель руководителя ИЦ — М.В. Ушакова

Главный специалист ИЦ, к.т.н. — И.Н. Привалов

Руководитель лаборатории
испытаний внутренней изоляции ИЦ — А.Н. Лубков

Протокол испытаний не может быть частично или полностью перепечатан или размножен без разрешения Заказчика или Испытательного центра

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Representante Legal
Piro'y S.A.

Приложение 1

Перечень применяемого испытательного оборудования (ИО) и средств измерений (СИ)

№ п/п	Наименование ИО/СИ	Аттестат, дата поверки, срок действия
1	Стенд длительных испытаний 100 кВ № 2, инв. № 01731	Аттестат ВНИИМ № 2203-177-20212, Протокол периодической аттестации от 18.03.11 г., периодичность – 3 года
2	Измерительный трансформатор напряжения НОМ-35-66 У1, зав. №1212285	Св-во о поверке ФГУ "Тест-С.-Пб" № 0094601от 07.07.2009 г., периодичность – 5 лет
3	Вольтметр Э-59, зав № 77614	Св-во о поверке ФБУ "Тест-С.-Пб" № 00113827 от 08.08.2012 г., периодичность – 1 год
4	Гигрометр психометрический ВИТ-1, зав. № 29	Первичная поверка от 03.2012 г., периодичность 2 года
5	Барометр-анероид БАММ-1, зав.№ 1622	Первичная поверка от 19.03.2012 г., периодичность 1 год

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Открытое акционерное общество «Научно-технический центр Единой энергетической системы» Санкт-Петербург Для документов

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Representante Legal
Piro'y S.A

Приложение 2

Результаты испытаний

№ п/п	Виды проверок и испытаний	Номер пункта ГОСТ Р 52725-2007		Нормированные параметры испытаний. Нормированное значение измеряемого параметра	Фактические параметры испытаний. Фактическое значение измеряемого параметра	Заключение о соответствии ГОСТ Р 52725-2007
		Технические требования	Метод испытаний			
1	2	3	4	5	6	7
1	Испытание воздействием соляного тумана при приложении переменного напряжения	9.18	9.18; ГОСТ Р 52082-2003	Испытание должно проводиться на самом длинном изоляционном корпусе с минимальной удельной длиной пути утечки, установленным изготовителем для этого ОПН. Перед испытаниями поверхность образца должна быть очищена от загрязнений и обезжирена. Испытуемый образец должен располагаться в испытательной камере с влажной атмосферой (соляной туман) объемом не более 10 м^3 при температуре окружающей среды (20±5)°С. Расстояние от испытуемого ОПН до стенок камеры должно быть не менее 0,6 м. Испытуемый образец должен быть подвергнут воздействию соляного тумана при приложении переменного напряжения промышленной частоты величиной 40,5 кВ в течение 1000 ч. Расход распыляемой воды должен составлять (0,4±0,1) л/ч/м^3. Содержание NaCl в воде должно составлять (5±0,25) кг/м^3. ОПН считается выдержавшим испытание, если после испытаний в камере не отмечено критических электрических повреждений	Испытание проводилось на ОПНп 35 кВ. Испытуемый образец был расположен в прозрачной испытательной камере (размером 1,6×1,6×2,1 м = 5,4 м^3) с влажной атмосферой (соляной туман) при температуре окружающей среды. Перед испытаниями поверхность образца была очищена от загрязнений и обезжирена. Испытуемый образец был подвергнут воздействию соляного тумана при приложении переменного напряжения промышленной частоты величиной (40,5±0,25) кВ в течение 1000 ч. Расход распыляемой воды (раствора) в испытательной камере составлял 2,5 л/ч (0,47 л/ч/м^3). Содержание NaCl в воде составляло 5 кг/м^3. Испытание напряжением проводилось по однофазной схеме. ОПНп 35 кВ выдержал испытание напряжением промышленной частоты при воздействии соляного тумана без перекрытия и электрических повреждений изоляции	Соответствует

Протокол испытаний не может быть частично или полностью перепечатан или размножен без разрешения лаборатории, выдавшей протокол.

Lic. Abelardo Brugada
Representante Legal
Piro'y S.A.

19Accredited by the Federal Accreditation Service for Technical Competence and Independence
Testing center of high-voltage electrical equipment
Open Joint-Stock Company "Scientific and Technical Center of the Unified Energy System"
(Information Center of Ecology and Technology Center of UES ")

Accreditation certificate: No. ROSS RU.0001.21MB14
Registered in the Unified Register: October 30, 2012
Valid through: January 16, 2017

TEST REPORT
Artificial contamination test

Test object	Surge arrester kV
Customer	JSC "Polymer-Apparat", 190068, St. Petersburg, B.Podyacheskaya Str., 1/3, lit.A

PROTOCOL CONTAINS:

1. Object test
2. Purpose, program and test methods
3. Test conditions for
4. Testing equipment and measuring instruments
5. Test results
6. Conclusions

CONCLUSION: Surge arrester OPNp 35 kV manufactured in JSC "Polymer-Apparat" (St. Petersburg) according to TU 3414-002-15207362-03, meets the requirements of clause 9.18 GOST R 52725-2007. The test results of the surge arrester sample apply to surge arrester manufactured by JSC "Polymer-Apparat" using the same technology (LSR) and having a specific creepage distance and an insulating height greater than the specimen.
Surge arrester of support and suspension versions, to which the test results can be extended:
OPNp-6/680 / (6.0 ... 8.5) -10-1V-UHL1; OPNp-10/680 / (10 ... 14) -10-1V-UHL1;
OPNP-15/680 / (17 ... 19) -10-1V-UHL 1; OPNP-20/680 / (24 ... 29) -10-1V-UHL 1; OPNp-35/680 / (36 .. .45) -10-Ш (1У) -УХЛ 1; OPNp-110/680 / (56 ... 60) -10-1ShGGU) -OOHL 1;
OPNP-110/680 / (73 ... 100) -10-Sh (1U) -UHL 1; OPNP-110/1000 / (73 ... 100) -10-Sh (1U) -UHL 1; OPNp-110/1450 / (73 ... 100) -10-Sh (GU) -UHL 1; OPNP-110/1800 / (73 ... 100) -10-111 (1U) -UHL 1; OPNP-150/680 / (100 ... 130) -10-Ш (1У) -УХЛ 1; OPNp-150/1000 / (100 ... 130) -10-111 (1U) -UHL 1; OPNp-220/680 / (146 ... 190) -10-111 (1U) -UHL1; OPNp-220/1000 / (146 ... 190) -10-111 (1U) -OOHL 1; OPNp-220/1450 / (146 ... 190) -10-1SCHGU-UHL 1; OPNp-220/1800 / (146 ... 190) -10-Sh (GU) -OOHL 1; OPNp-ZZO / 1000 / (210 ... 250) -10-111 (1U) -OOHL 1; OPNp-330/1450 / (210 ... 250) -10-111 (1U) -UN 1; OPNp-330/1800 / (210 ... 250) -10-11 (1U) -UHL1; OPNP-500/1000 / (303 ... 360) -10-Sh (1U) -UHL1; OPNp-500/1450 / (303 ... 360) -10-111 (1U) -OOHL 1; OPNP-500/1800 / (303 ... 360) -10-W (1U) -OOHL 1; OPNp-500/2100 / (303 .. .360) -10-111 (1U) -OOHL 1; OPNp-500/3000 / (303 ... 360) -10-Sh (1U) -OOHL 1; OPNP-750/2100 / (450 ... 490) -10-111 (1U) -OOHL 1; OPNp-500/3000 / (303 ... 360) -10-111 (1U> UHL 1. It is allowed to distribute test results to non-standard types of arresters if they are manufactured using LSR technology and have a specific creepage distance and insulation height greater than of the test sample.

Date of signing the test report: March 15, 2013.

Lic. Abelardo Brugada
Representante Legal
Piro'y S.A.

1. TEST OBJECT

1.1. Name of the product, type: surge arrester non-linear voltage class 35 kV (OPNp 35 kV).
1.2. KodOK:
1.3. HS code:
1.4. Production number: OPNp 35 kV selected from lot number 360, manufactured in JSC "Polymer-Apparat" 12.2012g.
1.5. Product Description: A nonlinear surge for a rated voltage of 35 kV is equipped with an EPCOS zinc oxide-zinc varistor manufactured by LSR (liquid silicone rubber) technology.
1.6. Photo: Photo of the tested 35 kV surge arrester is given in Appendix 4.
1.7. Manufacturer: JSC "Polymer-Apparat" (legal address: 190068, Russia, St. Petersburg, B. Podyachskaya St., house 1/3 of letter A).
1.8. Regulatory document (ND) according to which the product is manufactured: TU 3414-002-15207362-03 "Surge arrester non-linear series OPNp for networks of alternating current 3-35 kV".
1.9. Information on the act of sampling (organization, number, date): ITs VE OAO NTC UES, No. 1/13 dated January 10, 2013
1.10. Date of receipt of the sample: 01/25/2013
1.11. Date of testing: from February 1 to March 14, 2013

2. PURPOSE, PROGRAM AND TEST METHODS

2.1. The purpose of the tests: verification of compliance of the presented sample of a 35 kV OPNp sample produced by JSC "Polymer-Apparat" with the requirements of clause 9.18 of GOST R 52725-2007 for the certification of CJSC Polymer Apparatus products.
2.2. Test program: the tests were carried out in accordance with the requirements of clause 9.18 of GOST R 52725-2007.
2.3. Method (method) of testing: tests carried out according to GOST R 52725-2007 (clause 9.18) and GOST R 52082-2003 (clause 8.2.5).
2.4. Regulatory document on the product, for compliance with the requirements of which the tests were carried out: GOST R 52725-2007 "Non-linear surge arrester for electrical installations of alternating current with voltage from 3 to 750 kV. General technical conditions".

3. TEST CONDITIONS

3.1. Climatic conditions for testing: the tests were carried out in a closed room under the following atmospheric conditions: ambient temperature: + (19-22) ° C; relative humidity - 40-70%; atmospheric pressure - 99-102 kPa.

4. TEST EQUIPMENT AND MEASUREMENT TOOLS

The list of applied test equipment (EUT) and measuring instruments (SI) is given in Appendix 1.

5. TEST RESULTS

5.1. The test results are given in Appendix 2.
5.2. The design of the test sample is given in the Appendix.
5.3. Photographs of the test sample in test stone 4.
5.4. The testing scheme is given in Appendix 5.

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6. CONCLUSIONS

The 35 kV OPNp manufactured in JSC "Polymer-Apparat" (St. Petersburg) according to TU 3414-002-15207362-03 complies with the requirements of clause 9.18 of GOST R 52725-2007.

The test results of the surge arresters apply to surge arresters manufactured by "Polymer-Apparat" performed using a similar technology (LSR) and having a specific creepage distance and an isolation height higher than that of the sample.

Overvoltage suppressors of support and suspension versions, to which the test results can be extended:

OPNp-6/680 / (6.0 ... 8.5) -10-1V-UHL1;
OPNp-10/680 / (10 ... 14) -10-1V-UHL 1;
OPNP-15/680 / (17 ... 19) -10-1V-UHL 1;
OPNP-20/680 / (24 .. .29) -10-IV-UHL1;
OPNp-35/680 / (36 ... 45) -Y-W (1U) -UHL1;
OPNP-110/680 / (56 ... 60) -10-Sh (1U) -UHL1;
OPNP-110/680 / (73 ... 100) -10-Sh (1U) -UHL 1;
OPNP-110/1000 / (73 ... 100) -10-Sh (1U) -UHL 1;
OPNP-110/1450 / (73 ... 100) -10-111 (1U) -UHL 1;
OPNP-110/1800 / (73 ... 100) -10-111 (1U) -UHL 1;
OPNP-150/680 / (100 ... 130) -10-Ш (1У) -УХЛ 1;
OPNp-150/1000 / (100 ... 130) -10-111 (1U) -UHL 1;
OPNp-220/680 / (146 ... 190) -10-Sh (1U) -OOHL 1;
OPNp-220/1000 / (146 ... 190) -10-111 (1U) -OOHL 1;
OPNp-220/1450 / (146 ... 190) -10-Sh (1U) -UHL1;
OPNp-220/1800 / (146 ... 190) -10-111 (1U) -OOHL 1;
OPNP-330/1000 / (210 .. .250) -10-Ш (1У) -УХЛ 1;
OPNp-330/1450 / (210 ... 250) -10-111 (1U) -UN 1;
OPNP-330/1800 / (210 .. .250) -10-Ш (1У) -УХЛ 1;
OPNp-500/1000 / (303 .. .360) -10-111 (1U) -OOHL 1;
OPNP-500/1450 / (303 ... 360) -10-Sh (1U) -UHL1;
OPNP-500/1800 / (303 ... 360) -10-Sh (1U) -OOHL 1;
OPNP-500/2100 / (303 .. .360) -10-111 (1U) -Y HL1;
OPNp-500/3000 / (303 .. .360) -10-Ш (1У) -УХЛ 1;
OPNP-750/2100 / (450 ... .490) -10-111 (1U) -OOHL 1;
OPNp-500/3000 / (303 .. .360) -10-Ш (1У) -УХЛ 1.

It is allowed to distribute test results to non-standard types of arresters if they are made using LSR technology and have a specific creepage distance and insulation height greater than that of the test specimen.

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Normalized test parameters.
Normalized value
measured parameter

The test shall be carried out on the longest insulating casing with a minimum specific length of leakage nougat, as established by the manufacturer for this equipment.
Before testing, the sample surface should be free from contamination and degreased.
The test sample shall be located in a test chamber with a humid atmosphere (salt fog) with a volume of not more than 10 m3 at an ambient temperature of (20 ± 5) ° C. The distance from the test device to the chamber walls should be at least 0.6 m. The test sample should be exposed to salt fog when an alternating voltage of the industrial frequency of 40.5 kV is applied for 1000 hours. The flow rate of sprayed water should be (0 4 ± 0.1) l / h / m3. The content of NaCl in water should be (5 ± 0,25) kg / m '.
The arrester is considered to have passed the test, if after the tests in the chamber there is no critical electrical damage.

The actual test parameters.
The actual value of the measured parameter

The test was conducted on a 35 kV OPNp. The test sample was located in a transparent test chamber (size 1.6x1.6x2.1 m = 5.4 m3) with a moist atmosphere (salt fog) at ambient temperature.
Before testing, the sample surface was decontaminated and degreased.
The test sample was exposed to salt fog when an alternating voltage was applied at an industrial frequency of (40.5 ± 0.25) kV for 1000 h.
The flow rate of water sprayed (solution) in the test chamber was 2.5 l / h (0.47 l / h / m '). The content of NaCl in water was 5 kg / m '.
The voltage test was carried out according to a single-phase scheme.
A 35 kV OPNp withstood the test of a voltage of industrial frequency under the influence of salt fog ^ without-overlapping and electrical damage ^ evil ^

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Accredited by the Federal Accreditation Service
Testing center of high-voltage electrical equipment
Open Joint Stock Company "Research Institute for the Transfer
high voltage direct current
Accreditation Certificate: No. ROSS RU.0001.213T71
Date of entry in the register of information on an
accredited person: January 27, 2014 Legal address:
194233, St. Petersburg, ul. Kurchatova, d. 14, lit. A

TEST REPORT No. 145-2-17/6
Partial discharge test

Test object	Surge arrester OPNp-150/680/120- 10-III УХЛ1
Customer	JSC "Polymer-Apparat", 190068, St. Petersburg, B. POdyacheskaya Str., lit. A
Type of test, the document for compliance with which the tests were conducted	Tests of opn for compliance with the requirements of clause 6.4.1 of GOST R 52725-2007
Test date	June 20 to 29, 2017

PROTOCOL CONTAINS:

1. Object test
2. Purpose, program and test methods
3. Test conditions
4. Testing equipment and measuring instruments
5. Test results
6. Conclusions

CONCLUSION: **A nonlinear surge arrester of the type OPNp-150/680 / 120-10-III UHL1, manufactured by JSC "Polymer-Apparat" according to TU 3414-003-15207362-03, passed the leakproofness test to verify compliance with the requirements of clause 6.4.1 GOST R 52725-2007.**
Nonlinear surge arrester OPN-P / ZEU-150/110/10/2 (550) UHL1, manufactured in JSC "Polymer-Apparat" according to TU 3414-003-15207362-03, meets the requirements of clause 6.4.1 of GOST R 52725-2007.
The test results of the OPNP-150/680/120-10-III UHL1 manufactured at JSC "Polymer-Apparat" according to TU 3414-003-15207362-03 can be applied to non-linear surge arrester manufactured by JSC "Polymer-Apparat", manufactured according to TU 3414-002-15207362-03, TU 3414-003-15207362-03 and TU 3414-004-15207362-03

Date of signing the test report: July 17, 2017

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1. TEST OBJECT

1.1. Name of the product, type: non-linear surge arrester OPNp-150/680 / 120-10-III УХЛ1.
1.2. OKPD2 code: 27.12.10.130.
1.3. EEU TN VED Code: 8535 40 000 0.
1.4. Serial number: OPNp-150/680 / 120-10-III УХЛ1 - № 150043, selected from the batch, manufactured in JSC "Polymer-Apparat" in 2017.
1.5. Product Description: A non-linear surge arrester of a voltage class of 150 kV is a single-element protection device consisting of a polymer housing with an insulating ribbed silicone rubber coating, inside of which is placed a column of series-connected varistors terminated with metal flanges.
1.6. Photo: Photos of the test specimen are given in Appendix 3.
1.7. Manufacturer: JSC "Polymer-Apparat" Joint-Stock Company (legal address: 190068, Russian Federation, St. Petersburg, B. Podyachnaya str., 1/3, letter A).
1.8. Regulatory document (ND) according to which the product is manufactured: TU 3414-003-15207362-03 "Surge arresters non-linear series OPNp for alternating current 110-330 kV".
1.9. Information on the act of sampling (organization, number, date): act (no number) of JSC "Polymer-Apparat" as of 12.06.2017
1.10. Date of receipt of samples: 06/19/2017
1.11. Date of testing: from 20 to 29 June 2017

2. PURPOSE, PROGRAM AND TEST METHODS

2.1. The purpose of the tests: verification of compliance of OPNp-150/680/120-10-III UHL1 with the requirements of clause 6.4.1 of GOST R 52725-2007.
2.2. Test program: the tests were carried out in accordance with the requirements of GOST R 52725-2007 (clause 6.4.1).
2.3. Method (method) of testing: tests carried out according to GOST R 52725-2007 (paragraphs 9.12.3,9.15.2).
2.4. Regulatory document on the product, for compliance with the requirements of which the following tests were carried out: GOST R 52725 "Non-linear surge arrester for alternating current electrical installations with voltage from 3 to 750 kV. General technical conditions".

3. CONDITIONS FOR TESTING

Climatic test conditions: the tests were conducted indoors under the following atmospheric conditions:
- ambient temperature: + (17.6-23.8) ° C;
- relative humidity: (72-93)%;
- atmospheric pressure: (99.2-101.4) kPa.

4. TEST EQUIPMENT AND MEASUREMENT TOOLS

The list of applied test equipment (EUT) and measuring instruments (SI) is given in Appendix 1.

5. TEST RESULTS

5.1. The test results are given in Appendix 2.
5.2. Pictures of the test specimen are given in Appendix 3.
5.3. The oscillogram of partial discharges is given in the Appendix.

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6. CONCLUSIONS

Nonlinear surge arrester of the type OPNp-150/680/120-10-III UHL1, made in JSC "Polymer-Apparat" by TU 3414-003-15207362-03, passed the leak test for checking the requirements and. 6.4.1 GOST R 52725-2007.

The non-linear surge arrester OPN-P / ZEU-150/110/10/2 (550) UHL1, manufactured in JSC "Polymer-Apparat" according to TU 3414-003-15207362-03, meets the requirements and. 6.4.1 GOST R 52725-2007.

The test results of the OPNP-150/680 / 120-10-III UHL1, manufactured by JSC "Polymer-Apparat" according to TU 3414-003-15207362-03, can be extended to non-linear surge arrester produced by JSC "Polymer-Apparat", manufactured according to TU 3414-002-15207362-03, TU 3414-003-15207362-03 and TU 3414-004-15207362-03.

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List of applied test equipment (IO) and measuring instruments (SI)

№ п/	Test equipment and measurement instrument	Certificate, test date, validity
1	Installation of UPT-400 kV, inv. No. 30043	Certificate NIIPT № 53. Periodic Attestation Protocol of 17.03.2017 ,till 17.03.2020
2	Capacitive voltage divider MCF 135 / 200R, head. No. 859030	Certificate ВНИИМС № 206.1-1072-17 of 01.03.2017 till 28.02.2019
3	Universal Voltmeter - MUT-9, head. No. 850042	Certificate К. НТЦ ЕЭС № 42 of 30.06.2015 till 30.06.2017 г.
4	Multichannel temperature meter Termodat-22M2, head	Primary calibration of 22.04.2016 till 22.04.2018
5	Thermoelectric converters DTP gr. HC, head.	Primary calibration of 15.04.2016 till 15.04.2018
6	Digital measuring complex "SKIT CR"	Certificate К. ФБУ "Тест-С-Пб" № 17-01568 of 01.02.2017 till 31.01.2018
7	Hygrometer psychrometric VIT-1, head. No. of WHOP	Certificate ФБУ "Тест-С.-Пб" № 0011558 of 30.01.2017 г.,till 29.01.2018 г.
8	Aneroid barometer BAMM-1, head. No. 129	Certificate ФБУ "Тест-С.-Пб" № 0010608 of 27.01.2017 г., till 26.01.2018 г.

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Normalized test parameters
Normalized value
measured parameter

The test sample is placed in a vessel (bath) with boiling demineralized water for 42 hours. The water in the bath should completely close the test sample. The test specimen must be installed in a bath on a stand made of a material with low thermal conductivity. During testing, the sample should be in a fixed position; the minimum distance from the sample to the walls of the bath should be no less than the diameter of the shell of the limiter along the ribs.
Immediately after boiling, the sample should be removed from the bath and kept in a room with a normal temperature until the outer surface is completely dry. Then you should conduct an external examination and measurement of the level of partial discharges.
The time interval between the extraction of the sample from the bath and the end of the measurement of the level of partial discharges should not exceed 24 hours. The measurement of partial discharges is carried out at a voltage of industrial frequency. The sensitivity of the measurement circuit is not less than 10 pC. The test voltage on the limiter should be smoothly raised to a value of 1.25 Nsch> kept for 10 s, then reduced to 1.05 £ / u>. The limiter is considered to have passed the test, if the tires or flanges did not crack or bulge, and the level of measured partial discharges did not exceed 10 pC

The actual test parameters
The actual value of the measured parameter

Test object OPNP-150/680 / 120-10-III UHL1 was immersed in a bath of boiling demineralized water on a porcelain stand. The distance from the surge arrester to the walls of the bath was 50 cm. The water in the bath completely closed the surge arrester. During testing for 42 hours, the arrester was in a fixed position.
After boiling, the arrester was removed from the bath and kept for 8 hours in a room at ambient temperature (19 ° C) until the external surface was completely dry.
Then conducted an external examination. Cracking or heaving of tires or arresters flanges is absent.
After an external inspection of the surge arrester, partial discharges are measured.
The sensitivity of the measurement circuit is 1.6 pC.
The test voltage on the surge arrester was smoothly raised to a value of 1.25 £ / NR (150 kV) and held for 10 s, then lowered to 1.05 C / NR (126 kV).
At a voltage of 1.05 ^ level partial discharge

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Test Report

Document No.	B7020147	Copy No.	1	Number of pages	96
Apparatus	Polymer-housed surge arrester section type PA-DM section ST with additional thermal insulation				
Designation	---				
Serial Number	---				
Manufacturer	Joint-Stock Company " Polymer-Apparat"				
Client	Joint-Stock Company " Polymer-Apparat" Ak. Kostantinova str., 1 195427 Saint-Petersburg - Russia Federation				
Tested for	---				
Date(s) of tests	October 4 – December 4, 2017				
Tested by	CESI S.p.A. Via Rubattino, 54 20134 Milano - Italy				
Test performed	Power-frequency voltage-versus-time				

The apparatus, constructed in accordance with the description, drawings and photographs incorporated in this document has been subjected to the series of proving tests in accordance with:

IEC 60099-4 – Edition 3.0 (2014-06)

The results are shown in the record of proving tests and the oscillograms attached hereto. The ratings assigned by the Manufacturer are listed on the ratings page.
The document applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designations with that tested rests with the Manufacturer.

December 12, 2017

Date

Gregori Marco
B7020147 3059 AUT
Test Engineer in charge

The Manager - Arcidiaco Lorenzo
B7020147 821814 APP
Approved By Document Digitally Signed

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ENTE ITALIANO DI ACCREDITAMENTO
LAB N° 0030

The laboratory meets the requirements of the Standard EN ISO/IEC 17025: 2005 "General Requirements for the Competence of Testing and Calibration Laboratories". The in force status of the accreditation and the list of accredited tests may be checked in the WEB site: www.accredia.it

测思 Centro Elettrotecnico Sperimentale Italiano

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CESI

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PAD B7020147 (2448496) - CONFIDENTIAL USE

Notes

STL-Member

CESI Group members are founder members of the SHORT-CIRCUIT TESTING LIAISON (STL) which has been established in 1969. STL is a forum for voluntary international cooperation of testing organizations.

CESI Group Test Documents description

Type Test Certificate of .....

Issued for type tests of high voltage products (> 1 kV_{ac}; > 1,5 kV_{dc}), which have successfully been carried out in full compliance with the relevant specifications or standards and STL Guides valid at the time of the test. The Type Test Certificate consists of documents unequivocally identifying the test object and describes all conditions under which the tests were conducted. It gives evidence of the unobjectionable behavior of the test object during the tests in line with the normative documents applied as well as of the results of successful testing.

Test Certificate of (complete / selected) Type Tests

Issued if type tests of low voltage products (< 1 kV_{ac}; < 1,5 kV_{dc}) requested by the relevant product standard were passed. For these tests the equipment under test must be clearly identified by technical description, drawings, and additional specifications.

Certificate of Design Verification

Issued for passed design verification tests according to IEC 61439. For these tests the equipment under test must be clearly identified by technical description, drawings, and additional specifications.

Type Test Report

Issued for high and low voltage products if parts of selected type tests have been passed; those shall be carried out in full compliance with the relevant standards but (for high voltage products) do not fulfill all STL requirements for issuing a Type Test Certificate. For these tests the equipment under test must be clearly identified by technical description, drawings, and additional specifications.

Test Report

Issued for all other tests on high and low voltage products which have been carried out according to specifications, standards and/or client instructions

On-Site Test Record

Issued as a record of results acquired during the on-site tests / measurements

Test Award

Can be additionally issued for all named types of test documents above if the tests to be referenced were passed

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Tests witnessed by:

Identification of the object: Effected

The Manufacturer guarantees that the tested object is manufactured according to the submitted drawings.
CESI checked that these drawings adequately represent in shape and dimensions the essential details and the parts of the tested object.
These drawing, identified by CESI and numbered B7024364 No. 1 , is annexed to this document.

Test evaluation
With reference to the Standards/Specifications listed in the first page and the characteristics of the tested sample assigned by manufacturer, the carried out tests passed SUCCESSFULLY.

The data necessary to permit repetition of the tests are contained in the document marked: ----

The reported expanded uncertainties are determined in accordance with the Publication JCGM 100"Evaluation of measurement data - Guide to the expression of uncertainty in measurement" and are based on a standard uncertainty multiplied by a coverage factor k = 2, which for a normal distribution provides a level of confidence of approximately 95 %.

- Voltage a.c.	**: ± 3,0%**
- Residual peak voltage (impulse tests)	**: ± 3,0%**
- Current a.c.	**: ± 3,0%**
- Peak current (impulse tests)	**: ± 3,0%**
- Time (impulse tests)	**: ± 10,0%**
- Time (a.c. tests)	**: ± 1,5%**

Laboratory information

Receipt date of the sample	September 2017
Test location	CESI – Via Rubattino 54 – Milan
CESI testing team	Mr L. Podavitte
Test laboratory	P177
ODV SAP	70006781

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content	page	test date
Test object characteristics	5	
Photograph of the test object	6	
Reference standard	7	
Test carried out	7	
Test object identification	7	
Test procedure	8	
Summary of test results	9	
Initial test	10 to 11	October 4-5, 2017
Voltage correction factor and thermal energy calculations	12	October 5, 2017
With prior duty test	13 to 16	December 2-4, 2017
Without prior duty test	17 to 18	October 6, 2017
Test evaluation	19 to 20	December 4, 2017
Technical data of the test circuit	21 to 25	
Pages annexed:		
Oscillograms - n. 68 pages		
Client's drawing (Polymer-housed surge arrester section) – CESI no. B7024364 – n.1 page		
Client's drawing (MO resistor) – CESI no. B7020387 – n.1 page		
Technical document (TOV curve) CESI No.B7023131 – n.1 page		

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Test object characteristics (assigned by the client)

Manufacturer's name	Joint-Stock Company " Polymer-Apparat"
Polymer-housed surge arrester section type	PA-DM section ST
Drawing code	PA-DM.001.ST.02
MO-resistor supplier's	Joint-Stock Company " Polymer-Apparat"
Metal-oxide resistor type	B34/30
Arrester class	Distribution
Designation	DH
Number of MO resistor fitted	1
Nominal discharge current - [kA]	10
Rated voltage - U_r [kV]	1,077 x $U_{ref.}$
Continuous operating voltage - U_c [kV]	0,861 x $U_{ref.}$
Repetitive charge transfer rating - Q_{rs} [C]	0,4
Rated thermal charge transfer rating - Q_{th} [C]	1,1
Flat surface area [cm^2]	10,52
Reference current - $I_{ref.}$ [mA]	1,0
Rated frequency - [Hz]	48÷62
Year of manufacture	08/2017

geometrical characteristics measured on the MO resistor

Total height [mm]	31,1 mm
Diameter [mm]	36,6 mm

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Photographs of the test object

Photo no. 1

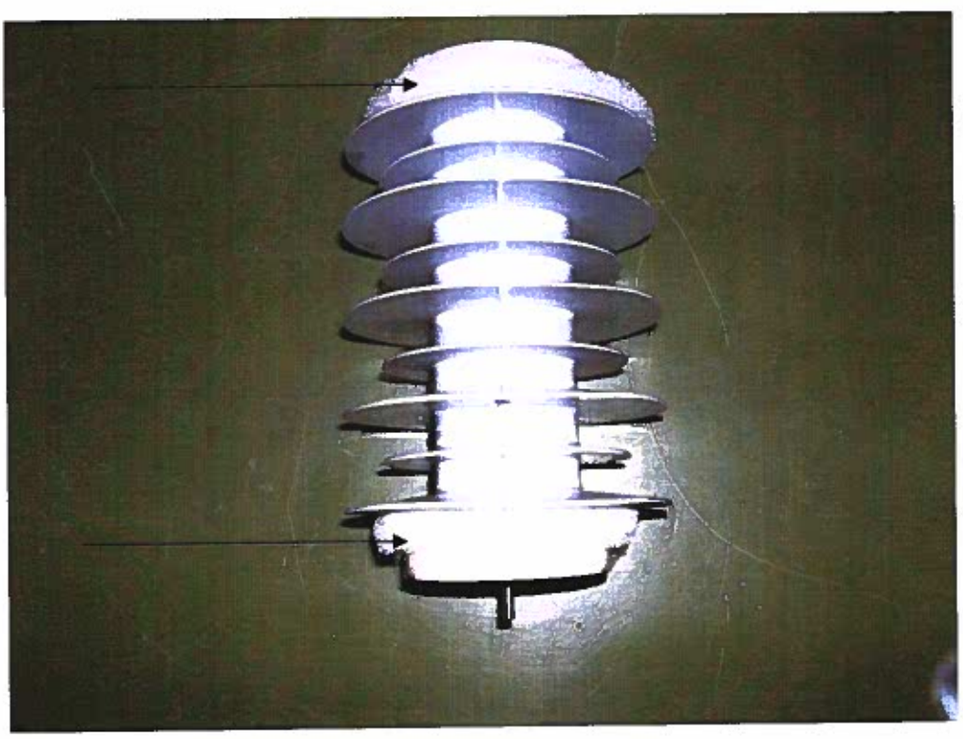

Photo no. 2

Polymer-housed surge arrester section type PA-DM section ST with additional thermal insulation

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Reference Standard

IEC 60099-4 (2014/06) – Edition 3 - Clause 10.8.8.
"Metal-oxide surge arresters without gaps for a.c. system"

Test carried out	Number of sample tested
Power-frequency voltage-versus-time test	6

Test object identification

Test object name	Identification of test sample (given by CESI)	Identification of test sample (given by JSC "Polymer Apparat)
Polymer-housed surge arrester section type PA-DH section ST with additional thermal insulation	TOV1	00102
	TOV2	00103
	TOV3	00104
	TOV4	00005
	TOV5	00009
	TOV6	00010

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Test procedure

The test procedure consisted of the following sequence:

1. Test performed on Polymer-housed metal-oxide surge arrester section in open air

Initial test

a) Measurement of the lightning impulse residual voltage at the nominal discharge current

b) Measurement of the power frequency reference voltage at the reference current

2. Test performed on Polymer-housed metal-oxide surge arrester section assembled in thermal model

Test with energy input (prior duty test)

c) The surge arrester sections were kept in an oven at the temperature of 66 °C till thermal equilibrium (not more than twenty hours)

d) Injection of two lightning current impulses 8/20 µs at the rated thermal charge transfer Q_{th} . A time shorter than 100 ms after the application of the second second lightning current impulses 8/20 µs energization at U_{TOV} (declared by the manufacturer) for a time t_{TOV} (declared by the manufacturer)and then at U_c' for 30 min. to verify the thermal stability.

Note:

- intervals between lightning duration current impulses: 60 seconds
- nominal test frequency : 50 Hz

Four samples were tested as specified below:

Sample	U_{TOV}	Duration	Note
TOV1	1,080 x U_r'	1 sec	prior duty test
TOV2	1,040 x U_r'	10 sec	
TOV3	1,000 x U_r'	100 sec	
TOV4	0,960 x U_r'	1000 sec	

Test without energy input (no-prior duty test)

e) The surge arrester sections were kept in an oven at the temperature of 66 °C till thermal equilibrium (not more than twenty hours)

f) Application of the overvoltage U_{TOV} (declared by the manufacturer) for a time t_{TOV} (declared by the manufacturer)and then at U_c' for 30 min. to verify the thermal stability.

Note:

- nominal test frequency : 50 Hz

Two samples were tested as specified below:

Sample	U_{TOV}	Duration	Note
TOV5	1,130 x U_r'	10 sec	no-prior duty test
TOV6	1,040 x U_r'	1000 sec	

3. Test performed on Polymer-housed metal-oxide surge arrester section in open air

g) Measurement of the lightning impulse residual voltage at nominal discharge current for comparison with initial value

f) After that the sample has cooled to ambient temperature and two current impulses 8/20 at 0,5 kA/cm^2 have been applied to check the integrity of the internal parts. The interval between impulses was 50-60 seconds.

Test result

The visual inspection of the sample after the test has revealed no sign of physical damage.
The variation of lightning impulse residual voltage before and after the test was less than 5% (maximum allowed variation according to reference standard is 5%). During the two last impulses the oscillograms not reveal any breakdown.
The thermal stability was achieved.

The acceptance criteria are fulfilled. The test result is positive.

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...sentante Legal
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Summary of test results

Variation of lightning impulse residual voltage at I_n

sample	before test		after test		Variation
	discharge current	residual voltage	discharge current	residual voltage	
	kA	kV	kA	kV	%
TOV1	10,15	14,04	10,18	14,26	+1,57
TOV2	10,10	14,06	10,14	14,24	+1,28
TOV3	10,07	14,16	10,10	14,38	+1,55
TOV4	10,15	14,30	10,07	14,36	+0,42
TOV5	10,14	14,17	10,04	14,00	+1,20
TOV6	10,08	14,35	10,05	14,25	-0,70

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Power frequency voltage versus time test.

Lightning impulse residual voltage measurement before the test

Test circuit: A0120

Date: October 4, 2017

Sample	Requested current	Charging voltage	Oscillogram	Current waveshape	Discharge current	Residual Voltage
No.		kV	No.	µs	kA	kV
TOV1	I_n	24,8	1	8,6/18,2	10,15	14,04
TOV2		24,8	2		10,10	14,06
TOV3		24,8	3		10,07	14,16
TOV4		24,8	4		10,15	14,30
TOV5		24,6	5		10,14	14,17
TOV6		24,6	6		10,08	14,35

Notes:

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Power frequency voltage versus time test.

Reference voltage test.

Test circuit: A0019

Date: October 5, 2017

Sample No.TOV1						
oscillogram	voltage	current	current	current	power	3rd harmonic amplitude
No.	kV	+ mA_{cr}	- mA_{cr}	mA_{rms}	W	µA
7	5,47	0,884	1,000	0,562	1,41	--

Sample No. TOV2						
oscillogram	voltage	current	current	current	power	3rd harmonic amplitude
No.	kV	+ mA_{cr}	- mA_{cr}	mA_{rms}	W	µA
8	5,37	0,939	1,000	0,570	1,46	---

Sample No. TOV3						
oscillogram	voltage	current	current	current	power	3rd harmonic amplitude
No.	kV	+ mA_{cr}	- mA_{cr}	mA_{rms}	W	µA
9	5,45	0,922	1,00	0,571	1,43	---

Sample No. TOV4						
oscillogram	voltage	current	current	current	power	3rd harmonic amplitude
No.	kV	+ mA_{cr}	- mA_{cr}	mA_{rms}	W	µA
10	5,39	0,887	1,000	0,564	1,42	---

Sample No. TOV5						
oscillogram	voltage	current	current	current	power	3rd harmonic amplitude
No.	kV	+ mA_{cr}	- mA_{cr}	mA_{rms}	W	µA
11	5,38	0,860	1,000	0,560	1,37	---

Sample No. TOV6						
oscillogram	voltage	current	current	current	power	3rd harmonic amplitude
No.	kV	+ mA_{cr}	- mA_{cr}	mA_{rms}	W	µA
12	5,40	0,884	1,000	0,563	1,39	---

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Power frequency voltage versus time test.

Voltage correction factor and thermal energy calculations

Date: October 5, 2017

Sample	U_{ref} [1]	KU_r [2]	KU_C [3]	U_r' [4]	U_c' [5]
No.	kV			kV	kV
TOV1	5,47	1,077	0,861	5,891	4,710
TOV2	5,37			5,783	4,624
TOV3	5,45			5,870	4,692
TOV4	5,39			5,805	4,641
TOV5	5,38			5,794	4,632
TOV6	5,40			5,816	4,694

[1] U_{ref} : measured reference voltage
[2] KU_r : maximum guaranteed factor for calculation of Ur' – $U_r/U_{ref.min.}$
[3] KU_C : maximum guaranteed factor for calculation of Uc' – $U_c/U_{ref.min.}$
[4] U_r' : corrected rated voltage [4] = [1] × [2]
[5] U_c' : corrected continuous operating voltage [5] = [1] × [3]

Sample	U_r'	Requested thermal charge transfer, Q_{th}	Requested Q_{th} per impulse
No.	kV	C	C
TOV1	5,891	1,1	0,55 (±10%)
TOV2	5,783		0,55 (±10%)
TOV3	5,870		0,55 (±10%)
TOV4	5,805		0,55 (±10%)

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Power frequency voltage versus time test.

Application of two lightning current impulses 8/20µs, corrected rated voltage U_r' and corrected continuous operating U_c' for evaluation of the thermal stability.

Test circuit: A0124-A0020-A0130

Sample No.: TOV 1

Ambient temperature: 20 °C
Preheating temperature: 66 °C

Date: December 2, 2017

Lightning current impulses 8/20 µs application

Oscillogram	Impulse	Charging voltage	Residual voltage	Discharge current	Q_{th}	Applicable range for Q_{th}
No.	No.	kV	kV	kA	C	C
13	1	65,0 x 2	---	38,14	0,56	0,495÷0,605
14	2	65,0 x 2	---	38,07	0,55	0,495÷0,605

Current impulse waveshape (µs)
8,8 /18,2

Temporary overvoltage application

Amplitude claimed by the manufacturer **Ur' x 1,080 = 5,891 x 1,080 = 6,362 kV**
Duration claimed by the manufacturer **1 sec.**

Oscillogram	Time	U_r'	Current	Current
No.	s	kV	+ mA_{cr}	- mA_{cr}
15	0	6,362	145,0	221,0
16	1		132,0	164,0

Corrected continuous operating voltage U_c' application to evaluate the thermal stability

Oscillogram	Time	U_c'	Current	Current	Power	Temperature
No.	min	kV	+ mA_{cr}	- mA_{cr}	W	°C
17	0	4,710	0,98	0,99	1,10	---
	5		0,91	0,94	0,76	---
	10		0,90	0,93	0,64	---
18	15		0,88	0,91	0,59	---
	20		0,87	0,90	0,54	---
	25		0,86	0,89	0,50	---
19	30		0,85	0,88	0,48	---

Note : Before the injection of the energy, the temperature of the test sample has been checked with instrument type FLUKE 52II thermometer CESI no.30889

continued

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Continued

Sample No.: TOV2

Ambient temperature: 20 °C
Preheating temperature: 66 °C

Date: December 2, 2017

Lightning current impulses 8/20 µs application

Oscillogram	Impulse	Charging voltage	Residual voltage	Discharge current	Q_{th}	Applicable range for Q_{th}
No.	No.	kV	kV	kA	C	C
20	1	65,0 x 2	---	37,80	0,55	0,495÷0,605
21	2	65,0 x 2	---	37,80	0,55	0,495÷0,605

Current impulse waveshape (µs)
8,8 /18,2

Temporary overvoltage application

Amplitude claimed by the manufacturer **Ur' x 1,040 = 5,783 x 1,040 = 6,014 kV**
Duration claimed by the manufacturer **10 sec.**

Oscillogram	Time	U_r'	Current	Current
No.	s	kV	+ mA_{cr}	- mA_{cr}
22	0	6,014	80,0	118,0
23	10		51,0	67,0

Corrected continuous operating voltage U_c' application to evaluate the thermal stability

Oscillogram	Time	U_c'	Current	Current	Power	Temperature
No.	min	kV	+ mA_{cr}	- mA_{cr}	W	°C
24	0	4,624	0,98	1,20	1,70	---
	5		0,90	0,93	0,76	---
	10		0,89	0,91	0,65	---
25	15		0,88	0,90	0,58	---
	20		0,87	0,88	0,53	---
	25		0,86	0,87	0,50	---
26	30		0,85	0,87	0,48	---

Note : Before the injection of the energy, the temperature of the test sample has been checked with instrument type FLUKE 52II thermometer CESI no.30889

continued

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LAB N° 0030

Continued

Sample No.: TOV3

Ambient temperature: 20 °C
Preheating temperature: 66 °C

Date: December 2, 2017

Lightning current impulses 8/20 µs application

Oscillogram	Impulse	Charging voltage	Residual voltage	Discharge current	Q_{th}	Applicable range for Q_{th}
No.	No.	kV	kV	kA	C	C
27	1	65,0 x 2	---	37,83	0,55	0,495÷0,605
28	2	65,0 x 2	---	37,90	0,55	0,495÷0,605

Current impulse waveshape (µs)
8,8 /18,2

Temporary overvoltage application

Amplitude claimed by the manufacturer **Ur' x 1,000= 5,870 x 1,000 = 5,870 kV**
Duration claimed by the manufacturer **100 sec.**

Oscillogram	Time	U_r'	Current	Current
No.	s	kV	+ mA_{cr}	- mA_{cr}
29	0	5,870	43,0	86,0
30	100		87,0	17,0

Corrected continuous operating voltage U_c' application to evaluate the thermal stability

Oscillogram	Time	U_c'	Current	Current	Power	Temperature
No.	min	kV	+ mA_{cr}	- mA_{cr}	W	°C
31	0	4,692	0,92	0,93	0,70	---
	5		0,89	0,91	0,57	---
	10		0,88	0,90	0,52	---
32	15		0,88	0,89	0,48	---
	20		0,87	0,88	0,42	---
	25		0,86	0,87	0,40	---
33	30		0,85	0,86	0,37	---

Note : Before the injection of the energy, the temperature of the test sample has been checked with instrument type FLUKE 52II thermometer CESI no.30889

continued

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LAB N° 0030

Continued

Sample No.: TOV4

Ambient temperature: 20 °C
Preheating temperature: 66 °C

Date: December 4, 2017

Lightning current impulses 8/20 µs application

Oscillogram	Impulse	Charging voltage	Residual voltage	Discharge current	Q_{th}	Applicable range for Q_{th}
No.	No.	kV	kV	kA	C	C
34	1	65,0 x 2	---	38,06	0,56	0,495÷0,605
35	2	65,0 x 2	---	37,90	0,55	0,495÷0,605

Current impulse waveshape (µs)
8,8 /18,2

Temporary overvoltage application

Amplitude claimed by the manufacturer **Ur' x 0,960 = 5,805 x 0,960 = 5,573 kV**
Duration claimed by the manufacturer **1000 sec.**

Oscillogram	Time	U_r'	Current	Current
No.	s	kV	+ mA_{cr}	- mA_{cr}
36	0	5,573	30,0	55,0
37	1000		2,30	3,60

Corrected continuous operating voltage U_c' application to evaluate the thermal stability

Oscillogram	Time	U_c'	Current	Current	Power	Temperature
No.	min	kV	+ mA_{cr}	- mA_{cr}	W	°C
38	0	4,641	0,87	0,88	0,60	---
	5		0,86	0,88	0,56	---
	10		0,85	0,87	0,52	---
39	15		0,84	0,86	0,47	---
	20		0,83	0,85	0,44	---
	25		0,82	0,84	0,42	---
40	30		0,81	0,83	0,40	---

Note : Before the injection of the energy, the temperature of the test sample has been checked with instrument type FLUKE 52II thermometer CESI no.30889

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Power frequency voltage versus time test.

Application of the temporary overvoltage U_{TOV} and evaluation of thermal stability

(WITHOUT PRIOR DUTY TEST)

Test circuit: A0123-A0130-A0020

Sample No.: TOV5

Preheating temperature: 66 °C

Date: October 6, 2017

Temporary overvoltage application

Amplitude claimed by the manufacturer **Ur' x 1,130 = 5,794 x 1,130 = 6,547 kV**
Duration claimed by the manufacturer **10 sec.**

Oscillogram	Time	Voltage	Current	Current	Power
No.	s	kV	+ mA_{cr}	- mA_{cr}	W
41	0	6,547	193,0	200,0	---
42	10		167,0	176,0	

Corrected continuous operating voltage U_c' application to evaluate the thermal stability

Oscillogram	Time	U_c'	Current	Current	Power	Temperature
No.	min	kV	+ mA_{cr}	- mA_{cr}	W	°C
43	0,5	4,632	0,74	0,76	0,47	---
	5		0,73	0,75	0,46	---
	10		0,72	0,74	0,43	---
44	15		0,71	0,74	0,40	---
	20		0,71	0,73	0,36	---
	25		0,70	0,72	0,35	---
45	31		0,69	0,71	0,33	---

Note : Before the injection of the energy, the temperature of the test sample has been checked with instrument type FLUKE 52II thermometer CESI no.30889

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continued

Sample No.: TOV6

Preheating temperature: 66 °C

Date: October 6, 2017

Temporary overvoltage application

Amplitude claimed by the manufacturer **Ur' x 1,040 = 5,816 x 1,040 = 6,049 kV**
Duration claimed by the manufacturer **1000 sec.**

Oscillogram	Time	Voltage	Current	Current	Power
No.	s	kV	$+mA_{cr}$	$- mA_{cr}$	W
46	0	6,049	42,0	56,0	---
47	1000		33,0	38,0	

Corrected continuous operating voltage U_c' application to evaluate the thermal stability

Oscillogram	Time	U_c'	Current	Current	Power	Temperature
No.	min	kV	$+ mA_{cr}$	$- mA_{cr}$	W	°C
48	0	4,694	0,80	0,84	0,84	---
	5		0,78	0,81	0,69	---
	10		0,77	0,79	0,62	---
49	15		0,75	0,77	0,55	---
	20		0,74	0,76	0,50	---
	25		0,73	0,75	0,47	---
50	30		0,72	0,75	0,45	---

Note : Before the injection of the energy, the temperature of the test sample has been checked with instrument type FLUKE 52II thermometer CESI no.30889

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continued

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Power frequency voltage versus time test.

Lightning impulse residual voltage measurement after the test

Test circuit: A0120

Date: December 4, 2017

Sample	Requested current	Charging voltage	Oscillogram	Current waveshape	Discharge current	Residual Voltage
No.		kV	No.	µs	kA	kV
TOV1	I_n	24,8	51	8,6/18,3	10,18	14,26
TOV2		24,8	52		10,14	14,24
TOV3		24,8	53		10,10	14,38
TOV4		24,8	54		10,07	14,36
TOV5		24,6	55		10,04	14,00
TOV6		24,7	56		10,05	14,25

Notes:

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Power frequency voltage versus time test.

Additional two lightning impulses residual voltage measurement for check no damage occurred during the test

Test circuit: A0120

Date: December 4, 2017

Sample	Requested current	Charging voltage	Oscillogram	Current waveshape	Discharge current	Residual voltage
No.		kV	No.	µs	kA	kV
TOV1	5,26(*)	19,4	57	7,8/20,0	5,44	13,22
		19,4	58		5,36	13,26
TOV2		19,4	59		5,46	13,21
		19,4	60		5,42	13,24
TOV3		19,4	67		5,33	13,33
		19,4	68		5,28	13,30
TOV4		19,4	61		5,27	13,31
		19,4	62		5,27	13,34
TOV5		19,4	63		5,48	13,12
		19,4	64		5,45	13,10
TOV6		19,4	65		5,31	13,36
		19,4	66		5,28	13,29

Notes:

Requested current = 0,5 kA/cm2 x 10,52 cm2 = 5,26 kA

- -where 0,5 kA/cm2 is peak current density
- where 10,52 cm2 is surface area on the metal-oxide resistor used for this test declared by the manufacturer

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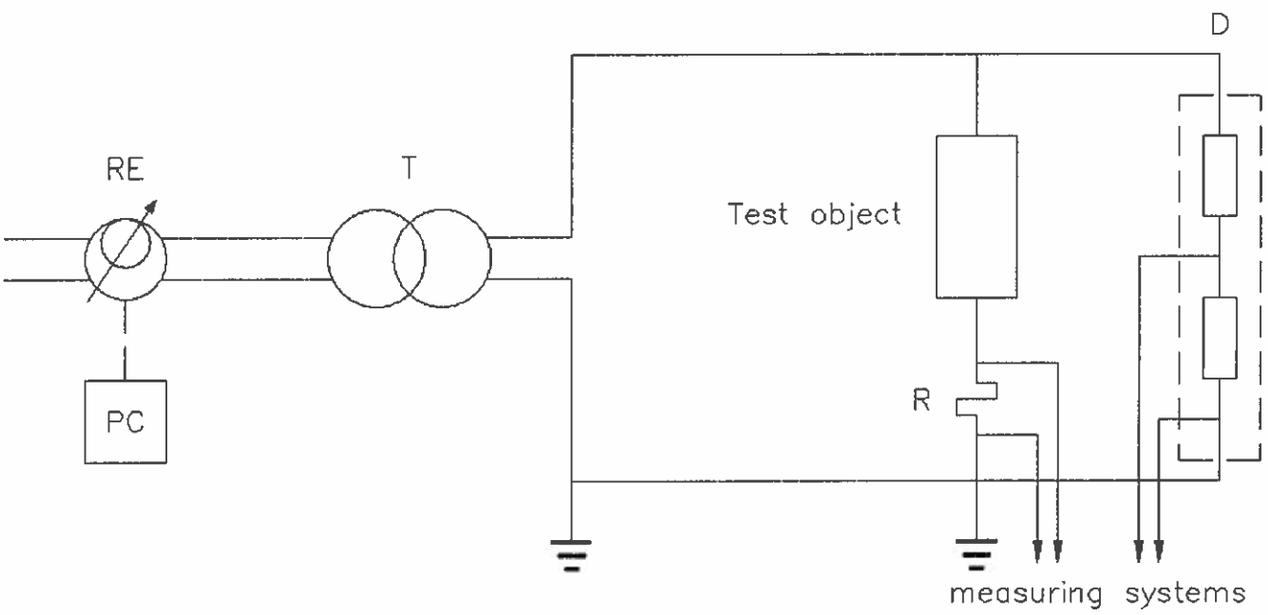
Circuit A0019



Power frequency supply

RE - programmable supply type PACIFIC A.C. Power Source 140 ASX.; CESI no. 0560408
PC - personal computer
T - voltage transformer type SPECIALTRASFO; power 30 kVA; voltage 200 V/15-30 kV

Current measuring system

R - Current shunt CESI No.31120; R= 940,5 Ω
- Electro optical system HBM CESI No. 57986(Rx) – 57987 (Tx)

OSC - Oscilloscope type NATIONAL INSTRUMENT NI PXI-1031/NI-PXI 8108/NI-PXI 5122;
- CESI No 056227- 0562226 (on channel No.1)

Voltage measuring system

D - Voltage divider SAGI; CESI No.11120
- Electro optical system type HBM CESI No. 57986(Rx) – 57991 (Tx)

OSC - Oscilloscope type NATIONAL INSTRUMENT NI PXI-1031/NI-PXI 8108/NI-PXI 5122;
- CESI No 056227- 0562226 (on channel No.2)

SOFTWARE SYSTEM:

SW - S.A.D. Surge arrester version 2.0

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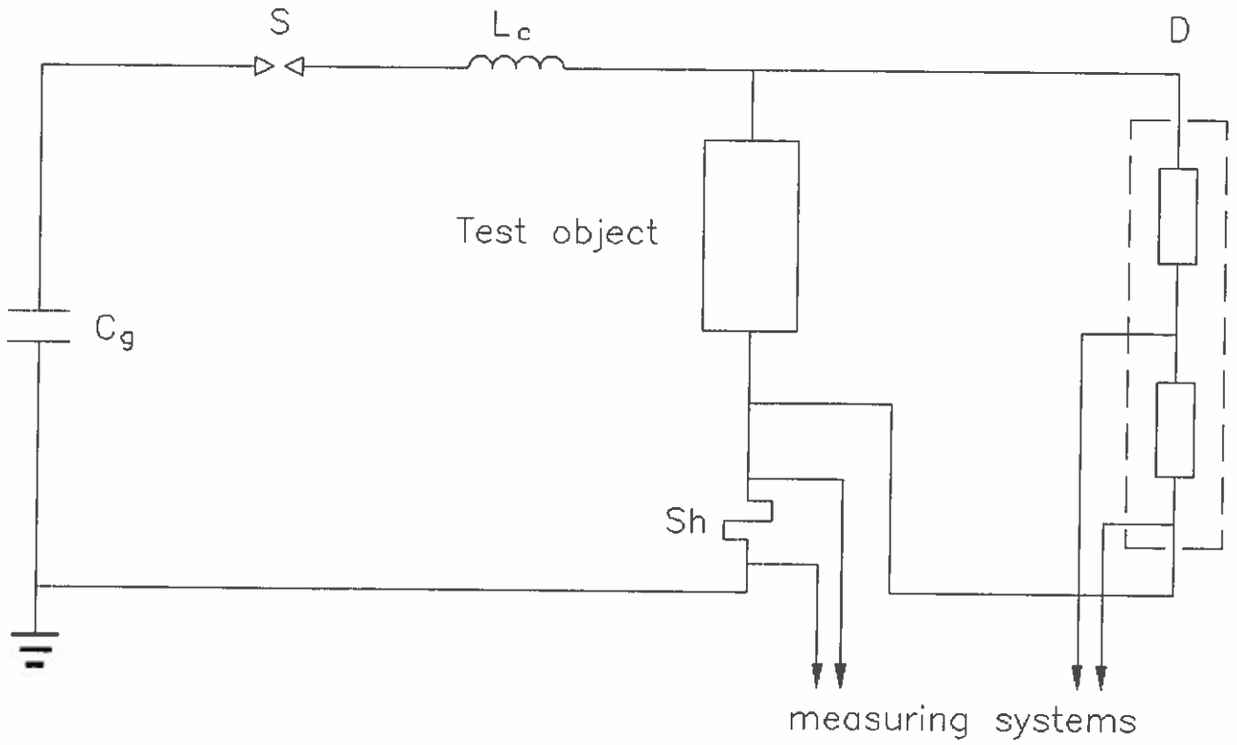
Circuit A0120



Impulse generator

No. of stages	1
Cg	6,64 µF
Lc	6 µH
S	- Spark-gap

Voltage measuring system.

D	- Voltage divider SAGI; CESI No.11120
	- Electro optical system type HBM CESI No. 57986(Rx) – 57991 (Tx)
OSC	- Oscilloscope type NATIONAL INSTRUMENT NI PXI-1031/NI-PXI 8108/NI-PXI 5122
	- CESI No 056227- 0562226 (on channel No.2)

Current measuring system

Sh	- Current shunt CESI No.6042; R= 2 mΩ; peak current= 250 kA
	- Electro optical system HBM CESI No. 57986(Rx) – 57987 (Tx)
OSC	- Oscilloscope type NATIONAL INSTRUMENT NI PXI-1031/NI-PXI 8108/NI-PXI 5152;
	- CESI No 056227- 0562226 (on channel No.1)

SOFTWARE SYSTEM:

SW - S.A.D. Surge arrester version 2.0

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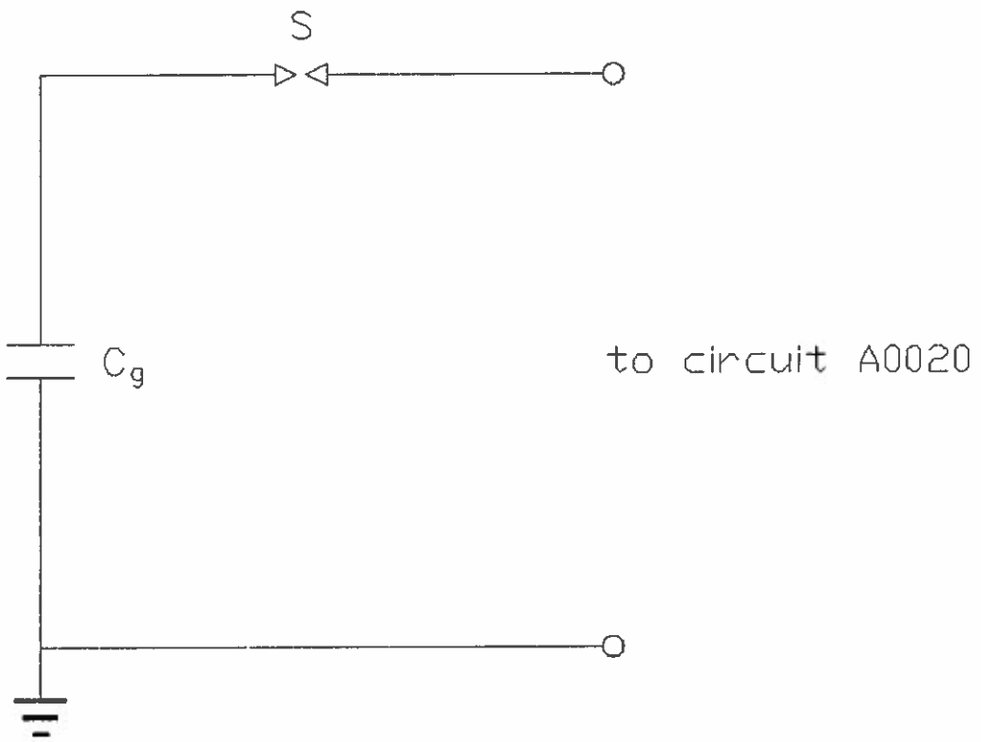
Circuit A0123



Impulse generator circuit for injection of Q_{th}

No. of stages 2
Cg 2,91 µF
Lc 12 µH

S - spark-gap

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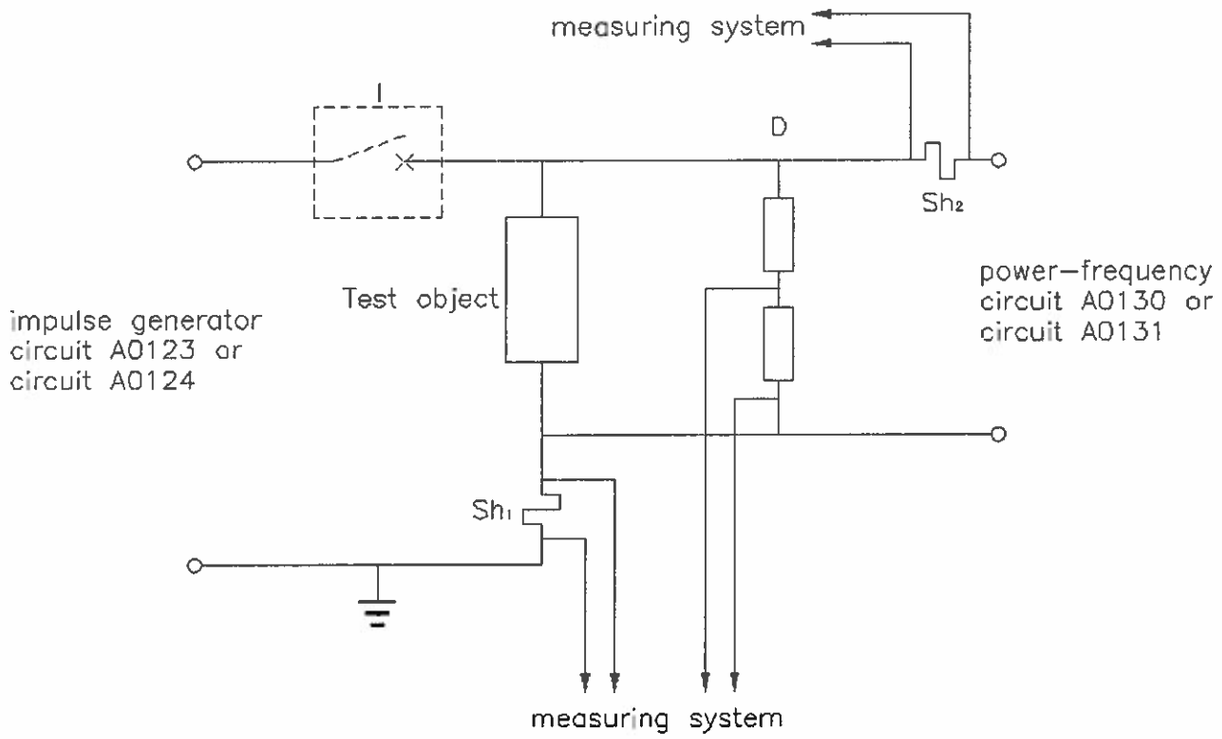
Circuit A0020



Impulse generator circuit A0123

Impulsive current measuring system

Sh_1	- Current shunt CESI No.6042; R= 2 m Ω
	- Electro optical system HBM CESI No. 57986(Rx) – 57987 (Tx)
$OSC_{2,3}$	- Oscilloscope type NATIONAL INSTRUMENT NI PXI-1031/NI-PXI 8108/NI-PXI 5122 - CESI No 056227- 0562226 (on channel No.2)
I	- Circuit-breaker

Power frequency circuit A0131

Voltage measuring system.

D	- Voltage divider SAGI; CESI No.11120
	- Electro optical system HBM CESI No. 57986(Rx) – 57991 (Tx)
$OSC_{2,3}$	- Oscilloscope type NATIONAL INSTRUMENT NI PXI-1031/NI-PXI 8108/NI-PXI 5122 - CESI No 056227- 0562226 (on channel No.2)

Current measuring system

Sh_2 (TOV - MCOV)	- Current shunt type CESI n. 058315 R= 500 Ω - Electro optical system CESI No. 57986(Rx) – 58294 (Tx)
$OSC_{2,3}$	- Oscilloscope type NATIONAL INSTRUMENT NI PXI-1031/NI-PXI 8108/NI-PXI 5122; - CESI No 056227- 0562226 (on channel No.1)

SOFTWARE SYSTEM:

SW - S.A.D. Surge arrester version 2.0

A1176IG

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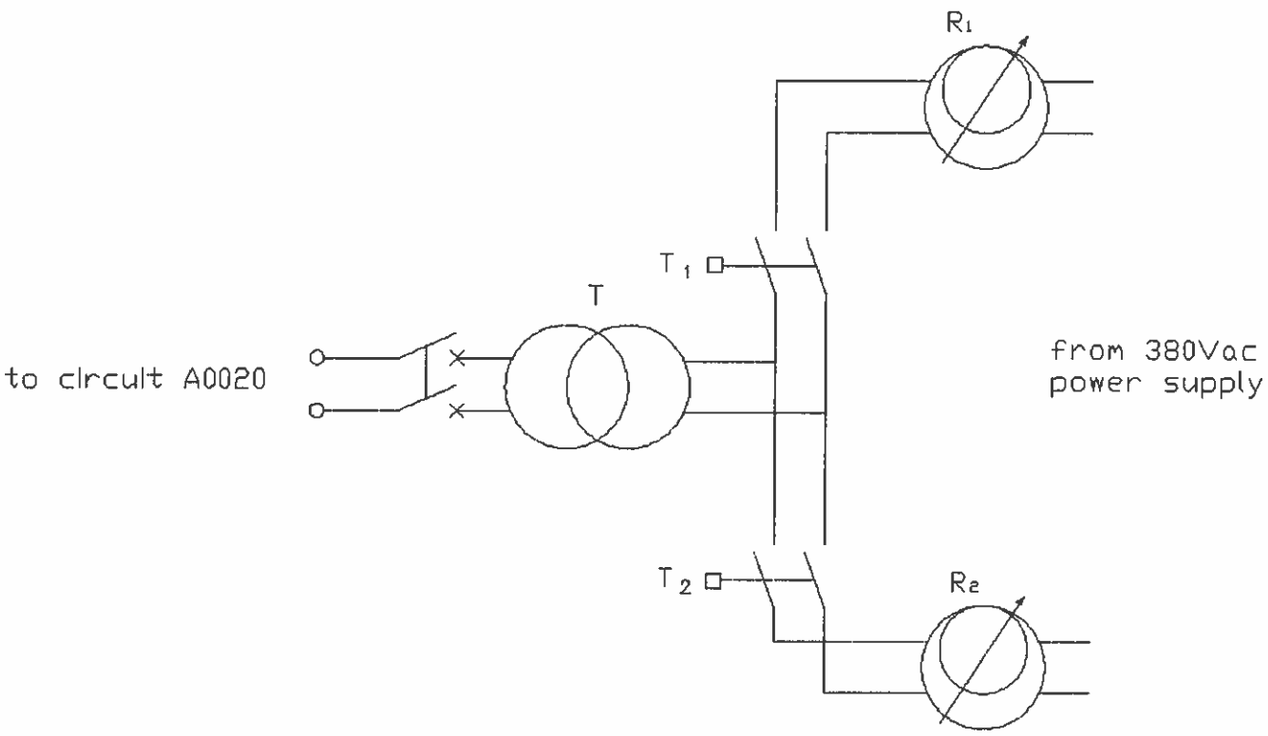
Circuit A0131



Power-frequancy circuit

from 380Vac power supply

R_1 single-phase voltage regulator CORMES; power 20 kVA; voltage 380/04220 Vac
R_2 single-phase voltage regulator CORMES; power 10 kVA; voltage 380/04220 Vac
T_1 voltage transformer type SPECIALTRASFO; power 30 kVA; voltage 200-400 V/15-30 kV

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