DNV·GL

KEMA REPORT OF PERFORMANCE

2314-19

Object	A three-phase oil-immersed power transformer
Type	TRP 80000-145/E **Serial No.** ET1036-464170
	140 kV ± 9 x 1,67% / 57,5 kV – 63 MVA / 80 MVA – YNd5 – 50 Hz
Client	Končar – Distribution and special transformers dd, Ulica Josipa Mokrovića 8, P.p. 100, 10090 Zagreb, Croatia
Manufacturer	Končar – Distribution and special transformers dd, Ulica Josipa Mokrovića 8, P.p. 100, 10090 Zagreb, Croatia *)
Tested by	KEMA B.V., Utrechtseweg 310, Arnhem, the Netherlands
Date of tests	10 July and 23 August 2019
Test specification	The tests have been carried out in accordance with IEC 60076-5:2006.
Summary and conclusion	The object has complied with the relevant requirements of the standard.

This report applies only to the object tested. The responsibility for conformity of any object having the same type references as that tested rests with the Manufacturer.

*) as declared by the manufacturer

This report consists of 108 pages in total.

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Date: 2023.07.03 11:54:30 EEST
Reason: MoldSign Signature
Location: Moldova

KEMA B.V.

Shankar Subramany
Director, High-Power Laboratory

KEMA Laboratories

Arnhem, 17 September 2019

INFORMATION SHEET

1 KEMA Type Test Certificate

A KEMA Type Test Certificate contains a record of a series of (type) tests carried out in accordance with a recognized standard. The object tested has fulfilled the requirements of this standard and the relevant ratings assigned by the manufacturer are endorsed by DNV GL. In addition, the object's technical drawings have been verified and the condition of the object after the tests is assessed and recorded. The Certificate contains the essential drawings and a description of the object tested. A KEMA Type Test Certificate signifies that the object meets all the requirements of the named subclauses of the standard. It can be identified by gold-embossed lettering on the cover and a gold seal on its front sheet.
The Certificate is applicable to the object tested only. DNV GL is responsible for the validity and the contents of the Certificate. The responsibility for conformity of any object having the same type references as the one tested rests with the manufacturer.
Detailed rules on types of certification are given in DNV GL's Certification procedure applicable to KEMA Laboratories.

2 KEMA Report of Performance

A KEMA Report of Performance is issued when an object has successfully completed and passed a subset (but not all) of test programmes in accordance with a recognized standard. In addition, the object's technical drawings have been verified and the condition of the object after the tests is assessed and recorded. The report is applicable to the object tested only. A KEMA Report of Performance signifies that the object meets the requirements of the named subclauses of the standard. It can be identified by silver-embossed lettering on the cover and a silver seal on its front sheet.
The sentence on the front sheet of a KEMA Report of Performance will state that the tests have been carried out in accordance with …… The object has complied with the relevant requirements.

3 KEMA Test Report

A KEMA Test Report is issued in all other cases. Reasons for issuing a KEMA Test Report could be:

- Tests were performed according to the client's instructions.
- Tests were performed only partially according to the standard.
- No technical drawings were submitted for verification and/or no assessment of the condition of the object after the tests was performed.
- The object failed one or more of the performed tests.

The KEMA Test Report can be identified by the grey-embossed lettering on the cover and grey seal on its front sheet.
In case the number of tests, the test procedure and the test parameters are based on a recognized standard and related to the ratings assigned by the manufacturer, the following sentence will appear on the front sheet. The tests have been carried out in accordance with the client's instructions. Test procedure and test parameters were based on ..... If the object does not pass the tests such behaviour will be mentioned on the front sheet. Verification of the drawings (if submitted) and assessment of the condition after the tests is only done on client's request.
When the tests, test procedure and/or test parameters are not in accordance with a recognized standard, the front sheet will state the tests have been carried out in accordance with client's instructions.

4 Official and uncontrolled test documents

The official test documents of DNV GL are issued in bound form. Uncontrolled copies may be provided as a digital file for convenience of reproduction by the client. The copyright has to be respected at all times.

5 Accreditation of KEMA Laboratories

The KEMA Laboratories of DNV GL are accredited in accordance with ISO/IEC 17025 by the respective national accreditation bodies. KEMA Laboratories Arnhem, the Netherlands, is accredited by RvA under nos. L020, L218, K006 and K009. KEMA Laboratories Chalfont, United States, is accredited by A2LA under no. 0553.01. KEMA Laboratories Prague, the Czech Republic, is accredited by CAI as testing laboratory no. 1035.

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1 IDENTIFICATION OF THE OBJECT TESTED

1.1 Ratings/characteristics of the object tested

Rated voltage	
• HV side	140 kV
• LV side	57,5 kV
Tapping range HV	± 9 x 1,67 %
Rated power HV	
• ONAN	63 MVA
• ONAF	80 MVA
Short-circuit impedance at principal tapping (measured during routine tests at 80 MVA)	
• HV-LV winding	12,62 %
Short-circuit impedance at principal tapping (guaranteed value)	
• HV-LV winding	12,00 %
Connection and phase displacement symbol	YNd5
Rated frequency	50 Hz
Category	II
Maximum system short-circuit power	10000 MVA
Guaranteed maximum temperature rise	
• top liquid	60 K
• HV windings	≤ 65 K
• LV windings	≤ 65 K
Insulation levels HV	
• LI	550 kV
• AC	230 kV
Insulation levels LV	
• LI	325 kV
• AC	140 kV
Insulation levels Neutral	
• LI	250 kV
• AC	95 kV
Insulation class	A

1.2 Description of the object tested

A three-phase oil-immersed power transformer

Manufacturing year	2019
Number of phases	3
Rated current	
• HV side	329,9 A
• LV side	803 A
Total mass	98500 kg
Winding material	
• HV side	Cu
• LV side	Cu
LV conductor type	Wire
Coil geometry	Circular
Insulating liquid	
• mass	18500 kg
• type	Ergon Hyvolt III
• standard	IEC 60296
Highest voltages (U_m)	145 kV

Current transformers	
• location	HV phases 1U and 1W
• ratio	500/2/1/1/1 A
• accuracy class	0.2sFs5/5P20/5P20/5P20/5P20
• rated output (VA rating)	10/20/20/20 VA
• location	HV phase 1V
• ratio	390/2 A + 500/2/1/1/1 A
• accuracy class	3Fs5 + 0.2sFs5/5P20/5P20/5P20/5P20
• rated output (VA rating)	10 VA + 10/20/20/20 VA
• location	HV neutral 1N
• ratio	500/1/1 A
• accuracy class	5P20/5P20
• rated output (VA rating)	20/20 VA
• location	LV phases 2U and 2W
• ratio	1200/2/1/1 A
• accuracy class	0.2sFs5/5P20/5P20
• rated output (VA rating)	10/20/20 VA
• location	LV phase 2V
• ratio	805/2 A + 1200/2/1/1 A
• accuracy class	3Fs5 + 0.2sFs5/5P20/5P20
• rated output (VA rating)	10 VA + 10/20/20 VA

1.3 List of drawings

The manufacturer has guaranteed that the object submitted for tests has been manufactured in accordance with the following drawings and/or documents. KEMA Laboratories has verified that these drawings and/or documents adequately represent the object tested. The manufacturer is responsible for the correctness of these drawings and/or documents and the technical data presented.

The following drawings and/or documents have been included in this report:

Drawing no./document no.	Revision
B60448	C
B72690	0

The following drawings and/or documents have been stamped by KEMA Laboratories and returned to the manufacturer:

Drawing no./document no.	Revision
B76859	C
665123	A
B77055	C
665124	A
B75828	A

2 GENERAL INFORMATION

2.1 The tests were witnessed by

Name	Company
Banjac, I. Gasic, D. Gojevic, V. Maljkovic, V.	Končar, Zagreb, Croatia
Nordmark, R.B.	E.ON Energidistribution, Vaxje, Sweden
Liljekvist, M.	E.ON Energidistribution, Malmo, Sweden
Helmer, T. Helmer, M.	Helmerverken, Partille, Sweden

2.2 The tests were carried out under responsibility of

Routine tests carried out before the short-circuit tests

The routine tests carried out before the short-circuit tests were not witnessed by a KEMA Laboratories inspector.

Short-circuit tests

Name	Company
Petropoulos, D.	KEMA B.V., Arnhem, The Netherlands

Routine tests carried out after the short-circuit tests witnessed by

Name	Company
Hanique, E.	KEMA B.V., Arnhem, The Netherlands

2.3 Reference to other reports

Report No	Tests performed
3085-19	Sound level measurement Temperature-rise test

2.4 Subcontracting

The DGA measurement was subcontracted to DNV GL – Energy Advisory.

2.5 The transformer was inspected by

Name	Company
Hanique, E.	KEMA B.V., Arnhem, the Netherlands

2.6 Accuracy of measurement

The guaranteed uncertainty for the measured voltages and currents taking into account the total measuring system, is less than 5%, unless mentioned otherwise.

3 LEGEND

Phase indications

If more than one phase is recorded on oscillogram, the phases are indicated by the digits 1, 2 and 3. These phases 1, 2 and 3 correspond to the phase values in the columns of the accompanying table, respectively from left to right.

Explanation of the letter symbols and abbreviations on the oscillograms

pu	Per unit (the reference length of one unit is represented by the black bar on the oscillogram)
Buch1	Buchholz gas-and oil-actuated relay
Buch2	Buchholz gas-and oil-actuated relay
I1pri	Primary current transformer
I1sec	Secondary current transformer
I2pri	Primary current transformer
I2sec	Secondary current transformer
I3pri	Primary current transformer
I3sec	Secondary current transformer
Itank	Tank current test object
U1S	Supply voltage
U2S	Supply voltage
U3S	Supply voltage

4 REACTANCE MEASUREMENT OVERVIEW

Tap position 1

Test number	Reactance					
	Measured between the phases			Change measured		
	Ω			%		
	U-N	V-N	W-N	U-N	V-N	W-N
Before tests	44,99	44,74	44,43	-	-	-
190710-4005	44,91	44,76	44,43	-0,18	0,05	0,00
190710-4006	44,91	44,75	44,43	-0,17	0,02	-0,01
190710-4007	44,91	44,75	44,43	-0,17	0,03	-0,02
After tests	45,03	44,75	44,43	0,08	0,02	-0,01

Tap position 10

Test number	Reactance					
	Measured between the phases			Change measured		
	Ω			%		
	U-N	V-N	W-N	U-N	V-N	W-N
Before tests	31,20	30,81	30,70	-	-	-
190710-4009	31,21	30,81	30,70	0,04	0,01	0,01
190710-4010	31,20	30,81	30,72	-0,01	0,03	0,05
190710-4011	31,20	30,82	30,71	0,01	0,03	0,04
After tests	31,22	30,82	30,71	0,07	0,06	0,02

Tap position 19

Test number	Reactance					
	Measured between the phases			Change measured		
	Ω			%		
	U-N	V-N	W-N	U-N	V-N	W-N
Before tests	21,06	20,72	20,66	-	-	-
190710-4013	21,06	20,72	20,68	0,01	-0,04	0,11
190710-4014	21,06	20,72	20,69	0,00	-0,04	0,12
190710-4015	21,07	20,71	20,69	0,02	-0,05	0,14
After tests	21,07	20,71	20,69	0,02	-0,05	0,14

Maximum deviation

The maximum deviation in reactance measured was 0,18%.

The maximum deviation allowed in accordance with IEC 60076-5 is 2%.

5 CALCULATION SHEET SHORT-CIRCUIT CURRENT

System power of: 10000 MVA
System voltage of: 145 kV

Tap position	1 Max.	10 Nom.	19 Min.
Tap voltage	161,04 kV	140,00 kV	118,96 kV
Impedance voltage	13,80%	12,62%	11,76%
Resistance (75 °C)	0,28%	0,27%	0,28%

Tap position 1 Max.

Supply voltage: 161,04 kV
Terminal voltage: 153,81 kV

Short-circuit current	Minimum value	Rated	Maximum value
HV current	1786,5 A	1985,0 A	2183,5 A
HV current peak	4,81 kA	5,06 kA	5,31 kA
LV current	5,00 kA	5,56 kA	6,12 kA

HV reactance: 44,73 Ω
HV inductance: 142,37 mH

Tap position 10 Nom.

Supply voltage: 140,00 kV
Terminal voltage: 131,09 kV

Short-circuit current	Minimum value	Rated	Maximum value
HV current	2203,0 A	2447,8 A	2692,5 A
HV current peak	5,93 kA	6,24 kA	6,55 kA
LV current	5,36 kA	5,96 kA	6,56 kA

HV reactance: 30,91 Ω
HV inductance: 98,40 mH

Tap position 19 Min.

Supply voltage: 118,96 kV
Terminal voltage: 108,04 kV

Short-circuit current	Minimum value	Rated	Maximum value
HV current	2698,7 A	2998,6 A	3298,4 A
HV current peak	7,26 kA	7,65 kA	8,03 kA
LV current	5,58 kA	6,20 kA	6,82 kA

HV reactance: 20,80 Ω
HV inductance: 66,20 mH

Peak factor according to IEC = 2,55
Peak factor according to X/R = 2,74

Z_{supply} / $Z_{transformer}$ = 6,80%

6 SUMMARY OF TESTS

Short-circuit tests								
Test no.			190710 4005	190710 4006	190710 4007	190710 4009	190710 4010	190710 4011
Tap position			1	1	1	10	10	10
	U	kV_{RMS}	84,0	84,6	84,6	70,5	70,3	70,4
Applied voltage, phase-to-ground, beginning	V	kV_{RMS}	82,9	83,8	83,5	70,3	70,2	70,3
	W	kV_{RMS}	84,3	85,3	84,9	70,9	70,8	70,9
	U	kV_{RMS}	82,6	83,3	83,1	69,4	69,3	69,4
Applied voltage, phase-to-ground, end	V	kV_{RMS}	82,1	82,9	82,6	69,0	69,0	69,0
	W	kV_{RMS}	83,7	84,4	84,2	69,9	69,8	69,8
	U	A_{peak}	-5147	5241	-5164	4974	-4920	4958
Current, HV winding	V	A_{peak}	3843	-3725	3756	-6420	6373	-6389
	W	A_{peak}	4095	-4266	4232	4780	-4782	4767
	U	A_{RMS}	1840	1865	1854	2249	2246	2249
Current, a.c. component, HV winding, beginning	V	A_{RMS}	1851	1865	1864	2258	2254	2257
	W	A_{RMS}	1870	1885	1884	2277	2277	2275
	U	A_{RMS}	1827	1847	1839	2224	2222	2222
Current, a.c. component, HV winding, end	V	A_{RMS}	1833	1848	1846	2230	2227	2229
	W	A_{RMS}	1854	1869	1867	2248	2249	2247
	U	A_{RMS}	1840	1865	1853	2249	2246	2248
Current, a.c. component, HV winding, average	V	A_{RMS}	1850	1865	1864	2257	2253	2256
	W	A_{RMS}	1870	1886	1884	2275	2276	2275
	U	kA_{peak}	14,2	-14,3	14,5	-8,37	8,30	-8,37
Current, LV winding	V	kA_{peak}	-13,6	13,5	-13,5	14,9	-14,7	14,8
	W	kA_{peak}	-7,89	8,49	-8,33	-14,5	14,5	-14,4
	U	kA_{RMS}	5,39	5,41	5,40	5,58	5,56	5,56
Current, a.c. component, LV winding, beginning	V	kA_{RMS}	5,40	5,40	5,39	5,52	5,51	5,52
	W	kA_{RMS}	5,24	5,28	5,27	5,55	5,54	5,54
	U	kA_{RMS}	5,28	5,33	5,33	5,50	5,50	5,50
Current, a.c. component, LV winding, end	V	kA_{RMS}	5,34	5,37	5,34	5,44	5,44	5,44
	W	kA_{RMS}	5,18	5,22	5,22	5,46	5,46	5,46
	U	kA_{RMS}	5,33	5,31	5,39	5,47	5,47	5,47
Current, a.c. component, LV winding, average	V	kA_{RMS}	5,37	5,38	5,41	5,37	5,51	5,51
	W	kA_{RMS}	5,19	5,28	5,24	5,54	5,54	5,54
	U	s	0,255	0,255	0,255	0,252	0,252	0,252
Duration, current	V	s	0,255	0,255	0,255	0,252	0,252	0,252
	W	s	0,255	0,255	0,256	0,252	0,252	0,252

Observations	
190710-4005	No visible disturbance.
190710-4006	No visible disturbance.
190710-4007	No visible disturbance.
190710-4009	No visible disturbance.
190710-4010	No visible disturbance.
190710-4011	No visible disturbance.

Short-circuit tests (continued)								
Test no.			190710 4013	190710 4014	190710 4015			
Tap position			19	19	19			
	U	kV_{RMS}	57,0	57,0	57,7			
Applied voltage, phase-to-ground, beginning	V	kV_{RMS}	56,6	56,5	57,2			
	W	kV_{RMS}	57,7	57,6	58,3			
	U	kV_{RMS}	56,1	56,0	57,1			
Applied voltage, phase-to-ground, end	V	kV_{RMS}	55,6	55,5	56,5			
	W	kV_{RMS}	56,4	56,3	57,5			
	U	A_{peak}	5692	-5658	5749			
Current, HV winding	V	A_{peak}	6248	-6282	6312			
	W	A_{peak}	-7965	7974	-8001			
	U	A_{RMS}	2712	2705	2739			
Current, a.c. component, HV winding, beginning	V	A_{RMS}	2715	2710	2744			
	W	A_{RMS}	2751	2737	2774			
	U	A_{RMS}	2699	2699	2717			
Current, a.c. component, HV winding, end	V	A_{RMS}	2702	2700	2723			
	W	A_{RMS}	2703	2705	2747			
	U	A_{RMS}	2710	2704	2744			
Current, a.c. component, HV winding, average	V	A_{RMS}	2712	2710	2749			
	W	A_{RMS}	2743	2735	2777			
	U	kA_{peak}	-15,1	15,1	-15,2			
Current, LV winding	V	kA_{peak}	-8,87	8,94	-8,95			
	W	kA_{peak}	15,8	-15,8	15,9			
	U	kA_{RMS}	5,68	5,67	5,74			
Current, a.c. component, LV winding, beginning	V	kA_{RMS}	5,61	5,61	5,67			
	W	kA_{RMS}	5,66	5,65	5,72			
	U	kA_{RMS}	5,57	5,56	5,67			
Current, a.c. component, LV winding, end	V	kA_{RMS}	5,53	5,52	5,62			
	W	kA_{RMS}	5,57	5,55	5,66			
	U	kA_{RMS}	5,66	5,64	5,73			
Current, a.c. component, LV winding, average	V	kA_{RMS}	5,61	5,60	5,68			
	W	kA_{RMS}	5,66	5,64	5,73			
	U	s	0,250	0,249	0,249			
Duration, current	V	s	0,250	0,249	0,249			
	W	s	0,250	0,249	0,249			

Observations	
190710-4013	No visible disturbance.
190710-4014	No visible disturbance.
190710-4015	No visible disturbance.

7 SHORT-CIRCUIT TESTS

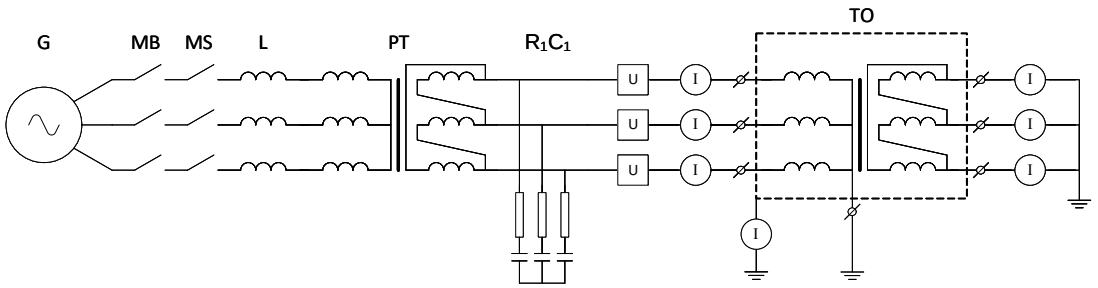
Standard and date

Standard	IEC 60076-5
Test date	10 July 2019

7.1 Condition before test

Transformer previously subjected to routine tests, carried out at the factory of the manufacturer without presence of a KEMA Laboratories inspector.
Supply to HV windings.
LV windings pre-set short-circuited by means of shunts and earthed.
Neutral terminal earthed.
Tank earthed.

7.2 Test circuit S01



G	= Generator	TO	= Test Object	U	= Voltage Measurement to earth
MB	= Master Breaker	L	= Reactor	I	= Current Measurement
MS	= Make Switch	R	= Resistor		
PT	= Power Transformer	C	= Capacitor		

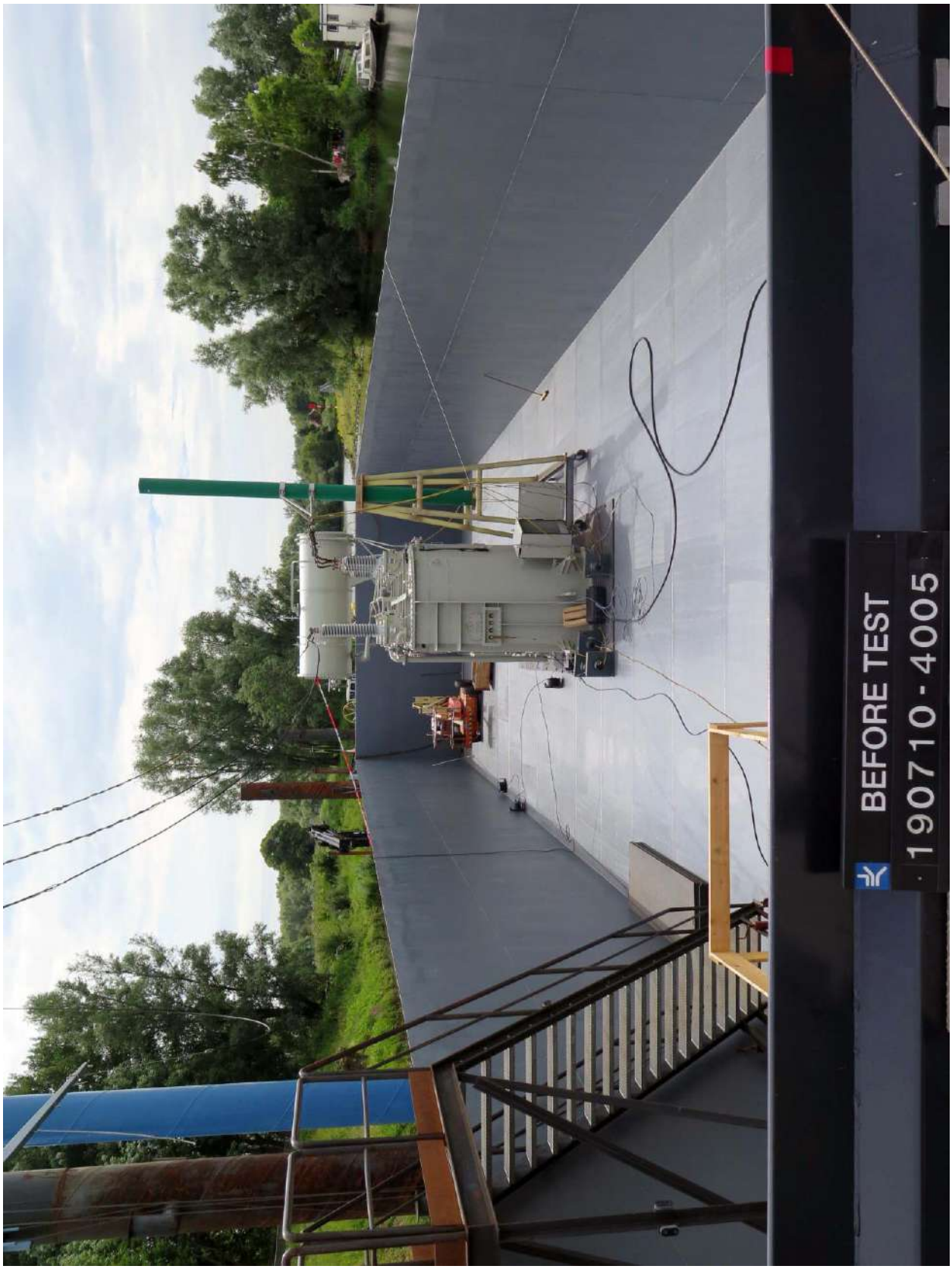
Supply		
Power	MVA	2234
Frequency	Hz	50
Phase(s)		3
Voltage	kV	250
Current	kA	5,16
Impedance	Ω	28
Power factor		< 0,1
Neutral		isolated

Voltage control elements added (supply)		
C_1	µF	0,2
R_1	Ω	282

Load	
Short-circuit point	earthed

Remarks: -

7.3 Photographs before test



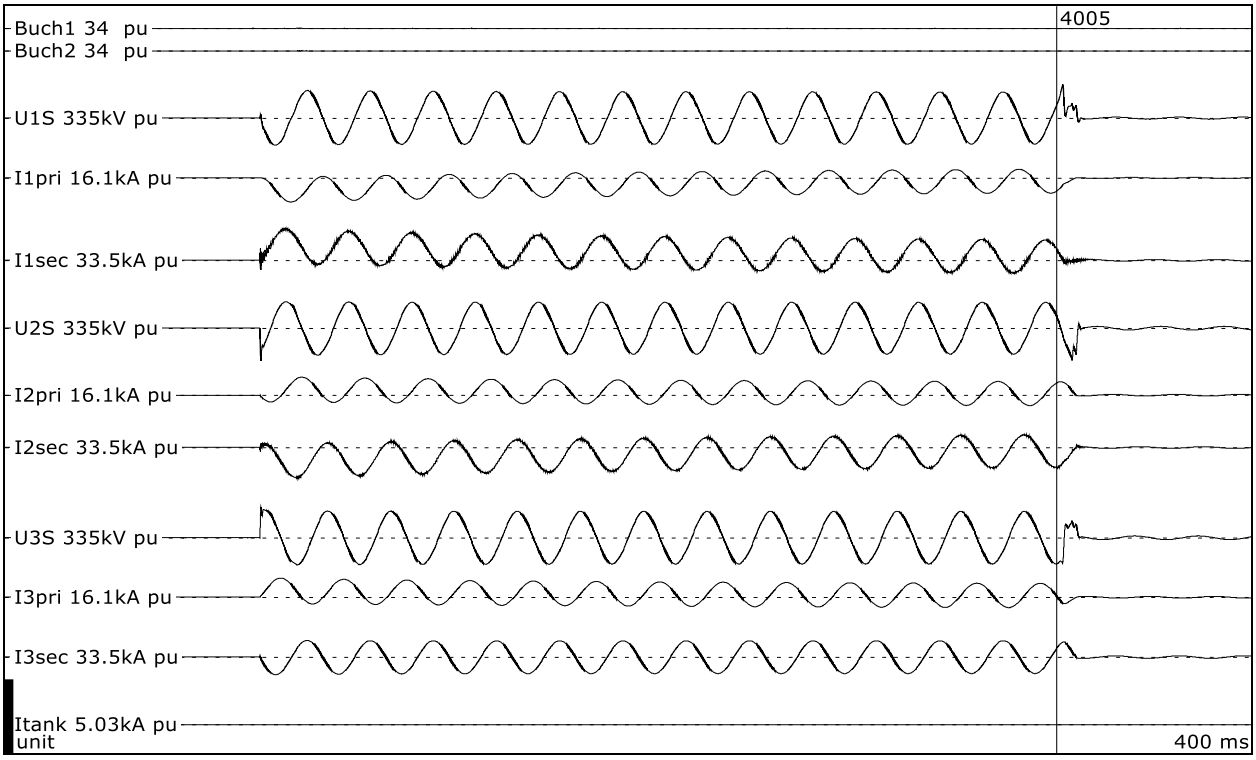

BEFORE TEST
190710 - 4005

7.4 Test results and oscillograms

Overview of test numbers
190710-4005 to 4007, 4009 to 4011, 4013 to 4015

Remarks
-

Short-circuit test

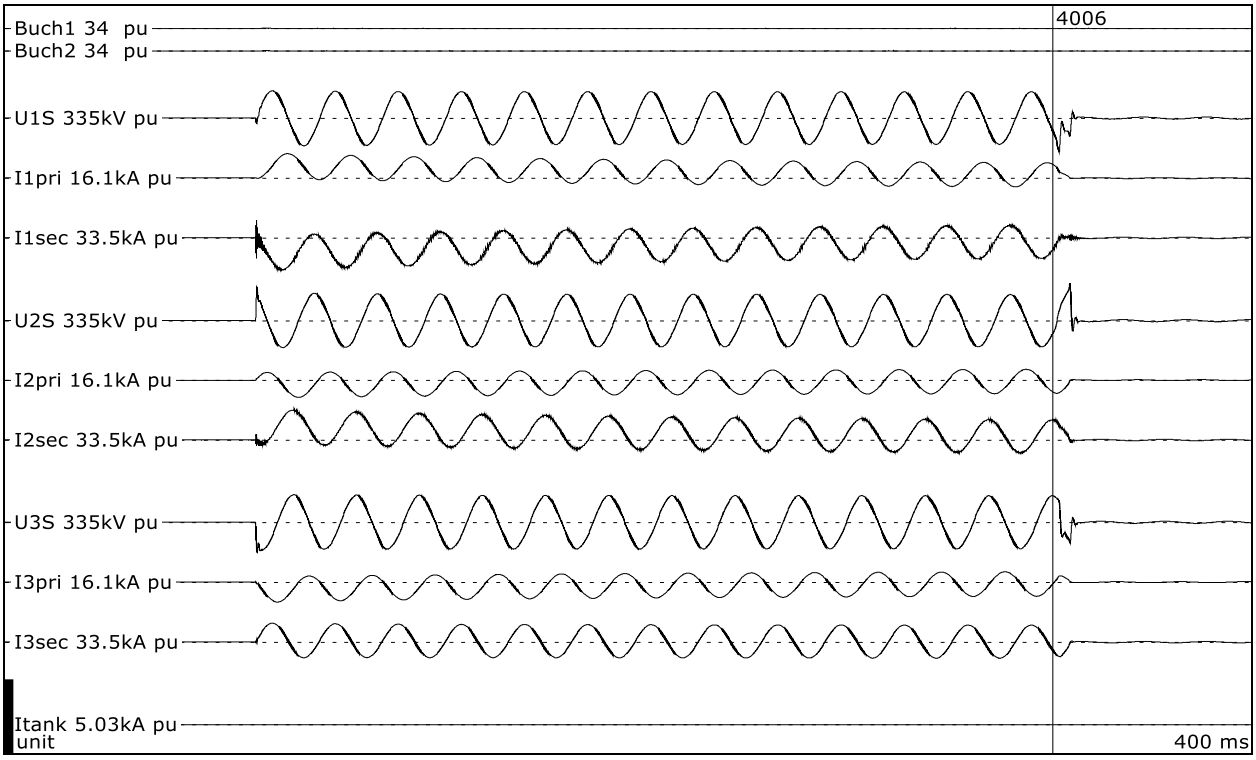


Test number: 190710-4005

Phase		**U**	**V**	**W**
Tap position		1		
Applied voltage, phase-to-ground, beginning	kV_{RMS}	84,0	82,9	84,3
Applied voltage, phase-to-ground, end	kV_{RMS}	82,6	82,1	83,7
Current, HV winding	A_{peak}	-5147	3843	4095
Current, a.c. component, HV winding, beginning	A_{RMS}	1840	1851	1870
Current, a.c. component, HV winding, end	A_{RMS}	1827	1833	1854
Current, a.c. component, HV winding, average	A_{RMS}	1840	1850	1870
Current, LV winding	kA_{peak}	14,2	-13,6	-7,89
Current, a.c. component, LV winding, beginning	kA_{RMS}	5,39	5,40	5,24
Current, a.c. component, LV winding, end	kA_{RMS}	5,28	5,34	5,18
Current, a.c. component, LV winding, average	kA_{RMS}	5,33	5,37	5,19
Duration, current	s	0,255	0,255	0,255

Observations: No visible disturbance.

Short-circuit test

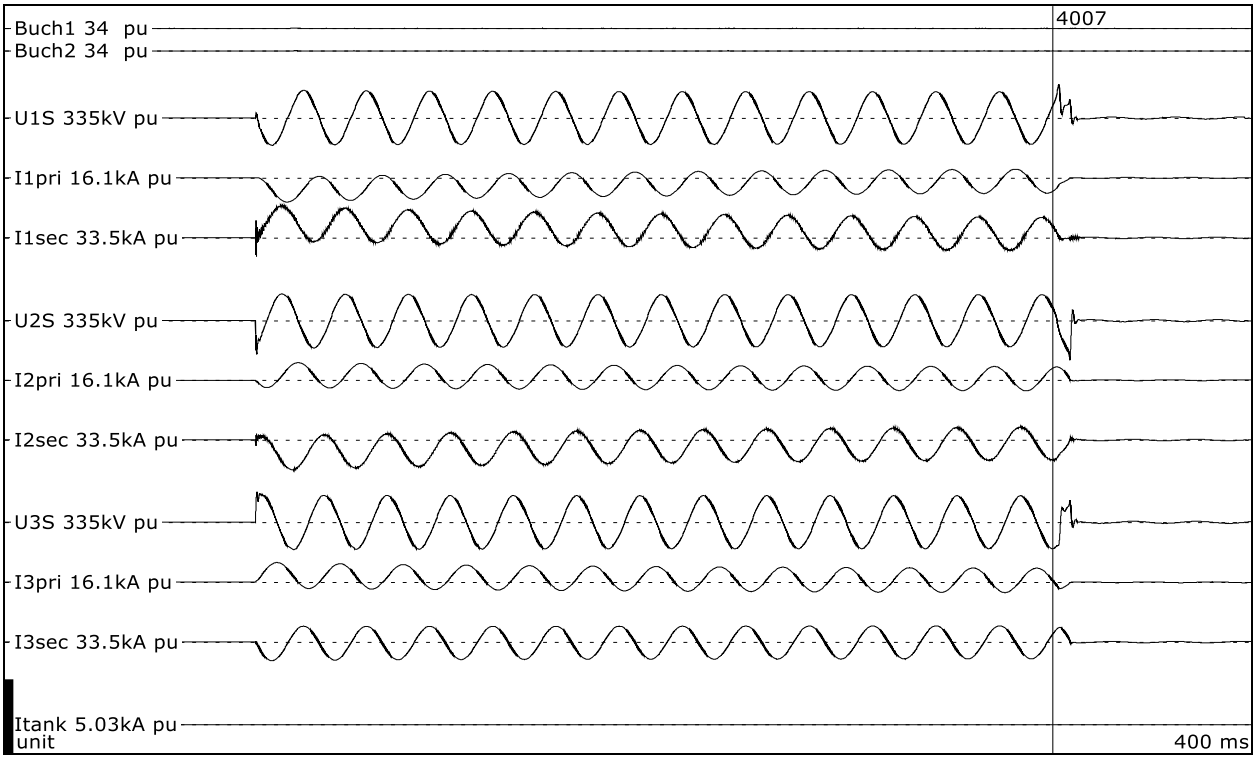


Test number: 190710-4006

Phase		**U**	**V**	**W**
Tap position		1		
Applied voltage, phase-to-ground, beginning	kV_{RMS}	84,6	83,8	85,3
Applied voltage, phase-to-ground, end	kV_{RMS}	83,3	82,9	84,4
Current, HV winding	A_{peak}	5241	-3725	-4266
Current, a.c. component, HV winding, beginning	A_{RMS}	1865	1865	1885
Current, a.c. component, HV winding, end	A_{RMS}	1847	1848	1869
Current, a.c. component, HV winding, average	A_{RMS}	1865	1865	1886
Current, LV winding	kA_{peak}	-14,3	13,5	8,49
Current, a.c. component, LV winding, beginning	kA_{RMS}	5,41	5,40	5,28
Current, a.c. component, LV winding, end	kA_{RMS}	5,33	5,37	5,22
Current, a.c. component, LV winding, average	kA_{RMS}	5,31	5,38	5,28
Duration, current	s	0,255	0,255	0,255

Observations: No visible disturbance.

Short-circuit test

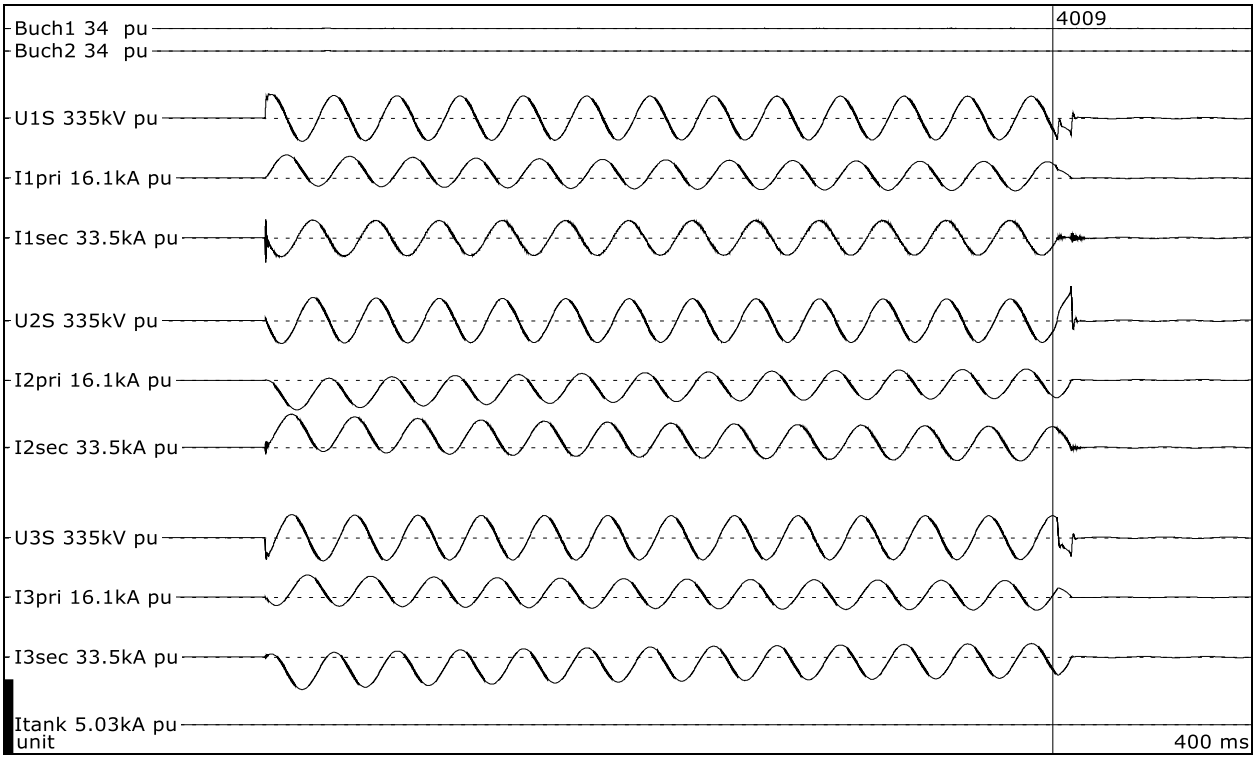


Test number: 190710-4007

Phase		**U**	**V**	**W**
Tap position		1		
Applied voltage, phase-to-ground, beginning	kV_{RMS}	84,6	83,5	84,9
Applied voltage, phase-to-ground, end	kV_{RMS}	83,1	82,6	84,2
Current, HV winding	A_{peak}	-5164	3756	4232
Current, a.c. component, HV winding, beginning	A_{RMS}	1854	1864	1884
Current, a.c. component, HV winding, end	A_{RMS}	1839	1846	1867
Current, a.c. component, HV winding, average	A_{RMS}	1853	1864	1884
Current, LV winding	kA_{peak}	14,5	-13,5	-8,33
Current, a.c. component, LV winding, beginning	kA_{RMS}	5,40	5,39	5,27
Current, a.c. component, LV winding, end	kA_{RMS}	5,33	5,34	5,22
Current, a.c. component, LV winding, average	kA_{RMS}	5,39	5,41	5,24
Duration, current	s	0,255	0,255	0,256

Observations: No visible disturbance.

Short-circuit test

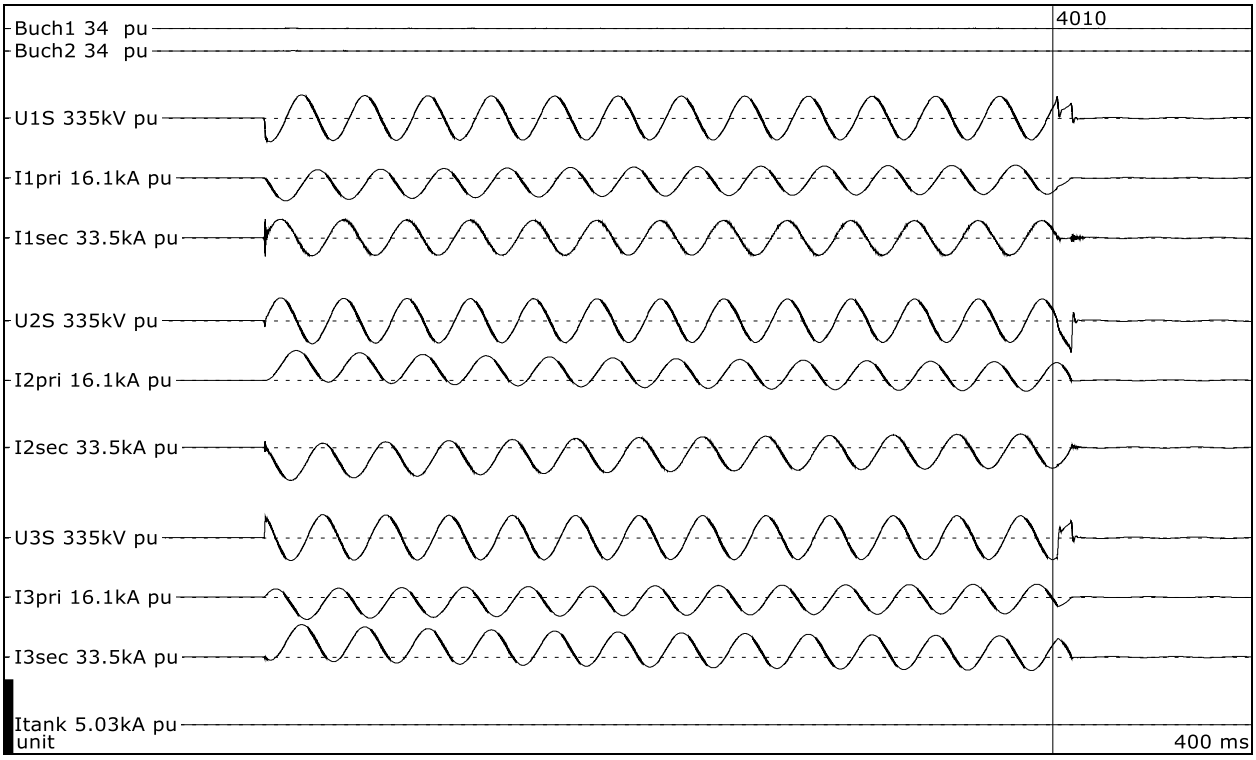


Test number: 190710-4009

Phase		**U**	**V**	**W**
Tap position		10		
Applied voltage, phase-to-ground, beginning	kV_{RMS}	70,5	70,3	70,9
Applied voltage, phase-to-ground, end	kV_{RMS}	69,4	69,0	69,9
Current, HV winding	A_{peak}	4974	-6420	4780
Current, a.c. component, HV winding, beginning	A_{RMS}	2249	2258	2277
Current, a.c. component, HV winding, end	A_{RMS}	2224	2230	2248
Current, a.c. component, HV winding, average	A_{RMS}	2249	2257	2275
Current, LV winding	kA_{peak}	-8,37	14,9	-14,5
Current, a.c. component, LV winding, beginning	kA_{RMS}	5,58	5,52	5,55
Current, a.c. component, LV winding, end	kA_{RMS}	5,50	5,44	5,46
Current, a.c. component, LV winding, average	kA_{RMS}	5,47	5,37	5,54
Duration, current	s	0,252	0,252	0,252

Observations: No visible disturbance.

Short-circuit test

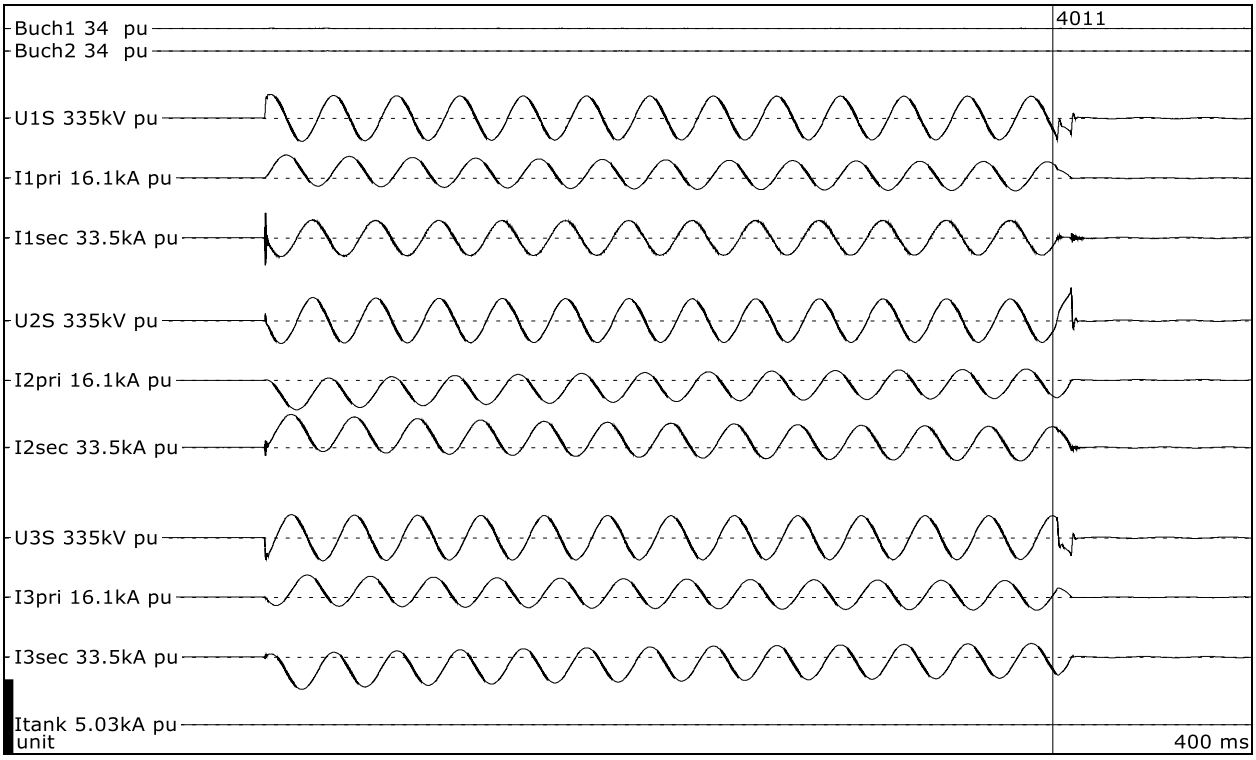


Test number: 190710-4010

Phase		**U**	**V**	**W**
Tap position		10		
Applied voltage, phase-to-ground, beginning	kV_{RMS}	70,3	70,2	70,8
Applied voltage, phase-to-ground, end	kV_{RMS}	69,3	69,0	69,8
Current, HV winding	A_{peak}	-4920	6373	-4782
Current, a.c. component, HV winding, beginning	A_{RMS}	2246	2254	2277
Current, a.c. component, HV winding, end	A_{RMS}	2222	2227	2249
Current, a.c. component, HV winding, average	A_{RMS}	2246	2253	2276
Current, LV winding	kA_{peak}	8,30	-14,7	14,5
Current, a.c. component, LV winding, beginning	kA_{RMS}	5,56	5,51	5,54
Current, a.c. component, LV winding, end	kA_{RMS}	5,50	5,44	5,46
Current, a.c. component, LV winding, average	kA_{RMS}	5,47	5,51	5,54
Duration, current	s	0,252	0,252	0,252

Observations: No visible disturbance.

Short-circuit test

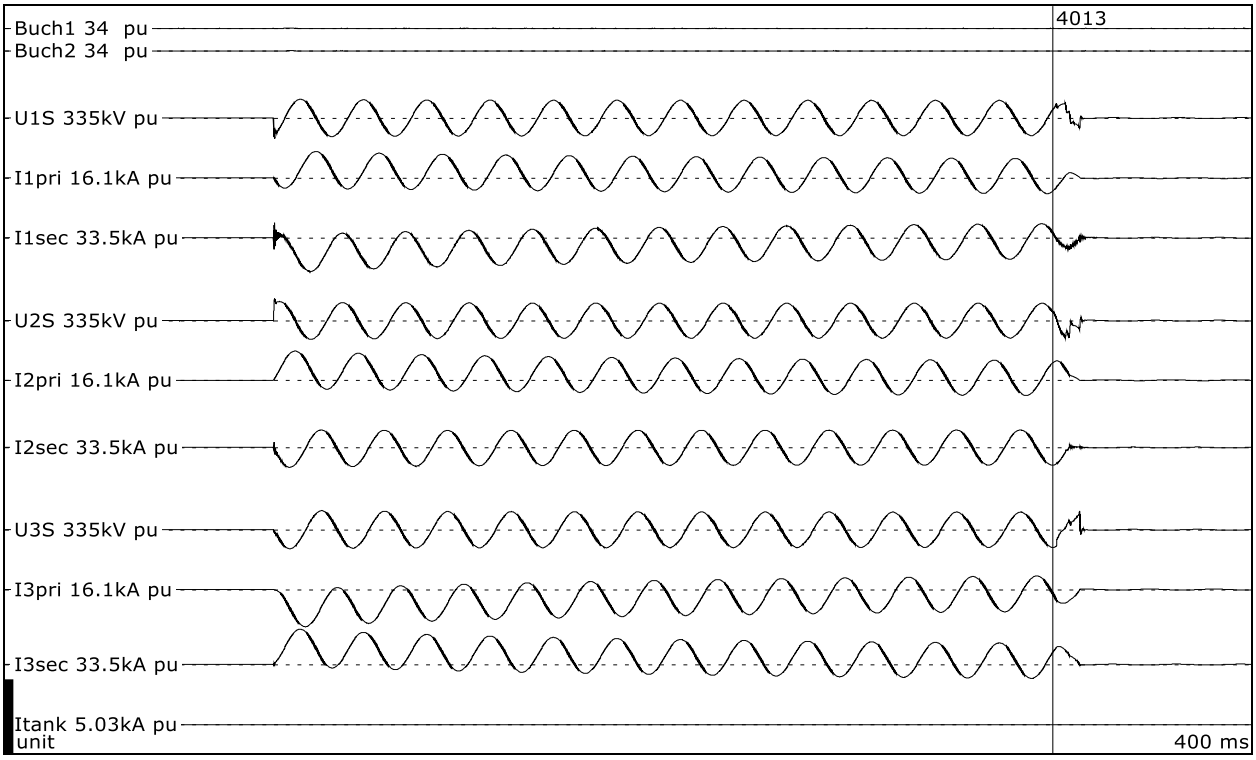


Test number: 190710-4011

Phase		**U**	**V**	**W**
Tap position		10		
Applied voltage, phase-to-ground, beginning	kV_{RMS}	70,4	70,3	70,9
Applied voltage, phase-to-ground, end	kV_{RMS}	69,4	69,0	69,8
Current, HV winding	A_{peak}	4958	-6389	4767
Current, a.c. component, HV winding, beginning	A_{RMS}	2249	2257	2275
Current, a.c. component, HV winding, end	A_{RMS}	2222	2229	2247
Current, a.c. component, HV winding, average	A_{RMS}	2248	2256	2275
Current, LV winding	kA_{peak}	-8,37	14,8	-14,4
Current, a.c. component, LV winding, beginning	kA_{RMS}	5,56	5,52	5,54
Current, a.c. component, LV winding, end	kA_{RMS}	5,50	5,44	5,46
Current, a.c. component, LV winding, average	kA_{RMS}	5,47	5,51	5,54
Duration, current	s	0,252	0,252	0,252

Observations: No visible disturbance.

Short-circuit test

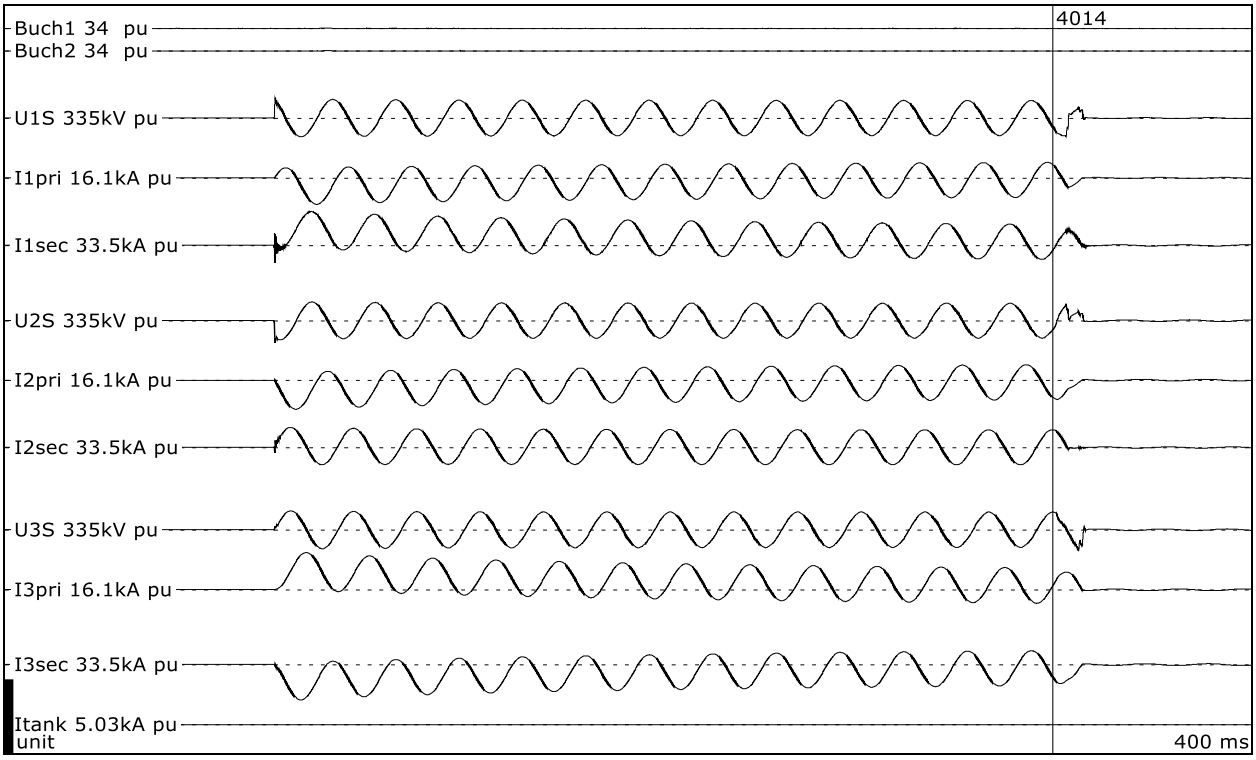


Test number: 190710-4013

Phase		**U**	**V**	**W**
Tap position		19		
Applied voltage, phase-to-ground, beginning	kV_{RMS}	57,0	56,6	57,7
Applied voltage, phase-to-ground, end	kV_{RMS}	56,1	55,6	56,4
Current, HV winding	A_{peak}	5692	6248	-7965
Current, a.c. component, HV winding, beginning	A_{RMS}	2712	2715	2751
Current, a.c. component, HV winding, end	A_{RMS}	2699	2702	2703
Current, a.c. component, HV winding, average	A_{RMS}	2710	2712	2743
Current, LV winding	kA_{peak}	-15,1	-8,87	15,8
Current, a.c. component, LV winding, beginning	kA_{RMS}	5,68	5,61	5,66
Current, a.c. component, LV winding, end	kA_{RMS}	5,57	5,53	5,57
Current, a.c. component, LV winding, average	kA_{RMS}	5,66	5,61	5,66
Duration, current	s	0,250	0,250	0,250

Observations: No visible disturbance.

Short-circuit test

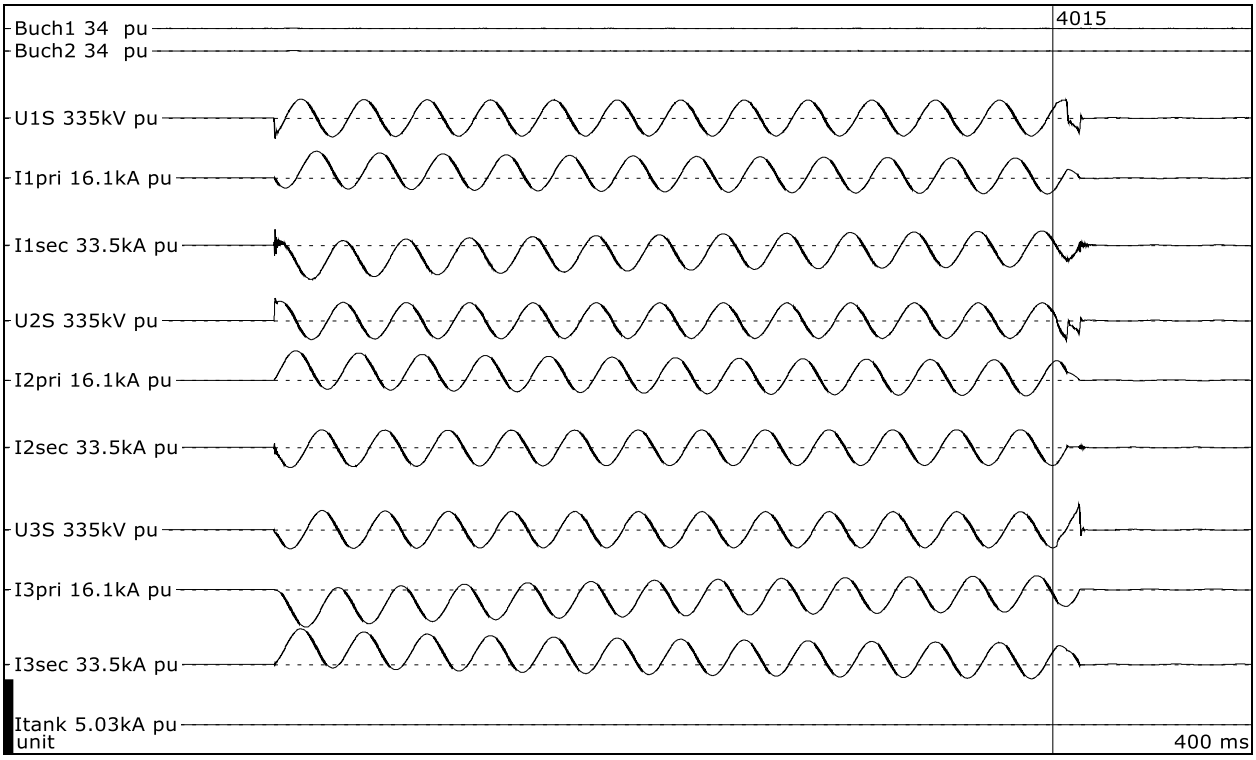


Test number: 190710-4014

Phase		**U**	**V**	**W**
Tap position		19		
Applied voltage, phase-to-ground, beginning	kV_{RMS}	57,0	56,5	57,6
Applied voltage, phase-to-ground, end	kV_{RMS}	56,0	55,5	56,3
Current, HV winding	A_{peak}	-5658	-6282	7974
Current, a.c. component, HV winding, beginning	A_{RMS}	2705	2710	2737
Current, a.c. component, HV winding, end	A_{RMS}	2699	2700	2705
Current, a.c. component, HV winding, average	A_{RMS}	2704	2710	2735
Current, LV winding	kA_{peak}	15,1	8,94	-15,8
Current, a.c. component, LV winding, beginning	kA_{RMS}	5,67	5,61	5,65
Current, a.c. component, LV winding, end	kA_{RMS}	5,56	5,52	5,55
Current, a.c. component, LV winding, average	kA_{RMS}	5,64	5,60	5,64
Duration, current	s	0,249	0,249	0,249

Observations: No visible disturbance.

Short-circuit test



Test number: 190710-4015

Phase		**U**	**V**	**W**
Tap position		19		
Applied voltage, phase-to-ground, beginning	kV_{RMS}	57,7	57,2	58,3
Applied voltage, phase-to-ground, end	kV_{RMS}	57,1	56,5	57,5
Current, HV winding	A_{peak}	5749	6312	-8001
Current, a.c. component, HV winding, beginning	A_{RMS}	2739	2744	2774
Current, a.c. component, HV winding, end	A_{RMS}	2717	2723	2747
Current, a.c. component, HV winding, average	A_{RMS}	2744	2749	2777
Current, LV winding	kA_{peak}	-15,2	-8,95	15,9
Current, a.c. component, LV winding, beginning	kA_{RMS}	5,74	5,67	5,72
Current, a.c. component, LV winding, end	kA_{RMS}	5,67	5,62	5,66
Current, a.c. component, LV winding, average	kA_{RMS}	5,73	5,68	5,73
Duration, current	s	0,249	0,249	0,249

Observations: No visible disturbance.

7.5 Condition after test

Externally no visible change.

7.6 Photographs after test


KONCAR
AFTER TEST
190710-4015

8 INSPECTION OF THE ACTIVE PART

On 23 August 2019 the transformer was untanked and the active part was inspected by a KEMA Laboratories inspector at the factory of the manufacturer.

The out-of-tank inspection with respect to displacements, deformations of core and windings, connections and supporting structures or traces of discharges did not reveal any apparent defects.

On request of the client the photographs taken during the inspection are not included in this report. Photographs are kept in KEMA Laboratories' files.

9 DISSOLVED GAS ANALYSIS

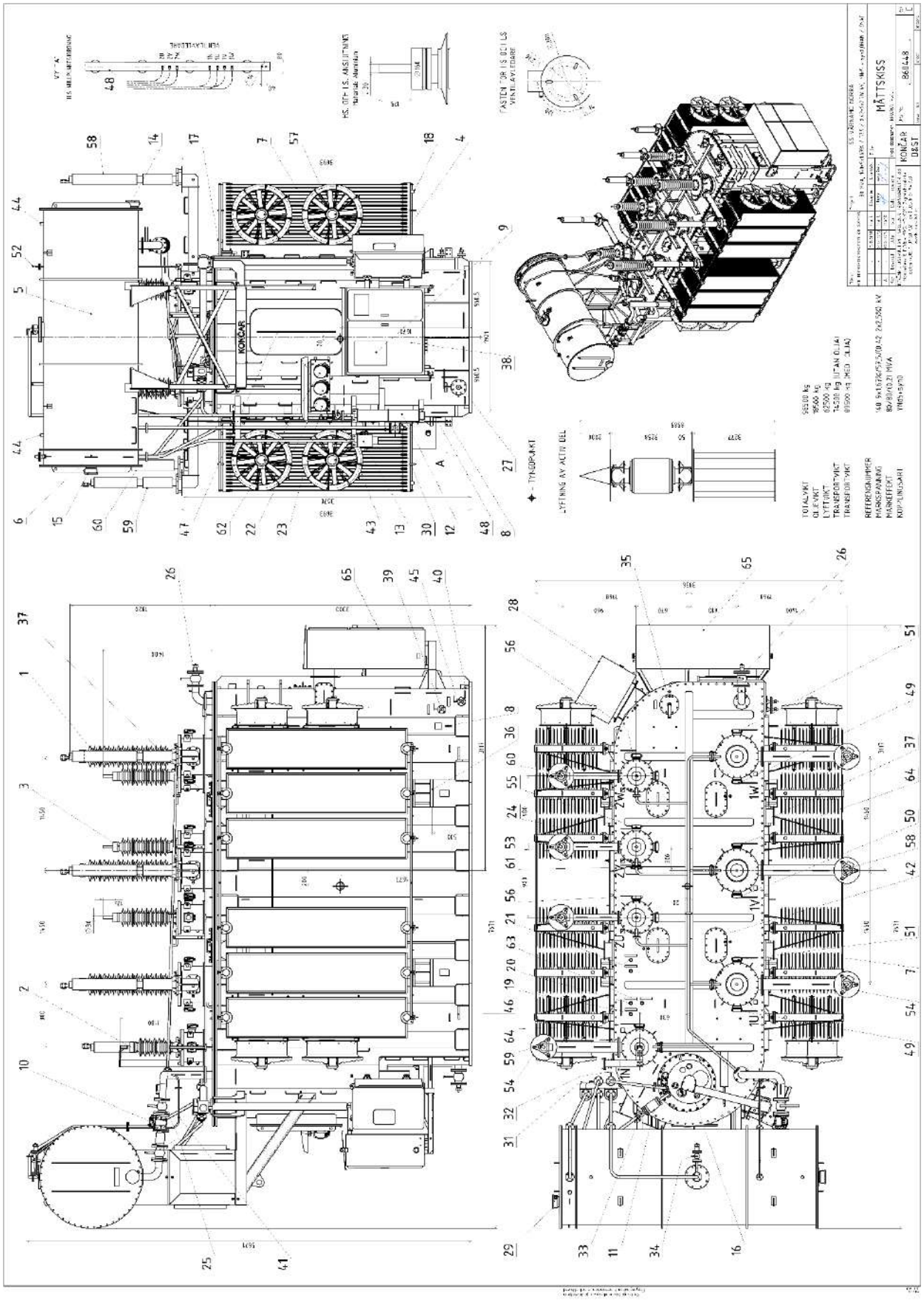
Standard and date

Standard IEC 60296

Date 16 July 2019

Sample taken	Before the short-circuit tests	After the short-circuit tests
Sample number	316128	316129
Hydrogen	< 3 µl/l	< 3 µl/l
Methane	< 1 µl/l	< 1 µl/l
Ethane	< 1 µl/l	< 1 µl/l
Ethylene	< 1 µl/l	< 1 µl/l
Acetylene	< 1 µl/l	< 1 µl/l
Propane	< 1 µl/l	< 1 µl/l
Propylene	< 1 µl/l	< 1 µl/l
Carbon monoxide	18 µl/l	14 µl/l
Carbon dioxide	< 200 µl/l	210 µl/l
N-butane	< 1 µl/l	< 1 µl/l
Iso-butane	< 1 µl/l	< 1 µl/l

10 DRAWINGS


MÄTSKISS
KONČAR
DIST
TOTALVIKT
OLJEVIKT
LYFTVIKT
TRANSPORTVIKT
TRANSPORTVIKT
REFERENSNUMMER
MÄRKSPÄNNING
MÄRKEFFEKT
KOPPLINGSART

CE KONČAR D&ST

TREFASTRANSFORMATOR
TRP 80000-145/E

STANDARD
IEC 60076

SERIENUMMER	ET1036-	TILLVERKNINGSÅR	
MÄRKEFFEKT	80 MVA	ANTAL FASER	3
KOPPLING	YNd5 + syn0	MÄRKFREKVENS	50 Hz
KYLNINGSTYP	ONAN/ONAF (63/80 MVA)		
OLJETYP	ERGON HYVOLT III ACC. TO IEC 60296		
P_o kW	P_r kW	P_{LL} kW	
PEI %	KÄRNMATERIAL / VIKT	GOES / 35.0	t
k_{sc} pu	LINDNINGSMATERIAL / VIKT	KOPPAR / 17.5	t
OLJEVIKT 18.5 t	VIKT AKTIV DEL	60.3	t
VIKT VID LYFT AV AKTIV DEL 62.5 t	TOTALVIKT	98.5	t
TRANSPORTVIKT (MED OLJA) 89.5 t	TRANSPORTVIKT (UTAN OLJA)	74.5	t
MAX. OMG.TEMP 40 °C	LINDN.TEMPSTEGRING 65 K	OLJETEMPERATURSTEGRING 60 K	
LINDNINGSKOPPLARTYP	MR VM III 500Y-72.5/B-10 19 1G	SERIENUMMER LK	2061147

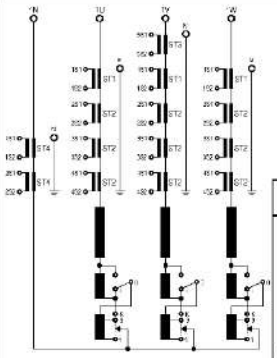
TANK, EXPANSIONSKÄRL OCH RADIATORER ÄR KONSTRUERADE ATT TÅLA FULLT VACUUM

LÄGE	MÄRKSPÄNNING (V)		MÄRKSTRÖM (A)		KORTSLUTNINGS-IMPEDANS (%)
	HS	LS	HS	LS	
1	161042	57500	286.8	803.3	
10	140000		329.9		
19	118958		388.3		

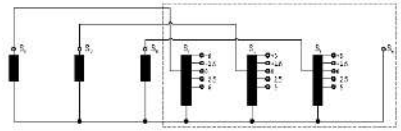
LINDNING	Um (kV)	ISOLATIONSNIVÅ	KORTSLUTNINGSEFFEKT
HS	145	LI550 AV230 - LI250 AV95	10000 MVA / 2s
LS	72.5	LI325 AV140	3000 MVA / 2s

STRÖMTRANSFORMATOR			
LÄGE	OMSÄTTNING	EFFEKT	KLASS
ST1	500/2 A	10 VA	0.2sFs5
ST2	500/1 A	20 VA	5P20
ST3	390/2 A	10 VA	3Fs5
ST4	500/1 A	20 VA	5P20
ST5	1200/2 A	10 VA	0.2sFs5
ST6	1200/1 A	20 VA	5P20
ST7	805/2 A	10 VA	3Fs5

HJÄLPLINDNING 200 kVA; 467.4 V; 247.0 A



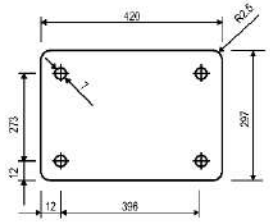
LINDNING	LÄGE	GRÖVVÄLJARENS LÄGE		MÄRKSPÄNNING (V)	MÄRKSTRÖM (A)
HS	1	1	1	161042	286.8
	2		2	158704	291.0
	3		3	156366	295.4
	4		4	154028	299.9
	5	3	5	151690	304.5
	6		6	149352	309.3
	7		7	147014	314.2
	8		8	144676	319.3
	9		9	142338	324.5
	10		K	140000	329.9
	11		1	137662	335.5
	12		2	135324	341.3
	13		3	132986	347.3
	14		4	130648	353.5
	15	5	5	128310	360.0
	16		6	125972	366.7
	17		7	123634	373.6
	18		8	121296	380.8
	19		9	118958	388.3
LS				57500	803.3



GENERALAGENT:
HELMER HV VERKEN
PARTILLE SVERIGE
TEL 031-445438

872690

TILLVERKAD I KROATIEN (ZAGREB)



RUPE Ø7 IZBUŠITI
PRIJE JETKANJA

ZAOBLJENI RUBOVI = R2.5

IZVEDBA: JETKANA
ČISTA METALNA POVRŠINA: POZADINA I POLJA
BOJA: CRNA (OZNAKE I OKVIRI POLJA)

TEHNIČKO DOBAVNI UVJETI: QATD4-800.01

MATERIJAL: PROKROM 2mm

TRP80000-145/E	Sirovina: LIM 2 C.B4.112 Č.4572		Masa (kg): 0.98
	Izradio: Ing. Gašić	Odobrio: Ing. Vasović	Naziv: NATPISNA PLOČICA
Rev. / Promjena br. / Datum / Ime	Datum: 16.04.2019.		
KONČAR-DISTRIBUTIVNI I SPECIJALNI TRANSFORMATORI d.d. Adresa: Josipa Mokrovića 8, P.P.100, 10090 Zagreb, HRVATSKA Tel. (01) 3783 777, Faks: (01) 3794 051 E-mail: info@koncar-dist.hr, Internet: www.koncardst.hr	KONČAR D&ST	Br. dijela: B 7 2 6 9 0	Rev.
		Mjerilo	List br. / Listova br.

OB-0105
2016-09-09

Appendix A Routine tests before the short-circuit tests

Routine tests before the short-circuit tests were carried out at the factory of the manufacturer on 14 June 2019 without presence of a KEMA Laboratories inspector.
See enclosed report on the following pages.
The responsibility for the content of this report rests with the manufacturer.

KONČAR D&ST

TRANSFORMER TEST REPORT

Before Short-circuit withstand test (IEC 60076-5)

TRANSFORMER

Type: TRP 80000-145/E
Serial No. : ET1036 - 464170

ROUTINE TESTS:	TEST REPORT No.:	Page :	STANDARD
Measurement of voltage ratio and check vector group	464170	2 / 7	IEC 60076-1 (11.3)
Measurement of winding resistance	464170	2,3 / 7	IEC 60076-1 (11.2)
Measurement of short-circuit impedance and load losses	464170	4 / 7	IEC 60076-1 (11.4)
Measurement of no-load losses and current	464170	5 / 7	IEC 60076-1 (11.5)
Three phase measurement of no-load current at 400V and 50Hz	464170	5 / 7	
Insulation resistance of the windings and check of core insulation	464170	6 / 7	IEC 60076-1 (11.1.2; 11.12)
Applied voltage test (AV)	464170	6 / 7	IEC 60076-3 (10)
Line terminal AC withstand test (LTAC)	464170	6 / 7	IEC 60076-3 (12)
Test on on-load tap changer	464170	6 / 7	IEC 60076-1 (11.7)
Check of auxiliary equipment according to drawing CS5530	464170	6 / 7	
Determination of capacitances winding -to-earth, and between windings	K1248	---	IEC 60076-1 (11.1.2; 11.1.4)
Induced voltage test with PD measurement (IVW, IVPD)	464170	7 / 7	IEC 60076-3 (11.3)
Lightning impulse test (LI + LIN)	U2921	----	IEC 60076-3 (13.2. 13.4)
Test on insulating of oil	226/19	----	IEC 60156
Leak testing with pressure	OL464170	----	IEC 60076-1 (11.8)
TYPE AND SPECIAL TESTS:			
Measurement of zero-sequence impedance	464170	4 / 7	IEC 60076-1 (11.6)
Chromatographic analysis of gases dissolved in oil	19/337	---	IEC 61181 (Tbl.A.1)

ALL SPECIFIED TESTS AND MEASUREMENTS WERE PERFORMED.
TRANSFORMER PASSED THE TESTS AND MEASUREMENTS MET SPECIFIED TOLERANCES.

The test was carried out in the presence of :

Tested by :	Approved by :	Date and stamp :
V. Gojević, dipl.ing.	V. Maljković, dipl.ing.	14.06.2019.

KONČAR D&ST

TRANSFORMER TEST REPORT

TRANSFORMER

Serial No. : ET1036 - 464170

Before Short-circuit withstand test (IEC 60076-5)

RATING PLATE

CE KONČAR D&ST

TREFASTRANSFORMATOR
TRP 80000-145/E

STANDARD
IEC 60076

SERIENUMMER	ET1036- 464170	TILLVERKNINGSÅR	2019.
MÄRKEFFEKT	80 MVA	ANTAL FASER	3
KOPPLING	YNd5 + syn9	MÄRKFREKVENS	50 Hz
KYLNINGSTYP	ONAN/ONAF (63/80 MVA)		
OLJETYP	ERGON HYVOLT III ACC. TO IEC 60296		
P_k 28,97 kW	P_t 214,99 kW	P_{ca} 0 kW	
PE! 99,803 %	KÄRNMATERIAL / VIKT	GOES / 35.0 t	
k_{ac} 0,36708 pu	LINDNINGSMATERIAL / VIKT	KOPPAR / 17.5 t	
OLJEVIKT 18.5 t	VIKT AKTIV DEL	60.3 t	
VIKT VID LYFT AV AKTIV DEL 62.5 t	TOTALVIKT	98.5 t	
TRANSPORTVIKT (MED OLJA) 89.5 t	TRANSPORTVIKT (UTAN OLJA)	74.5 t	
MAX. OMG.TEMP. 40 °C	LINDN.TEMPSTEGRING 65 K	OLJETEMPERATURSTEGRING 60 K	
LINDNINGSKOPPLARTYP	MR VM III 500Y-72.5/B-10 19 1G	SERIENUMMER LK 2061147	

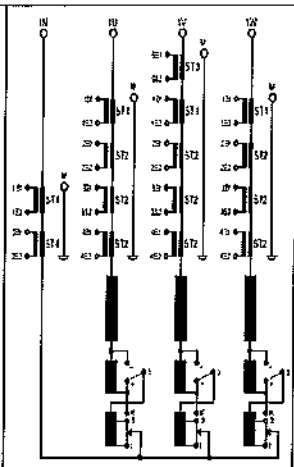
TANK, EXPANSIONSKÄRL OCH RADIATORER ÄR KONSTRUERADE ATT TÅLA FULLT VACUUM

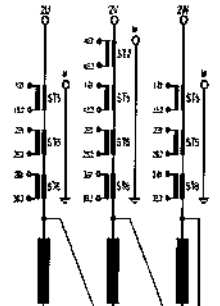
LÄGE	MÄRKSPÄNNING (V)		MÄRKSTRÖM (A)		KORTSLUTNINGS-IMPEDANS (%)
	HS	LS	HS	LS	
1	161042	57500	286.8	803.3	13,80
10	148000		329.9		12,62
19	116958		388.3		11,76

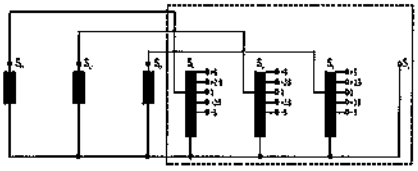
LINDNING	Um (kV)	ISOLATIONSNIVÅ	KORTSLUTNINGSEFFEKT
HS	145	LI550 AV230 - LI250 AV95	10000 MVA / 2s
LS	72.5	LI325 AV140	3000 MVA / 2s

STRÖMTRANSFORMATOR			
LÄGE	OMSÄTTNING	EFFEKT	KLASS
ST1	500/2 A	10 VA	0.2s Fs5
ST2	500/1 A	20 VA	5P20
ST3	300/2 A	10 VA	3Fs5
ST4	500/1 A	20 VA	5P20
ST5	1200/2 A	10 VA	0.2s Fs5
ST6	1200/1 A	20 VA	5P20
ST7	600/2 A	10 VA	3Fs5

HJÄLPLINDNING 200 kVA; 467.4 V; 247.0 A







LINDNING	LÄGE	GRADVÄXLARENS LÄGE		MÄRKSPÄNNING (V)	MÄRKSTRÖM (A)
HS	1	0+	1	161042	286.8
	2		2	158704	291.0
	3		3	156366	295.4
	4		4	154028	299.9
	5		5	151690	304.5
	6		6	149352	309.3
	7		7	147014	314.2
	8		8	144676	319.3
	9		9	142338	324.5
	10		K	140000	329.9
	11	0-	1	137662	335.5
	12		2	135324	341.3
	13		3	132986	347.3
	14		4	130648	353.5
	15		5	128310	360.0
	16		6	125972	366.7
	17		7	123634	373.8
	18		8	121296	381.0
	19		9	116958	388.3
LS				57500	803.3

GENERALAGENT:
HELMER VERKEN
PARTILLE, SVERIGE
TEL 031-445456

B72690

TILLVERKAD I KROATIEN (ZAGREB)

KONČAR D&ST

TRANSFORMER TEST REPORT

Serial No. : 464170

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Before Short-circuit withstand test (IEC 60076-5)

1.0. RATING VALUES

Transformer type :	TRP 80000-145/E		Tap-changer type :	MR VM III 500Y-72,5/B-10 19 1G	
Serial No. :	464170		Serial No. :	2061147	
Winding :	HS	LS	Aux. winding		
Insulation level :	LI550 AV230 - LI250 AV95	LI325 AV140	AV3		Part No.: ET1036
Rated power (kVA)	80000	80000	200		Transport mass (t): 74,5
	161042				Oil mass (t): 18,5
Rated voltage (V)	140000	57500	467,4		Total mass (t): 98,5
	118958				Frequency (Hz): 50
	286,8				Vector group: YNd5+syn0
Rated current (A)	329,9	803,3	247,0		Type of cooling: ONAN/ONAF
	388,3				Tested in acc.: IEC60076

2.0. TEST RESULTS

2.1.1. Impedance voltage at 80MVA and 75°C

Winding :	HS / LS			Aux. winding / HS	Aux. winding / LS
Tap position	1	10	19	10	----
Rated (%)	----	12,00	----	----	----
Guaranteed (%)	----	11,1 - 12,9	----	----	----
Measured (%)	13,80	12,62	11,76	0,86	0,87

2.1.2. Load losses at 80MVA and 75°C

Rated (kW)	----	223,00	----	----	----
Guaranteed (kW)	----	227,46	----	----	----
Measured (kW)	220,03	214,99	224,47	0,582	0,583

2.3. No - load loss and current

	No-load losses			No-load current at 80MVA	
Voltage (%)	90,0	100,0	105,0	Voltage (%)	100,0
Rated (kW)	----	29,00	----	Rated (%)	0,120
Guaranteed (kW)	----	29,58	----	Guaranteed (%)	0,120
Measured (kW)	22,25	28,97	33,65	Measured (%)	0,051

2.4. Total losses at 80MVA and 75°C (no load + load losses)

				Total losses at 0,2MVA and 75°C (no-load + load losses)	
Tap position	1	10	19	----	----
Rated (kW)	----	252,00	----	----	----
Guaranteed (kW)	----	257,04	----	----	----
Measured (kW)	249,00	243,96	253,44	29,55	29,55

2.5. Efficiency at 80MVA and 75°C

Winding HS / LS at position 10

Load (%)	25	50	75	100	125
Measured PF=1.0 (%)	99,79	99,79	99,75	99,70	99,64
Guaranteed (%)	-----	-----	-----	-----	-----
Measured PF=0.8 (%)	99,73	99,74	99,69	99,62	99,54
Guaranteed (%)	-----	-----	-----	-----	-----

2.6. Variation of the secondary voltage

			Load (%)	100	125
Guaranted PF=1.0 (%)	-----	-----	Measured (%)	1,06	1,33
Guaranted PF=0.8 (%)	-----	-----	Measured (%)	8,28	10,35

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TRANSFORMER TYPE : TRP 80000-145/E Part No.: ET1036

3 . 0 .	Measurement voltage ratio and vector group				
Tap position	Phase 1U - 2U (%)	Phase 1V - 2V (%)	Phase 1W - 2W (%)	Voltage (V)	Calculated ratio
1	0,06	0,05	0,06	161042	2,801
2	0,05	0,05	0,06	158704	2,760
3	0,05	0,05	0,06	156336	2,719
4	0,06	0,05	0,06	154028	2,679
5	0,05	0,05	0,06	151690	2,638
6	0,06	0,05	0,06	149352	2,597
7	0,05	0,05	0,06	147014	2,557
8	0,05	0,05	0,06	144676	2,516
9	0,05	0,05	0,06	142338	2,475
10	0,05	0,05	0,05	140000 / 57500	2,435
11	0,05	0,05	0,05	137662	2,394
12	0,05	0,05	0,05	135324	2,353
13	0,05	0,05	0,05	132986	2,313
14	0,05	0,05	0,05	130648	2,272
15	0,05	0,05	0,05	128310	2,231
16	0,05	0,05	0,05	125972	2,191
17	0,05	0,05	0,05	123634	2,150
18	0,05	0,05	0,05	121296	2,109
19	0,05	0,05	0,05	118958	2,069
(HS / LS)	Vector group is :	YNd5			

Tap position	Phase 1U - Sr1 (%)	Phase 1V - Ss1 (%)	Phase 1W - St1 (%)	Voltage (V)	Calculated ratio
10	-0,03	-0,05	-0,04	140000 / 467,4	299,529
(1 / Aux. Winding)	Vector group is :	YNyn0			

3 . 1 .	Measurement of winding resistance in (Ω)			(measurement at temperature 28 °C)	
Winding HS	1U - 1V	1U - 1W	1V - 1W		
1	0,726	0,726	0,726		
10	0,574	0,574	0,573		
19	0,464	0,464	0,463		
Winding LS	2U - 2V	2U - 2W	2V - 2W		
---	0,0660	0,0660	0,0656		
Aux. winding	Sr1 - Ss1	Sr1 - St1	Ss1 - St1		
---	0,00449	0,00449	0,00440		

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Part No.: ET1036

3 . 1 .	Measurement of winding resistance in (Ω)			(measurement at temperature 28 °C)	
Winding HS	**1U - 1N**	**1V - 1N**	**1W - 1N**		
1	0,364	0,363	0,364		
2	0,355	0,355	0,355		
3	0,347	0,346	0,347		
4	0,338	0,338	0,338		
5	0,330	0,330	0,330		
6	0,322	0,321	0,321		
7	0,313	0,313	0,313		
8	0,305	0,304	0,304		
9	0,297	0,296	0,296		
10	0,288	0,287	0,286		
11	0,299	0,299	0,299		
12	0,291	0,290	0,291		
13	0,282	0,282	0,282		
14	0,274	0,274	0,274		
15	0,266	0,265	0,265		
16	0,257	0,257	0,257		
17	0,249	0,248	0,249		
18	0,240	0,240	0,240		
19	0,232	0,232	0,232		
Aux. winding	**Sr1 - Sn**	**Ss1 - Sn**	**St1 - Sn**		
----	0,00356	0,00296	0,00240		

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Part No.: ET1036

2 . 1 . Load losses and impedance voltage measurement

Combination **		HS / LS	HS / LS	HS / LS	Aux. winding / HS	Aux. winding / LS
Tap position		**1**	**10**	**19**	**10**	**----**
Temperature	**(°C)**	**28**	**28**	**28**	**28**	**28**
Frequency	**(Hz)**	**50**	**50**	**50**	**50**	**50**
Measured voltage	(u-v)	12636	10097	7566	3,62	3,73
	(u-w)	12654	10108	7571	4,31	4,43
	(v-w)	12650	10108	7574	3,86	3,97
Average		12647	10104	7570	3,93	4,04
Constant		1	1	1	1	1
VOLTAGE	**(V)**	**12647**	**10104**	**7570**	**3,93**	**4,04**
Measured current	(u)	163,7	189,3	210,9	245,2	247,0
	(v)	163,1	188,8	210,4	246,3	248,2
	(w)	162,7	187,9	209,1	244,5	246,4
Average		163,2	188,7	210,1	245,3	247,2
Constant		1	1	1	1	1
CURRENT	**(A)**	**163,2**	**188,7**	**210,1**	**245,3**	**247,2**
Measured power	(u)	24730	26280	24980	156,7	159,2
	(v)	17020	15620	14470	172,7	175,8
	(w)	22870	20930	18820	190,7	193,4
Total		64620	62830	58270	520,1	528,4
Constant		1	1	1	1	1
LOAD LOSSES	**(W)**	**64620**	**62830**	**58270**	**520,1**	**528,4**
Calculated to	**(kVA**	**80000**	**80000**	**80000**	**200**	**200**
	(A)	**286,8**	**329,9**	**388,3**	**247,0**	**247,0**
LOAD LOSSES	**(W)**	**199657**	**192123**	**198942**	**527,4**	**527,7**
I2 R losses	(W)	153329	157410	168600	408,9	408,7
Stray losses	(W)	46328	34713	30342	118,5	119,0
Impedance voltage	**(V)**	**22229,8**	**17669,1**	**13988,0**	**3,96**	**4,04**
	(%)	**13,804**	**12,621**	**11,759**	**0,847**	**0,865**
Temperature	**(°C)**	**75**	**75**	**75**	**75**	**75**
I2 R losses	(W)	180730	185540	198730	482,0	481,7
Stray losses	(W)	39304	29450	25742	100,5	101,0
LOAD LOSSES	**(W)**	**220034**	**214990**	**224472**	**582,5**	**582,7**
Impedance voltage	**(V)**	**22230,5**	**17669,9**	**13988,9**	**4,00**	**4,08**
	(%)	**13,804**	**12,621**	**11,759**	**0,856**	**0,873**

NOTE : Measuring equipement : YOKOGAWA Power Analyser

** : Connected / Short-circuit winding

2. 1. 1. Measurement of zero-sequence impedance

Winding / Tap	Voltage (V)	Current (A)	Imped. (Ω/phase)	Ro (Ω / phase)	Xo (Ω / phase)
HS / 1	1480,8	103,70	42,84	2,18	42,78
HS / 10	1076,4	109,00	29,63	1,57	29,58
HS / 19	715,8	107,40	19,99	1,09	19,96

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Before Short-circuit withstand test (IEC 60076-5)

Serial No. : 464170

TRANSFORMER TYPE : TRP 80000-145/E | Part No.: ET1036

2 . 3 .	No - load losses and no - load current measurement				
Voltage (%)	**90,0**	**100,0**	**105,0**	**110,0**	
RMS measured vltg. (u-v)	51679	57372	60146	62877	
(u-w)	51759	57457	60227	62954	
(v-w)	51648	57314	60056	62731	
Average	51695	57381	60143	62854	
Constant	1	1	1	1	
RMS VOLTAGE (V)	**51695**	**57381**	**60143**	**62854**	
Mean measured vltg. (u-v)	51715	57450	60297	63205	
(u-w)	51824	57589	60447	63354	
(v-w)	51735	57478	60328	63221	
Average	51758	57506	60357	63260	
Constant	1	1	1	1	
MEAN VOLTAGE (V)	**51758**	**57506**	**60357**	**63260**	
Form factor	1,109	1,108	1,106	1,103	
Measured current (u)	0,207	0,332	0,525	1,021	
(v)	0,291	0,402	0,579	1,044	
(w)	0,344	0,500	0,726	1,289	
Average	0,281	0,411	0,610	1,118	
Constant	1	1	1	1	
CURRENT (A)	**0,281**	**0,411**	**0,610**	**1,118**	
Measured power (u)	5167	6278	6729	6867	
(v)	7962	10886	13318	17244	
(w)	9099	11739	13486	15991	
Total	22228	28903	33533	40102	
Constant	1	1	1	1	
LOSSES (W)	**22228**	**28903**	**33533**	**40102**	
Correction (W)	**27**	**63**	**119**	**258**	
LOSSES (W)	**22255**	**28966**	**33652**	**40360**	

NOTE : Measuring equipement : YOKOGAWA Power Analyser

MEASUREMENT AT FREQUENCY 50 (Hz) ON WINDING : LS

The power was corrected to the sine - wave voltage basis .

2. 3. 1.	Single phase measurement of no - load current at 230 (V) and 50 (Hz)				
Winding	Phase 1U (m A)	Phase 1V (m A)	Phase 1W (m A)		
HS - tap position 10	1,2	0,6	1,4		

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Before Short-circuit withstand test (IEC 60076-5)

Serial No. : 464170

TRANSFORMER TYPE : TRP 80000-145/E

Part No.: ET1036

3.2. Insulation resistance of the windings (MΩ)

(measured by 2500VDC at temperature 28 °C)

Between	R 15"	R 60"	R 60" / R 15"		
HS - (LS + Aux. winding + core + core clamp + earth)	11400	13700	1,20		
LS - (HS + Aux. winding + core + core clamp + earth)	8560	11400	1,33		
Aux. winding - (HS + LS + core + core clamp + earth)	53600	84700	1,58		

Check of core insulation (MΩ)

(measured by 2500VDC at temperature 28 °C)

Between	R 15"	R 60"	R 60" / R 15"		
core - (HS + LS + Aux. winding + core clamp + earth)	2560	4930	1,93		

3.3. Dielectric test of the transformer

Lightning impulse test (LI + LIN) — Test report No.: U2921

	Between	Test voltage (kV)	Frequency (Hz)	Duration (sec)
Applied voltage (AV) test	HS - (LS + Aux. winding + core + core clamp + earth)	95	50	60
	LS - (HS + Aux. winding + core + core clamp + earth)	140	50	60
	Aux. winding - (HS + LS + core + core clamp + earth)	3	50	60
Line terminal AC withstand test (LTAC)	1U - (1V + 1W + earth)	230	200	30
	1V - (1U + 1W + earth)	230	200	30
	1W - (1U + 1V + earth)	230	200	30

NOTE : Winding HS - tap position 1.

1. Tap changer was tested in accordance with IEC 60076-1 (clause 11.7).
2. Functionally test of the auxillary box has been done in accordance with drawing No.: CS5530.
3. Current transformers:

	Phase			
	1U	1V	1W	1N
ST1 - 500 / 2A; 10VA; 0.2sFs5; Ser.No.:	91006536	91006538	91006537	
ST2 - 500 / 1A; 20VA; 5P20; Ser.No.:				
ST3 - 390 / 2A; 10VA; 3Fs5; Ser.No.:				
ST4 - 500 / 1A; 20VA; 5P20; Ser.No.:				91006539
	2U	2V	2W	
ST5 - 1200 / 2A; 10VA; 0,2sFs5; Ser.No.:	91006540	91006542	91006541	
ST6 - 1200 / 1A; 20VA; 5P20; Ser.No.:				
ST7 - 805 / 2A; 10VA; 3Fs5; Ser.No.:				

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TRANSFORMER TEST REPORT

Before Short-circuit withstand test (IEC 60076-5)

Serial No. : 464170

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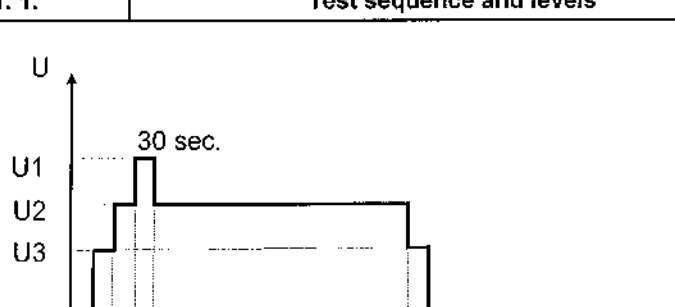
TRANSFORMER TYPE : TRP 80000-145/E

Part No.: ET1036

3 . 4 . 1. Induced voltage test with PD measurement (IVW, IVPD)

3 . 4 . 1. 1. Test sequence and levels



Standard:	IEC 60076-3
Supply	three-phase
Supplied terminals	2U - 2V - 2W
Tap position	10
Supply frequency (Hz)	200
U4 (kV)	56,0
U3 (kV)	168,0
U2 (kV)	221,2
U1 (kV)	275,0
Allowed PD at voltage level (pC)	
U3	<100
U2	<250

3 . 4 . 1. 2. Measuring equipement, calibration and background noise level

Measuring equipement:

PD detector: "Tettex" DDX9101

Calibrator: "Haefely" type 451

Calibration: Calibraton performed with 100 pC

Callbration signal	1U	1V	1W
Measured (pC)			
1U	100	5	5
1V	5	100	5
1W	5	5	100

Background noise level with source connected and voltage 0 (V): < 10 pC

3 . 4 . 1. 3. Test and PD measurement

Voltage level	Duration (min)	Measured on phase (pC) 1U	1V	1W
U3	1,0	70	70	60
U2	5,0	80	70	70
U1	0,5	---	---	---
U2	5,0	80	70	70
U2	5,0	80	70	70
U2	5,0	80	70	70
U2	5,0	80	70	70
U2	5,0	80	70	70
U2	5,0	80	70	70
U2	5,0	80	70	70
U2	5,0	80	70	70
U2	5,0	80	70	70
U2	5,0	80	70	70
U2	5,0	80	70	70
U2	5,0	80	70	70
U2	5,0	80	70	70
U3	1,0	70	70	60

3 . 4 . 1. 4. Results :

No collapse of voltage observed.

Measured level of PD is lower than in IEC 60076 - 3 specified.

TRANSFORMER PASSED IVPD TEST.

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LIGHTNING IMPULSE TEST REPORT

Before Short-circuit withstand test (IEC 60076-5)

Test report no. U2921

Transformer type	Serial number		
TRP 80000-145/E	**ET1036 - 464170**		
Winding HS	Winding LS	Hjälplindning	
Tap position / Voltage (V)	Voltage (V)	Voltage (V)	
1 / 161042	-	-	
10 / 140000	57500	467,4	
19 / 118958	-	-	
Connection symbol **YNd5+syn0**	Rated short-circuit impedance 12,0%		

1. Specified test voltages — Standard: IEC 60076 - 3

Terminals	Full wave		Chopped wave	
	$\hat{}$ kV	Wave shape (µs)	$\hat{}$ kV	Time to chopping (µs)
1U, 1V, 1V	550	1.2/50	-	-
1N	250	1.2/50	-	-
2U, 2V, 2W	325	1.2/50	-	-
-	-	-	-	-
-	-	-	-	-

2. Measurements

Applied voltage was measured with capacitive voltage divider HIGH VOLT SMC670/1200 and measuring device for recording impulse voltage and current HIGH VOLT MIAS 100-14/4B in accordance with IEC 60060.

3. Result

By comparing the voltage and current records it has been proved that the transformer withstood the test.

4. Remarks

a) Voltage and current wave records are stored by Manufacturer in files: 464170

The test was carried out in presence of:

Tested by:	Approved by:	Date and stamp:
Darko Bistrički, dipl.ing.	Vedran Maljković, dipl.ing.	14.06.2019.

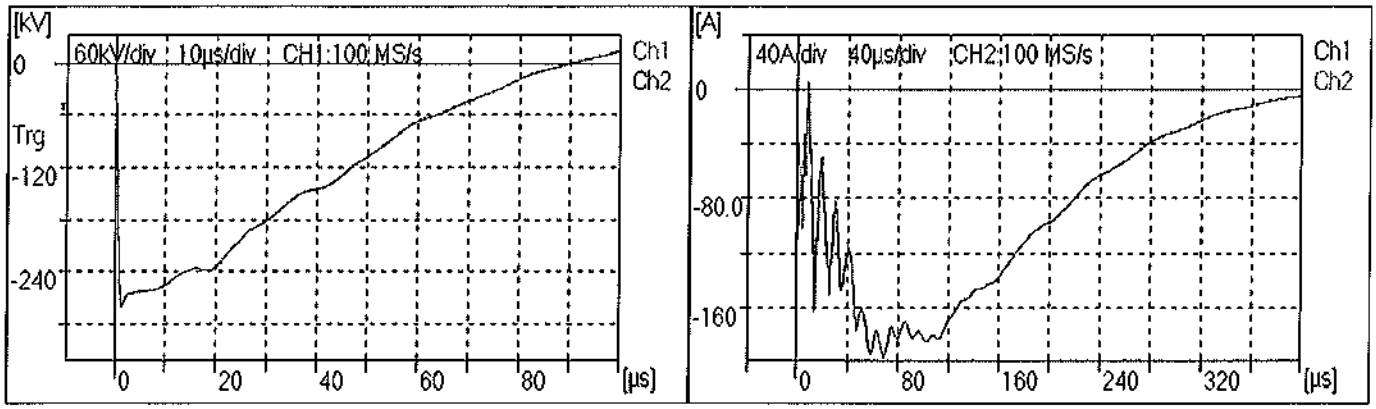
5. Testing of Winding HS

5.1. Connection of terminals

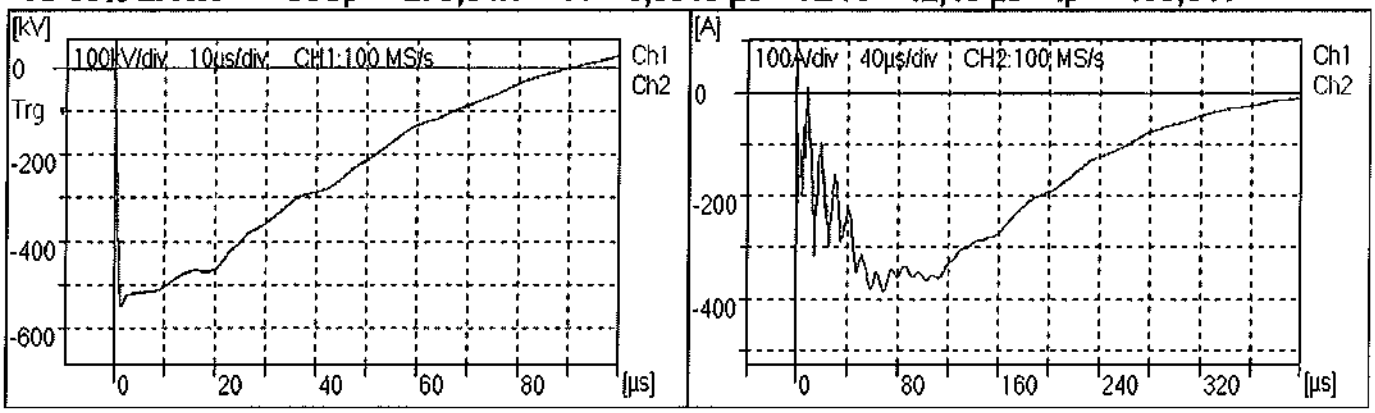
line terminal under test	connected to the impulse voltage generator
other line terminals of the winding under test	directly earthed
neutral terminal 1N	earthed through shunt S1
2U, 2V, 2W	short circuited and directly earthed
S_{r1}, S_{s1}, S_{t1}	short circuited and directly earthed

5.2. Order of tests

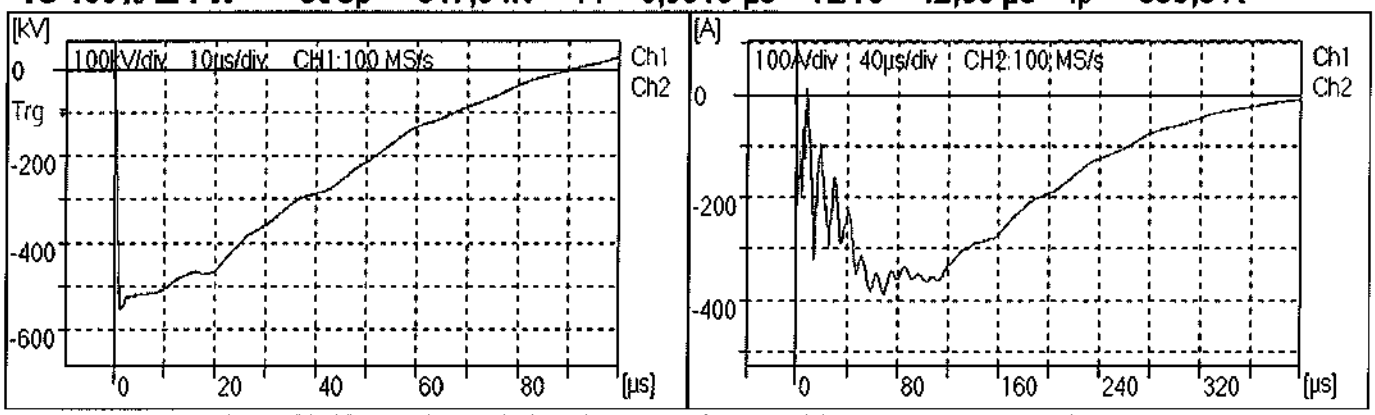
Terminal	Tap position	Description	Page
1U	19	Applied voltage and current through shunt S1 oscillograms	3
1V	10	Applied voltage and current through shunt S1 oscillograms	4
1W	1	Applied voltage and current through shunt S1 oscillograms	5



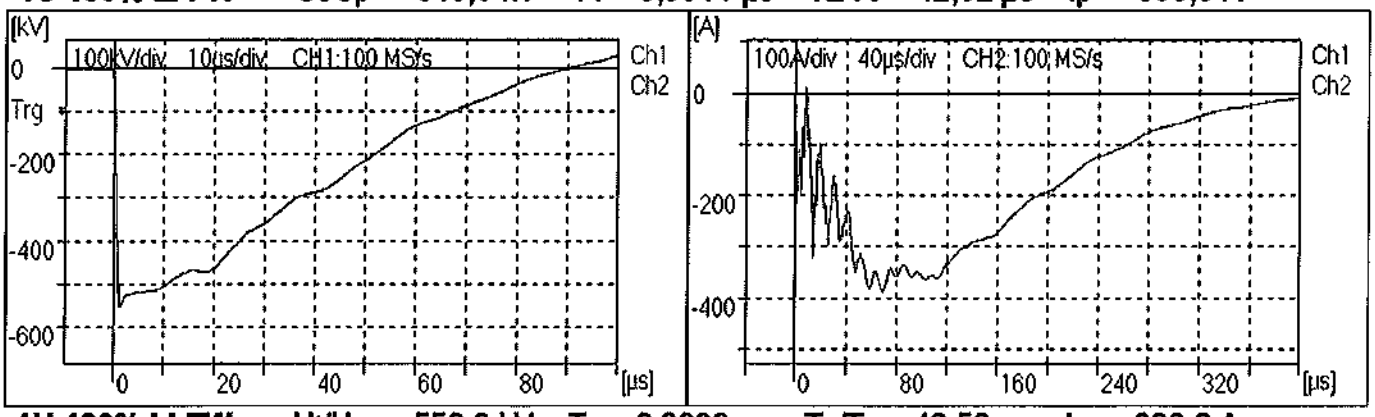
1U 50% LI RW Ut/Up = -279,0 kV T1 = 0,9845 µs T2/Tc = 42,40 µs Ip = -195,6 A



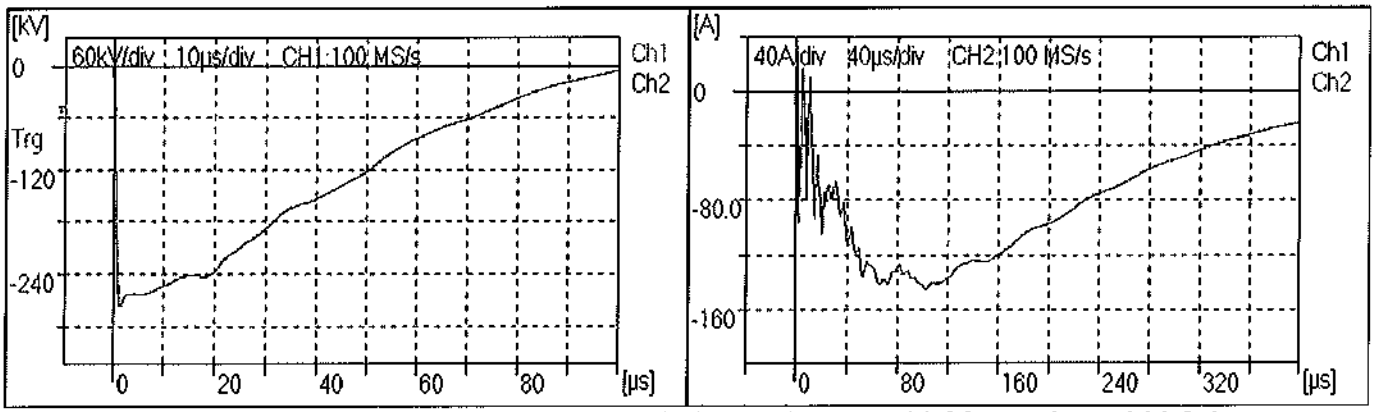
1U 100% LI FW Ut/Up = -547,9 kV T1 = 0,9918 µs T2/Tc = 42,60 µs Ip = -385,8 A



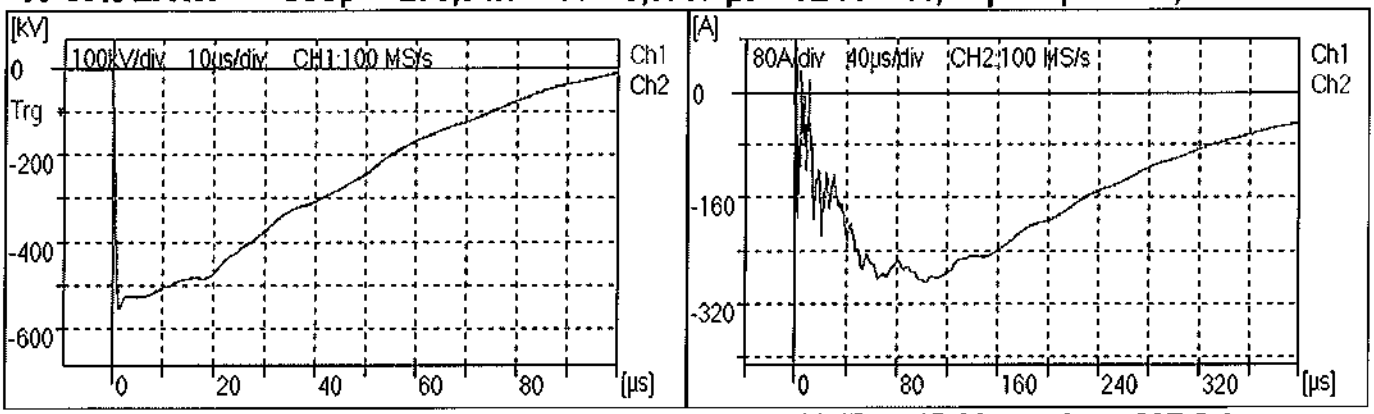
1U 100% LI FW Ut/Up = -549,5 kV T1 = 0,9914 µs T2/Tc = 42,62 µs Ip = -386,9 A



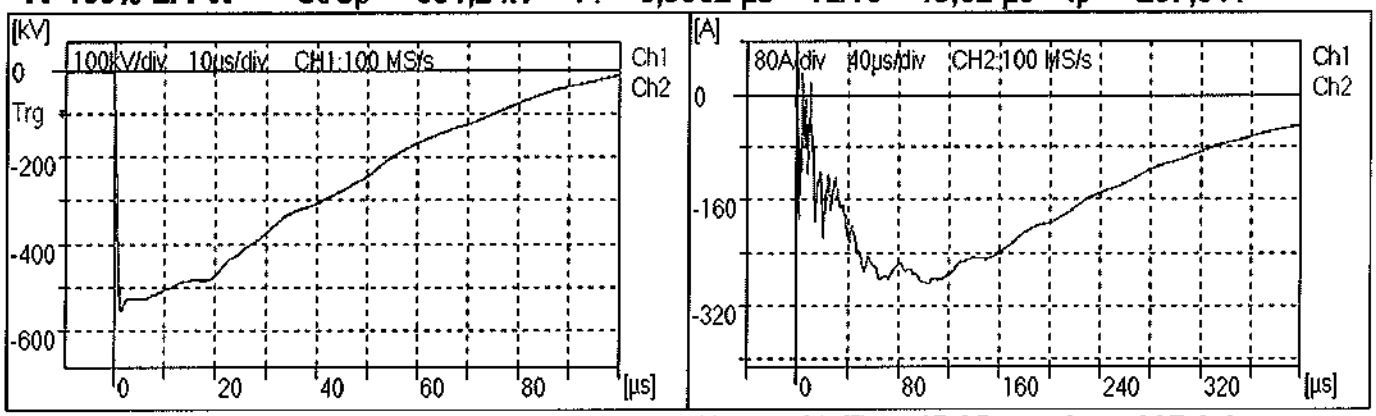
1U 100% LI FW Ut/Up = -550,0 kV T1 = 0,9932 µs T2/Tc = 42,58 µs Ip = -386,8 A



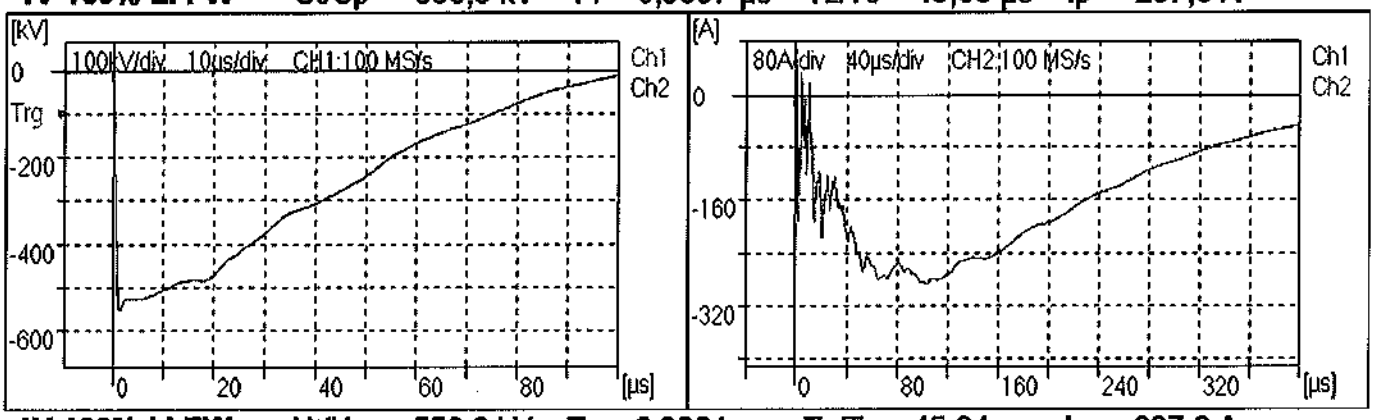
1V 50% LI RW Ut/Up = -275,9 kV T1 = 0,9737 µs T2/Tc = 44,86 µs Ip = -144,2 A



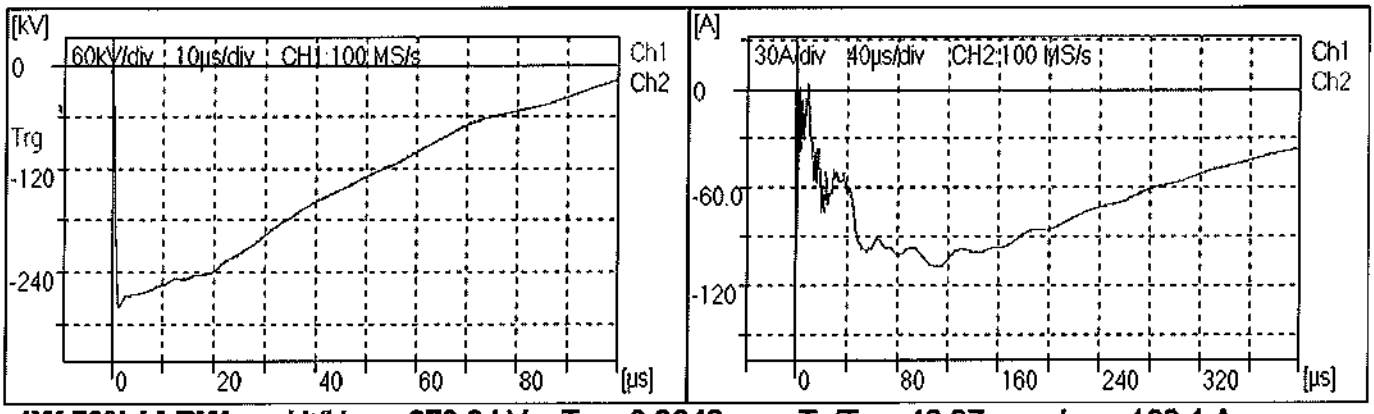
1V 100% LI FW Ut/Up = -551,2 kV T1 = 0,9902 µs T2/Tc = 45,02 µs Ip = -287,8 A



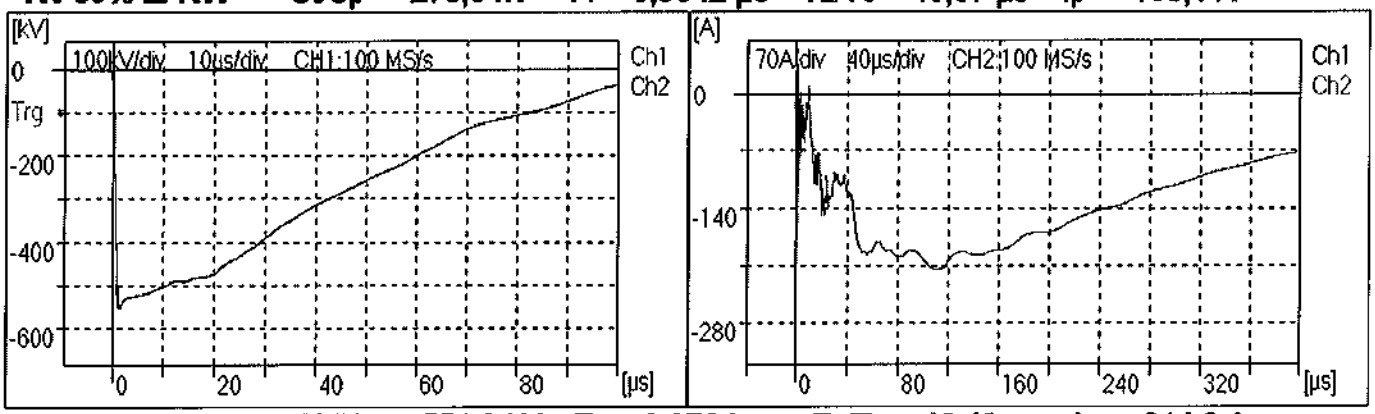
1V 100% LI FW Ut/Up = -550,5 kV T1 = 0,9897 µs T2/Tc = 45,05 µs Ip = -287,3 A



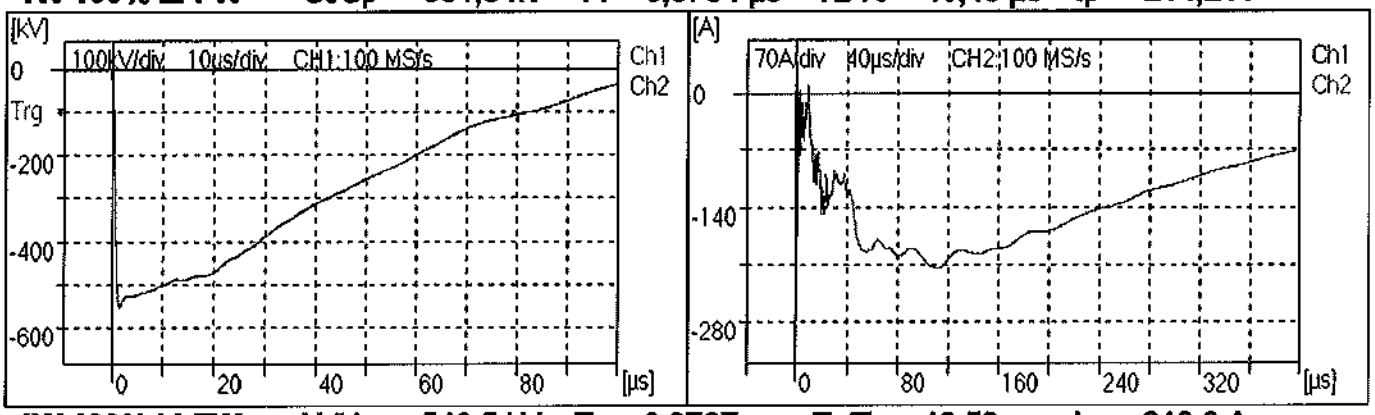
1V 100% LI FW Ut/Up = -550,6 kV T1 = 0,9884 µs T2/Tc = 45,04 µs Ip = -287,2 A



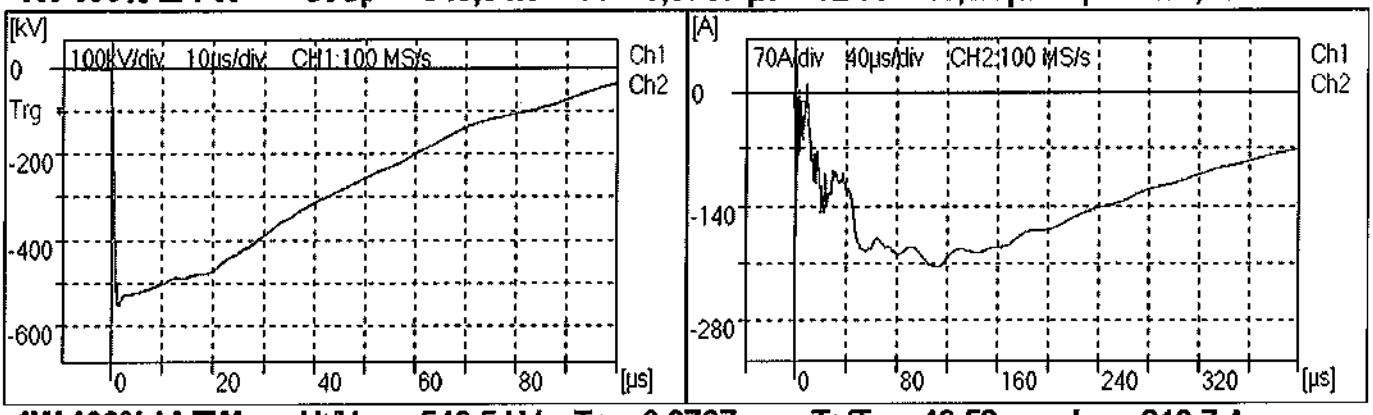
1W 50% LI RW Ut/Up = -278,9 kV T1 = 0,9642 µs T2/Tc = 46,37 µs Ip = -108,1 A



1W 100% LI FW Ut/Up = -551,3 kV T1 = 0,9784 µs T2/Tc = 46,48 µs Ip = -214,2 A



1W 100% LI FW Ut/Up = -549,5 kV T1 = 0,9767 µs T2/Tc = 46,52 µs Ip = -213,6 A



1W 100% LI FW Ut/Up = -549,5 kV T1 = 0,9767 µs T2/Tc = 46,52 µs Ip = -213,7 A

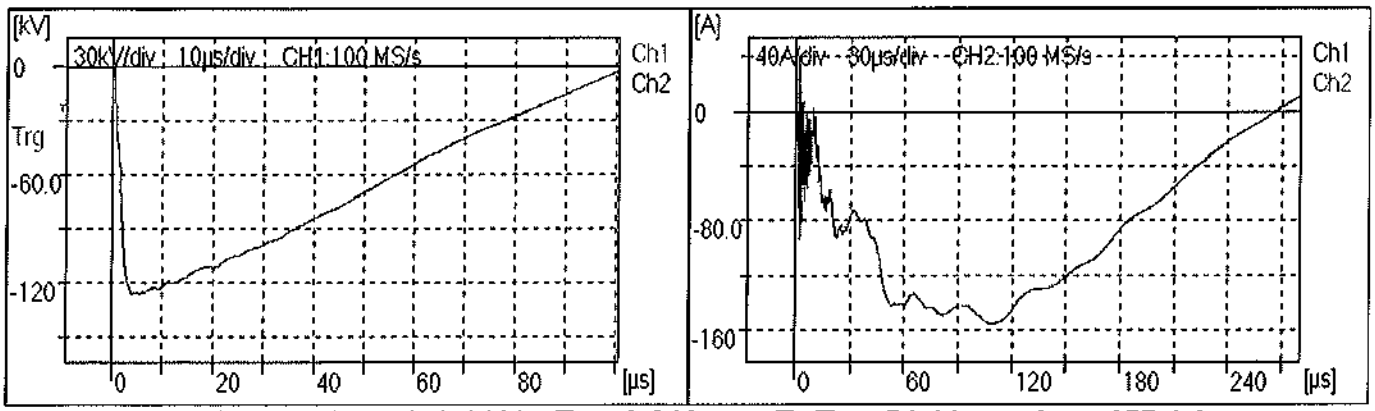
6. Testing of neutral terminal 1N of Winding HS

6.1. Connection of terminals

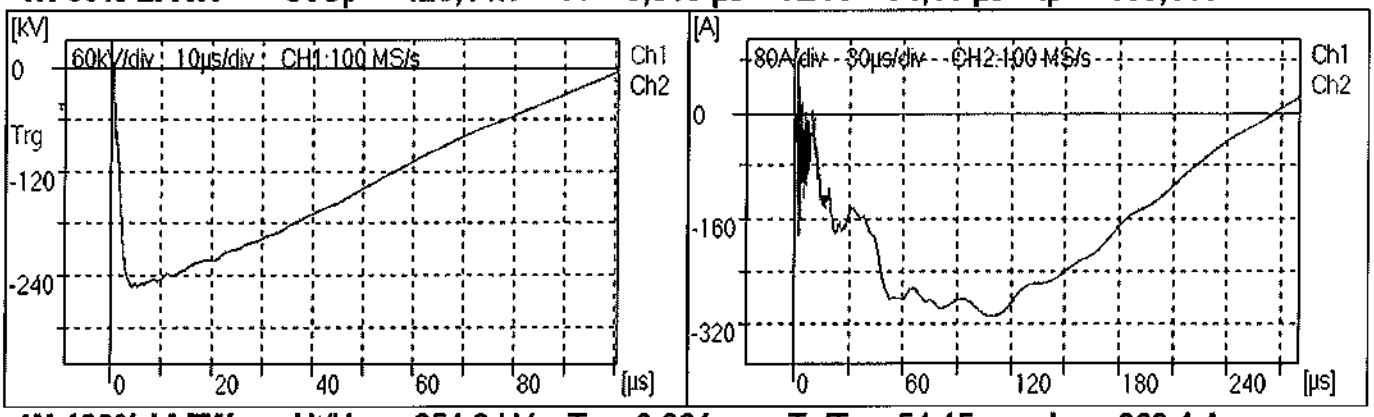
neutral terminal 1N	connected to the impulse voltage generator
line terminals of the winding under test	short circuited and earthed through shunt S1
2U, 2V, 2W	short circuited and directly earthed
S_{r1}, S_{s1}, S_{t1}	short circuited and directly earthed

6.2. Order of tests

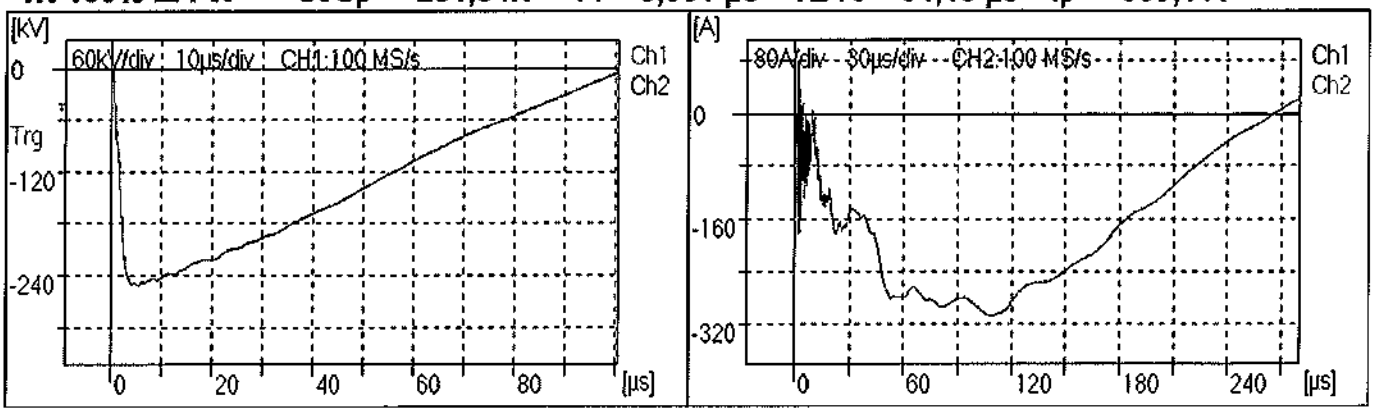
Terminal	Tap position	Description	Page
1N	1	Applied voltage and current through shunt S1 oscillograms	7



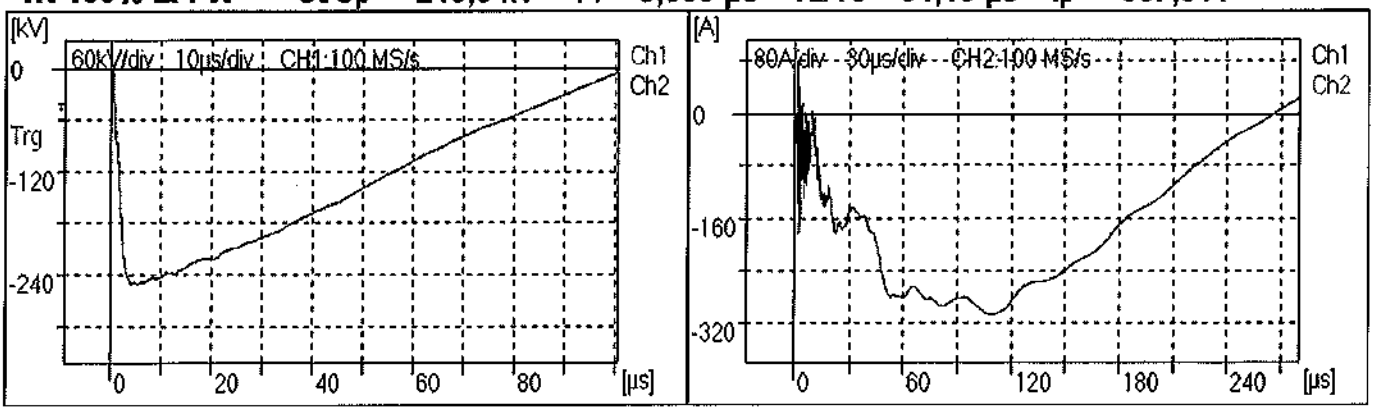
1N 50% LI RW Ut/Up = -126,1 kV T_1 = 3,043 µs T_2/T_c = 54,11 µs Ip = -155,1 A



1N 100% LI FW Ut/Up = -251,3 kV T_1 = 3,061 µs T_2/T_c = 54,15 µs Ip = -309,1 A



1N 100% LI FW Ut/Up = -249,8 kV T_1 = 3,058 µs T_2/T_c = 54,19 µs Ip = -307,5 A



1N 100% LI FW Ut/Up = -249,8 kV T_1 = 3,061 µs T_2/T_c = 54,19 µs Ip = -307,3 A

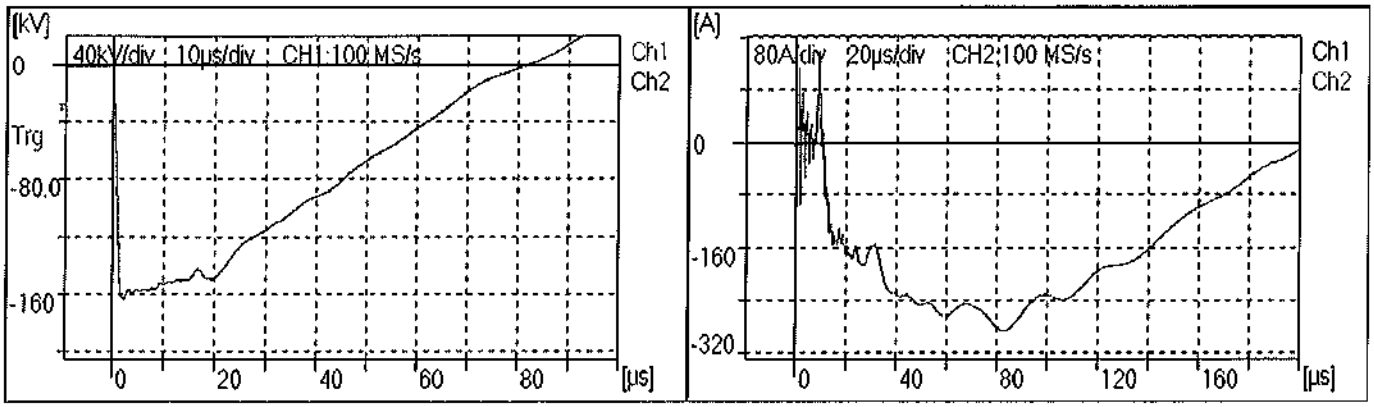
7. Testing of Winding LS

7.1. Connection of terminals

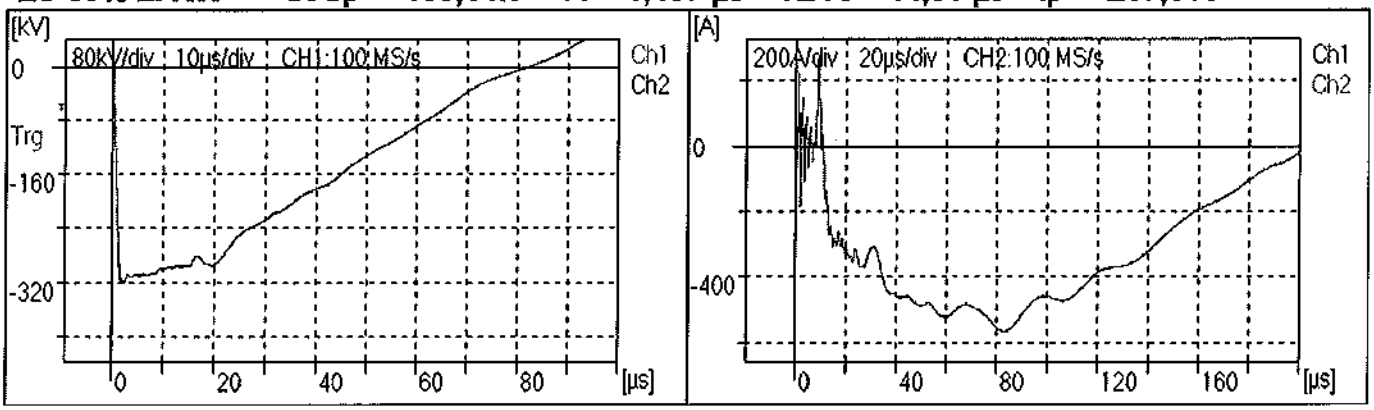
line terminal under test	connected to the impulse voltage generator
other line terminals of the winding under test	earthed through shunt S1
1U, 1V, 1W, 1N	short circuited and directly earthed
S_{r1}, S_{s1}, S_{t1}	short circuited and directly earthed

7.2. Order of tests

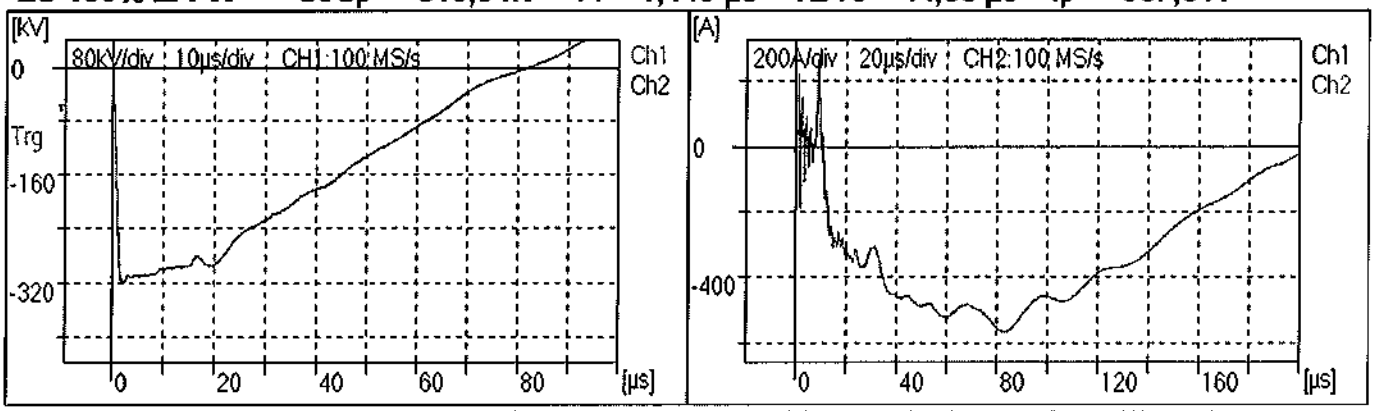
Terminal	Tap position	Description	Page
2U	-	Applied voltage and current through shunt S1 oscillograms	9
2V	-	Applied voltage and current through shunt S1 oscillograms	10
2W	-	Applied voltage and current through shunt S1 oscillograms	11



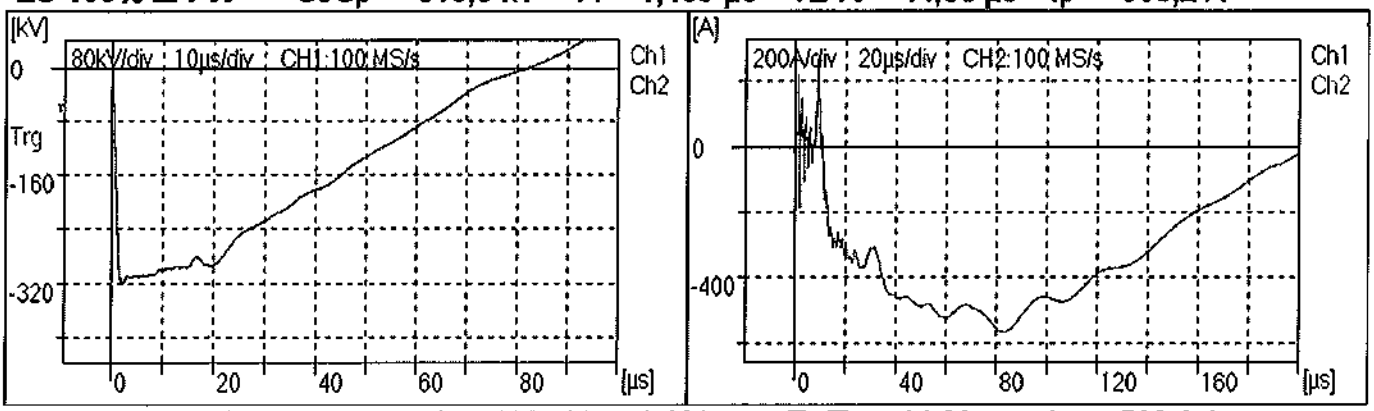
2U 50% LI RW Ut/Up = -163,1 kV T_1 = 1,437 µs T_2/T_c = 44,81 µs Ip = -287,3 A



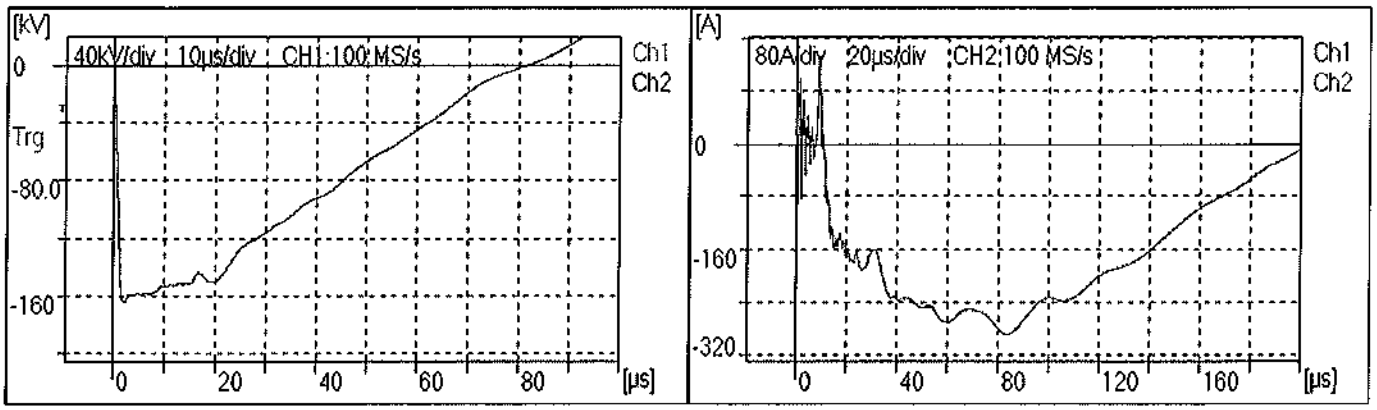
2U 100% LI FW Ut/Up = -319,9 kV T_1 = 1,440 µs T_2/T_c = 44,88 µs Ip = -567,6 A



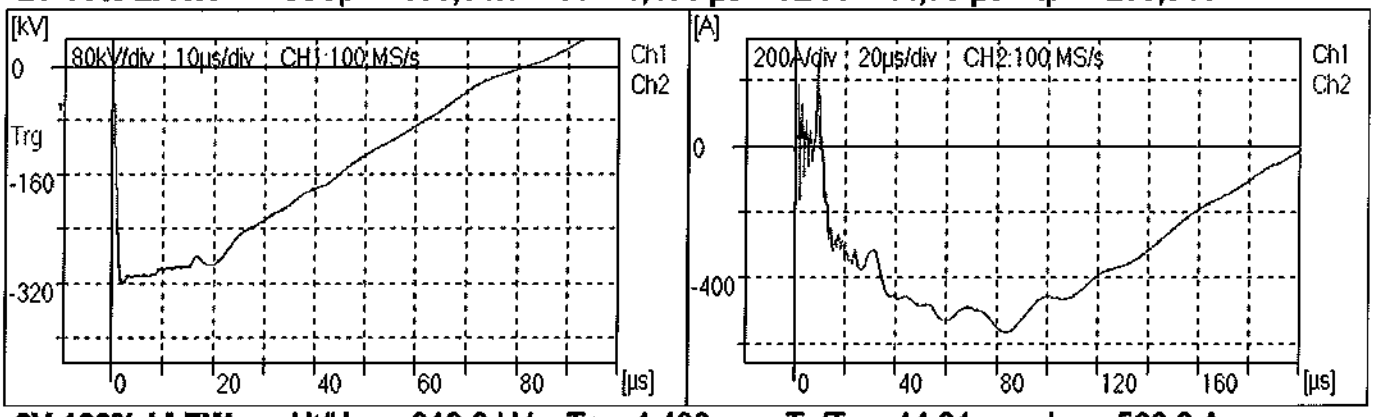
2U 100% LI FW Ut/Up = -319,9 kV T_1 = 1,439 µs T_2/T_c = 44,88 µs Ip = -568,2 A



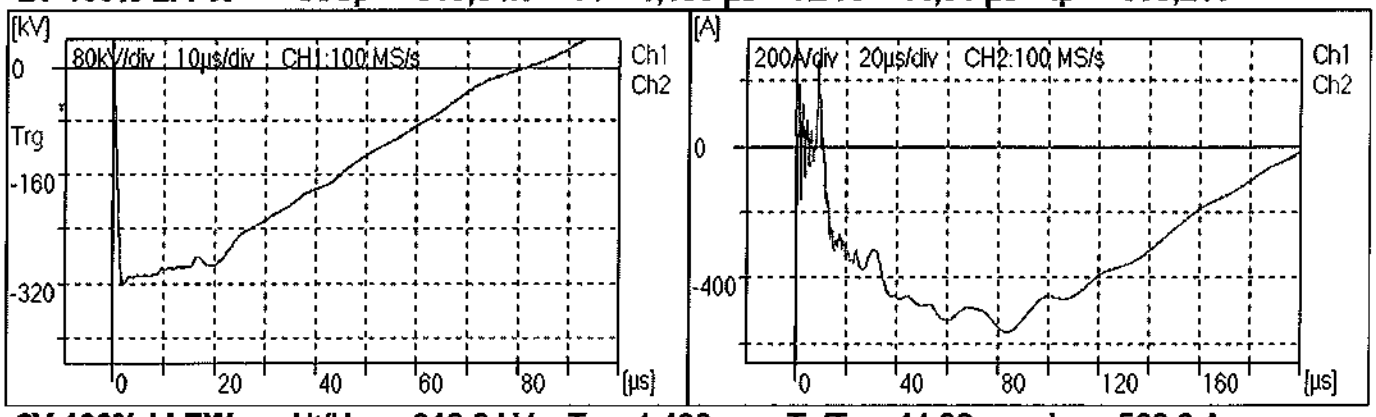
2U 100% LI FW Ut/Up = -319,8 kV T_1 = 1,439 µs T_2/T_c = 44,89 µs Ip = -568,3 A



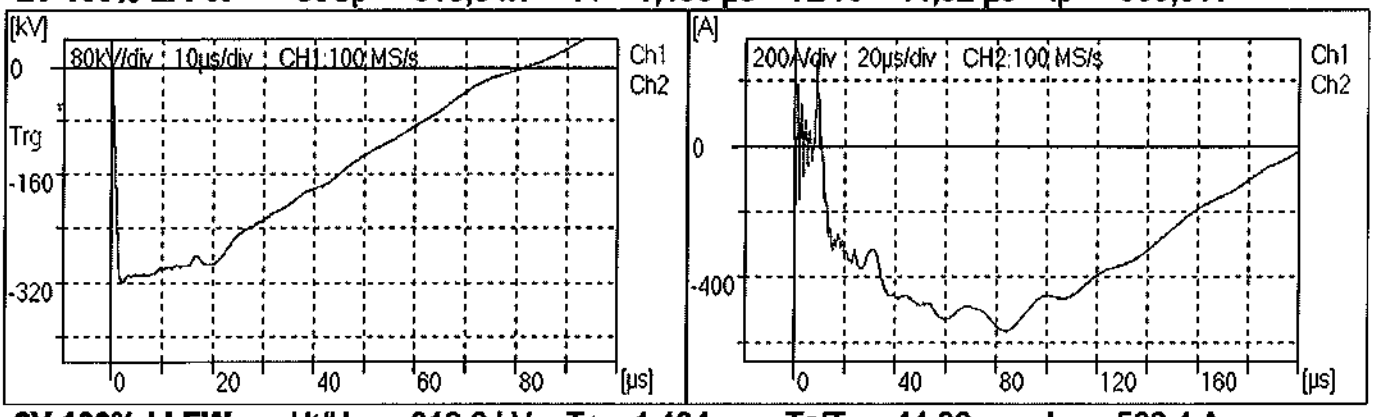
2V 50% LI RW Ut/Up = -163,8 kV T1 = 1,431 µs T2/Tc = 44,73 µs Ip = -288,9 A



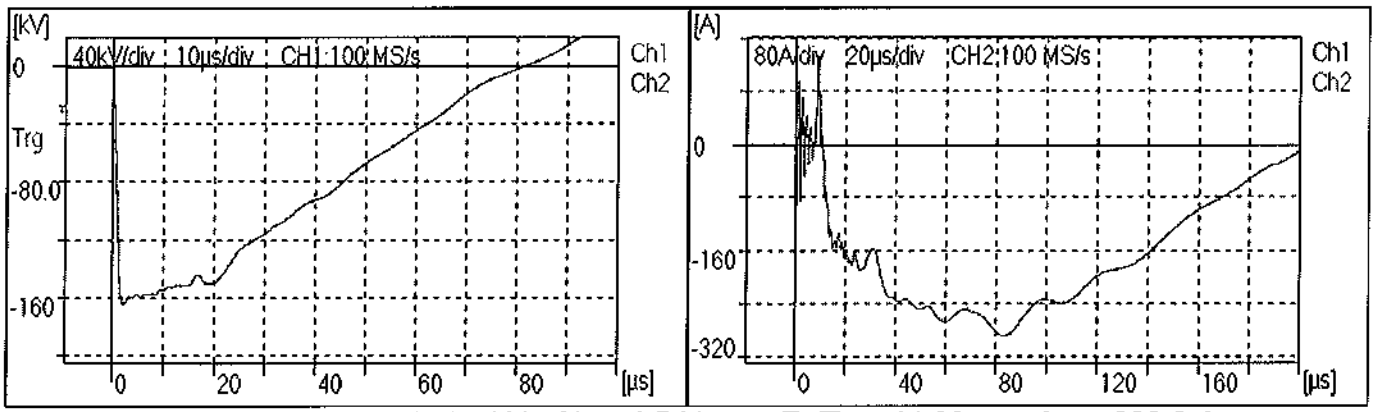
2V 100% LI FW Ut/Up = -319,0 kV T1 = 1,433 µs T2/Tc = 44,81 µs Ip = -566,2 A



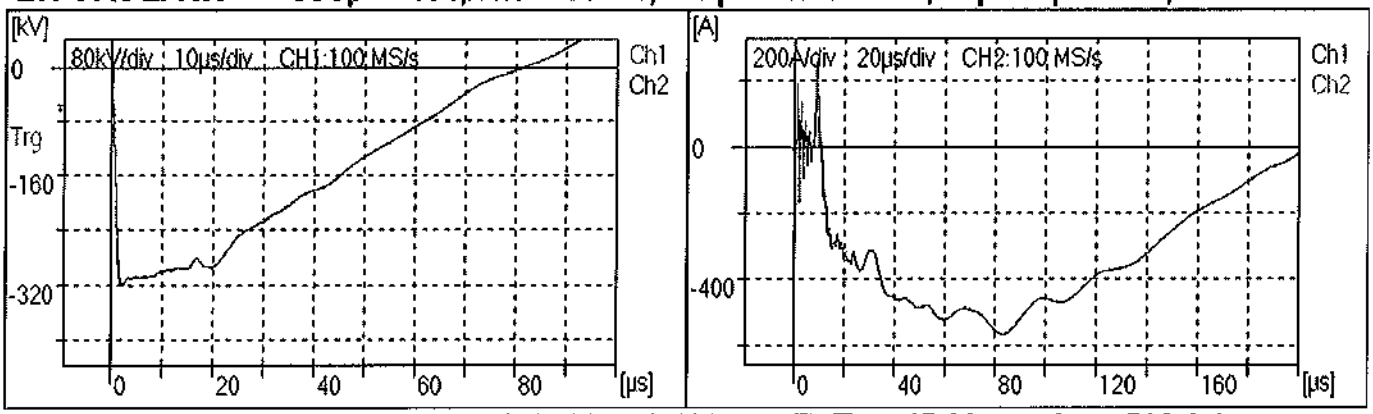
2V 100% LI FW Ut/Up = -318,8 kV T1 = 1,433 µs T2/Tc = 44,82 µs Ip = -566,3 A



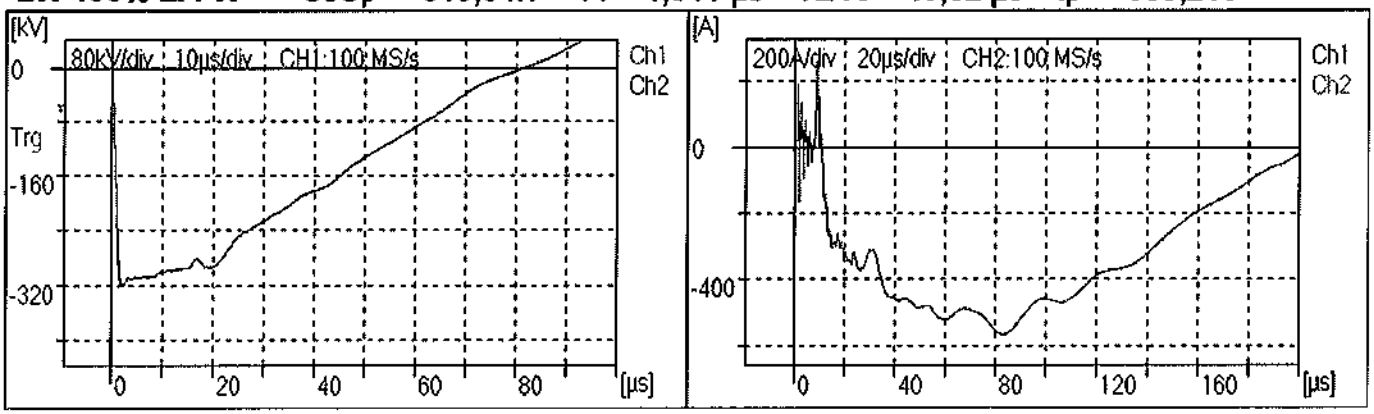
2V 100% LI FW Ut/Up = -319,0 kV T1 = 1,434 µs T2/Tc = 44,80 µs Ip = -566,4 A



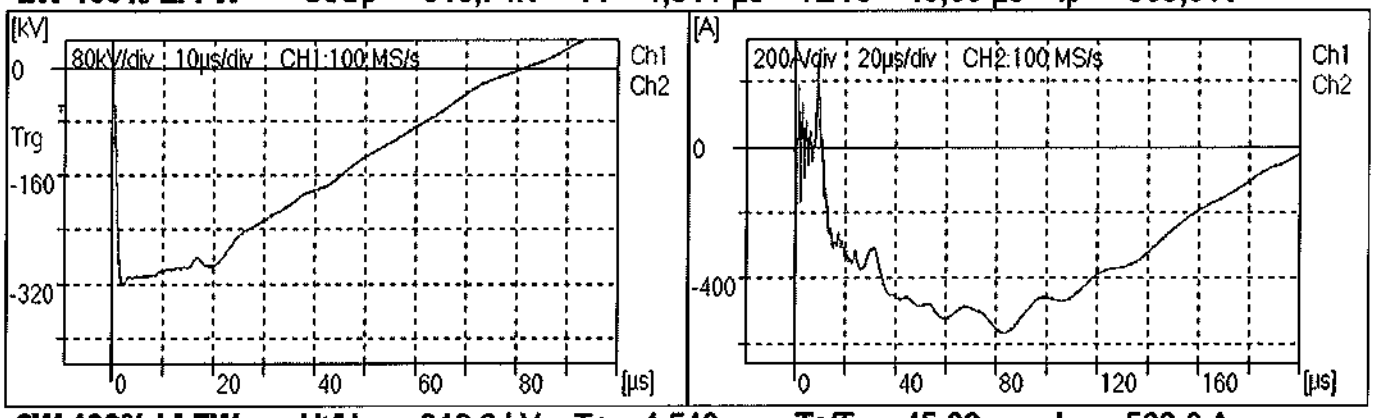
2W 50% LI RW Ut/Up = -164,2 kV T1 = 1,541 µs T2/Tc = 44,93 µs Ip = -289,8 A



2W 100% LI FW Ut/Up = -319,5 kV T1 = 1,541 µs T2/Tc = 45,02 µs Ip = -568,2 A

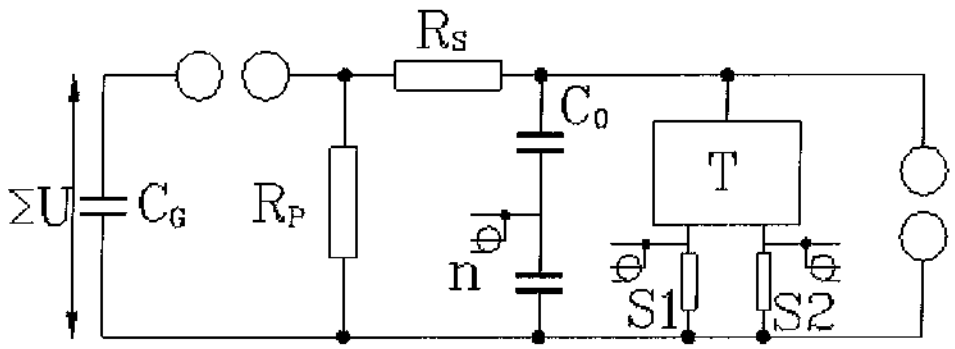


2W 100% LI FW Ut/Up = -319,7 kV T1 = 1,544 µs T2/Tc = 45,03 µs Ip = -568,0 A



2W 100% LI FW Ut/Up = -319,6 kV T1 = 1,543 µs T2/Tc = 45,02 µs Ip = -568,0 A

8.1 Equivalent lightning impulse circuit



8.2 Impulse circuit´s constants

	Winding HS	Neutral terminal 1N	Winding LS	
C_G (pF)	166667	166667	500000	
R_S (Ω)	140	140	80	
R_P (Ω)	396	396	316	
C_0 (pF)	670	670	670	
C_1 (pF)	-	-	-	
S1 (Ω)	0,5	0,5	0,5	

KONČAR D&ST

MEASUREMENT OF CAPACITANCES AND DISSIPATION FACTOR OF WINDINGS

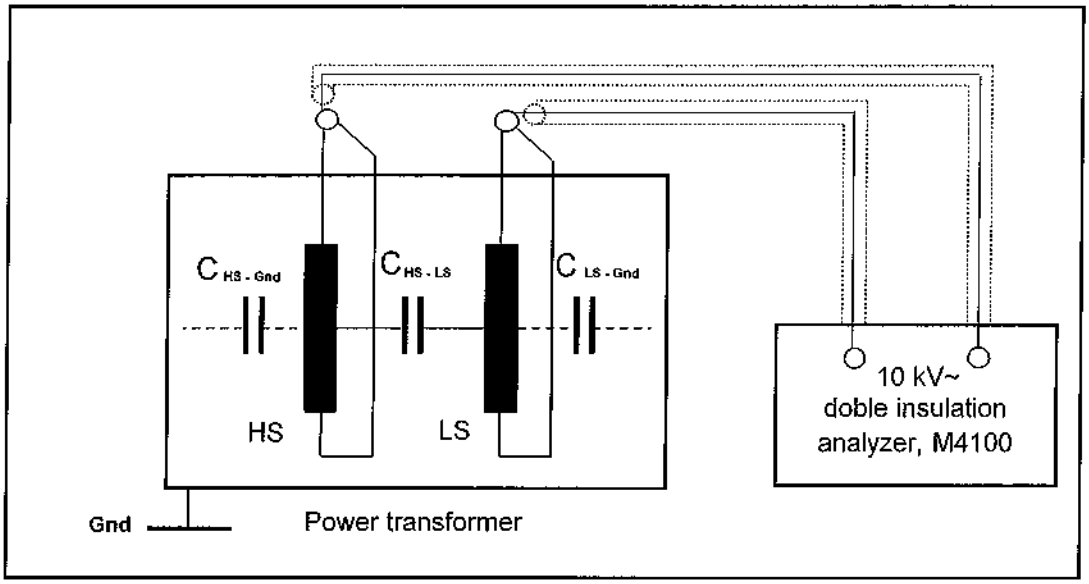
Test report No :	K1248
Page :	1 / 1

NOTE : Before Short-circuit withstand test (IEC 60076-5)

1.0. RATING VALUES

Transformer type :	TRP 80000-145/E	Vector Group :	YNd5+syn0
Rated power (kVA) :	80000	Type of cooling :	ONAN/ONAF
Rated voltage (kV) :	140 / 57,5 / 0,4674	Frequency (Hz) :	50
Serial No. :	ET1036 - 464170	Tested in accordance :	IEC 60076-1

2.0. TEST CIRCUIT



3.0. TEST RESULTS

Measured combination	HS - Gnd	HS - LS	LS - Gnd	HS - (LS + Gnd)	LS - (HS + Gnd)	
Measured at oil temperature 28 °C						
tanδ (%)	0,292	0,195	0,296	0,226	0,256	
C (pF)	4897,0	9563,8	15237,4	14461,4	24800,2	
Ut (kV)	10	10	10	10	10	
Corrected values to 20 °C						
tanδ (%)	0,248	0,166	0,252	0,192	0,218	

NOTE: During the test hjälplindning was short-circuited and grounded.

Tested by :	Approved by :	Date and stamp :
Vedran Gojević, dipl.ing.	Vedran Maljković, dipl.ing.	14.06.2019.

Appendix B Routine tests after the short-circuit tests

Routine tests after the short-circuit tests were carried out at the factory of the manufacturer on 23 August 2019 in presence of a KEMA Laboratories inspector.
See enclosed report on the following pages.

KONČAR D&ST

TRANSFORMER TEST REPORT

After Short-circuit withstand test (IEC 60076-5)

TRANSFORMER

Type: TRP 80000-145/E
Serial No. : ET1036 - 464170

ROUTINE TESTS:	TEST REPORT No.:	Page :	STANDARD
Measurement of voltage ratio and check vector group	464170	2 / 7	IEC 60076-1 (11.3)
Measurement of winding resistance	464170	2,3 / 7	IEC 60076-1 (11.2)
Measurement of short-circuit impedance and load losses	464170	4 / 7	IEC 60076-1 (11.4)
Measurement of no-load losses and current	464170	5 / 7	IEC 60076-1 (11.5)
Three phase measurement of no-load current at 400V and 50Hz	464170	5 / 7	
Insulation resistance of the windings and check of core insulation	464170	6 / 7	IEC 60076-1 (11.1.2; 11.12)
Applied voltage test (AV)	464170	6 / 7	IEC 60076-3 (10)
Line terminal AC withstand test (LTAC)	464170	6 / 7	IEC 60076-3 (12)
Test on on-load tap changer	464170	6 / 7	IEC 60076-1 (11.7)
Check of auxiliary equipment according to drawing CS5530	464170	6 / 7	
Determination of capacitances winding -to-earth, and between windings	K1249	---	IEC 60076-1 (11.1.2; 11.1.4)
Induced voltage test with PD measurement (IVW, IVPD)	464170	7 / 7	IEC 60076-3 (11.3)
Lightning impulse test (LI + LIN)	U2922	----	IEC 60076-3 (13.2. 13.4)
Test on insulating of oil	312/19	----	IEC 60156
Leak testing with pressure	OL464170	----	IEC 60076-1 (11.8)
TYPE AND SPECIAL TESTS:			
Measurement of zero-sequence impedance	464170	4 / 7	IEC 60076-1 (11.6)
Temperature-rise test	Z1283	---	IEC 60076-2
Determination of sound levels	B2027	---	IEC 60076-10
Chromatographic analysis of gases dissolved in oil	19/436, 19/437	---	IEC 61181 (Tbl.A.1)
Frequency response analysis	F528	---	IEC 60076-18
Short-circuit withstand test		---	IEC 60076-5
Auxiliary transformer - test report	12971	---	IEC 60076-11
Lx measurement before and after Short-circuit withstand test	I19025	---	IEC 60076-1 (11.9)

ALL SPECIFIED TESTS AND MEASUREMENTS WERE PERFORMED.
TRANSFORMER PASSED THE TESTS AND MEASUREMENTS MET SPECIFIED TOLERANCES.

The test was carried out in the presence of :

Mr. Ernst HANIQUE, Senior Inspector, KEMA Laboratories Arnhem Energy

DNV·GL
Ernst Hanique
Date: 20-08-2019
KEMA Laboratories

Tested by : V. Gojević, dipl.ing.

Approved by : V. Maljković, dipl.ing.

Date and stamp : 23 AUG. 2019

KONČAR Distributivni i specijalni transformatori d.d. Zagreb
ISPITNA STANICA TESTING STATION 4

TRANSFORMER

Serial No. : ET1036 - 464170

After Short-circuit withstand test (IEC 60076-5)

RATING PLATE

CE KONČAR D&ST

TREFASTRANSFORMATOR
TRP 80000-145/E

STANDARD
IEC 60076

SERIENUMMER	ET1036- 464170		TILLVERKNINGSÅR	2019.	
MÄRKEFFEKT	80 MVA		ANTAL FASER	3	
KOPPLING	YNd5 + syn0		MÄRKFREKVENS	50 Hz	
KYLNINGSTYP	ONAN/ONAF (63/80 MVA)				
OLJETYP	ERGON HYVOLT III ACC. TO IEC 60296				
P_0 28,88 kW	P_k 213,15 kW		P_{cc} 0 kW		
PEI 0,998039 %	KÄRNMATERIAL / VIKT		GOES / 35.0 t		
k_{sc} 0,368092 pu	LINDNINGSMATERIAL / VIKT		KOPPAR / 17.5 t		
OLJEVIKT	18.5 t		VIKT AKTIV DEL	60.3 t	
VIKT VID LYFT AV AKTIV DEL	62.5 t		TOTALVIKT	98.5 t	
TRANSPORTVIKT (MED OLJA)	89.5 t		TRANSPORTVIKT (UTAN OLJA)	74.5 t	
MAX. OMG.TEMP. 40 °C	LINDN.TEMP.STEGRING 65 K		OLJETEMPERATURSTEGRING 60 K		
LINDNINGSKOPPLARTYP	MR VM III 500Y-72.5/B-10 19 1G		SERIENUMMER LK 2061147		

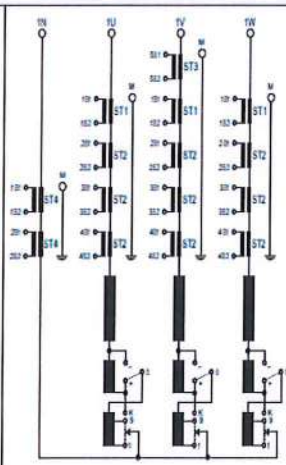
TANK, EXPANSIONSKÄRL OCH RADIATORER ÄR KONSTRUERADE ATT TÅLA FULLT VACUUM

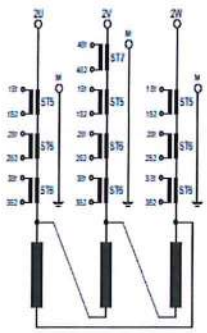
LÄGE	MÄRKSPÄNNING (V)		MÄRKSTRÖM (A)		KORTSLUTNINGS-IMPEDANS (%)
	HS	LS	HS	LS	
1	161042	57500	286.8	803.3	13,81
10	140000		329.9		12,63
19	118958		388.3		11,77

LINDNING	Um (kV)	ISOLATIONSNIVÅ	KORTSLUTNINGSEFFEKT
HS	145	LI550 AV230 - LI250 AV95	10000 MVA / 2s
LS	72.5	LI325 AV140	3000 MVA / 2s

STRÖMTRANSFORMATOR			
LÄGE	OMSÄTTNING	EFFEKT	KLASS
ST1	500/2 A	10 VA	0.2sFs5
ST2	500/1 A	20 VA	5P20
ST3	390/2 A	10 VA	3Fs5
ST4	500/1 A	20 VA	5P20
ST5	1200/2 A	10 VA	0.2sFs5
ST6	1200/1 A	20 VA	5P20
ST7	805/2 A	10 VA	3Fs5

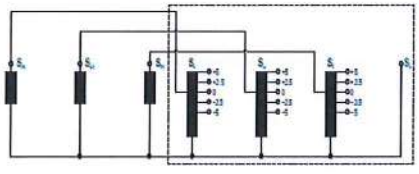
HJÄLPLINDNING 200 kVA; 467.4 V; 247.0 A





LINDNING	LÄGE	GROVVÄLJARENS LÄGE		MÄRKSPÄNNING (V)	MÄRKSTRÖM (A)
HS	1		1	161042	286.8
	2		2	158704	291.0
	3		3	156366	295.4
	4		4	154028	299.9
	5	0 +	5	151690	304.5
	6		6	149352	309.3
	7		7	147014	314.2
	8		8	144676	319.3
	9		9	142338	324.5
	10		K	140000	329.9
	11		1	137662	335.5
	12		2	135324	341.3
	13		3	132986	347.3
	14		4	130648	353.5
	15	0 -	5	128310	360.0
	16		6	125972	366.7
	17		7	123634	373.6
	18		8	121296	380.8
	19		9	118958	388.3

LS		57500	803.3



GENERALAGENT:
HELMER VERKEN
PARTILLE, SVERIGE
TEL. 031-445456

B72690

TILLVERKAD I KROATIEN (ZAGREB)

DNV·GL

Ernst Hanique

Date: 23 AUG. 2019

KEMA Laboratories

KONČAR D&ST

TRANSFORMER TEST REPORT

Serial No. DNV·GL
Ernst Hanique
Date: 23 AUG. 2019
KEMA Laboratories
464170

After Short-circuit withstand test (IEC 60076-5)

1 . 0 .	RATING VALUES				
Transformer type :	TRP 80000-145/E		Tap-changer type :	MR VM III 500Y-72,5/B-10 19 1G	
Serial No. :	464170		Serial No. :	2061147	
Winding :	HS	LS	Aux. winding		
Insulation level :	LI550 AV230 - LI250 AV95	LI325 AV140	AV3		Part No.: ET1036
Rated power (kVA)	80000	80000	200		Transport mass (t): 74,5
	161042				Oil mass (t): 18,5
Rated voltage (V)	140000	57500	467,4		Total mass (t): 98,5
	118958				Frequency (Hz): 50
	286,8				Vector group: YNd5+syn0
Rated current (A)	329,9	803,3	247,0		Type of cooling: ONAN/ONAF
	388,3				Tested in acc.: IEC60076

2 . 0 .	TEST RESULTS				
2. 1. 1.	Impedance voltage at 80MVA and 75°C			Impedance voltage at 0,2MVA and 75°C	
Winding :	HS / LS			Aux. winding / HS	Aux. winding / LS
Tap position	1	10	19	10	----
Rated (%)	----	12,00	----	----	----
Guaranteed (%)	----	11,1 - 12,9	----	----	----
Measured (%)	13,81	12,63	11,77	0,86	0,87
2. 1. 2.	Load losses at 80MVA and 75°C			Load losses at 0,2MVA and 75°C	
Rated (k W)	----	223,00	----	----	----
Guaranteed (k W)	----	227,46	----	----	----
Measured (k W)	218,45	213,15	222,51	0,588	0,589

2 . 3 .	No - load loss and current				
	No-load losses			No-load current at 80MVA	
Voltage (%)	90,0	100,0	105,0	Voltage (%)	100,0
Rated (k W)	----	29,00	----	Rated (%)	0,120
Guaranteed (k W)	----	29,58	----	Guaranteed (%)	0,120
Measured (k W)	22,08	28,88	33,93	Measured (%)	0,052
2 . 4 .	Total losses at 80MVA and 75°C (no load + load losses)			Total losses at 0,2MVA and 75°C (no-load + load losses)	
Tap position	1	10	19	----	----
Rated (k W)	----	252,00	----	----	----
Guaranteed (k W)	----	257,04	----	----	----
Measured (k W)	247,33	242,02	251,39	29,47	29,47

2 . 5 .	Efficiency at 80MVA and 75°C				
	Winding HS / LS at position 10				
Load (%)	25	50	75	100	125
Measured PF=1.0 (%)	99,79	99,79	99,75	99,70	99,64
Guaranteed (%)	-----	-----	-----	-----	-----
Measured PF=0.8 (%)	99,74	99,74	99,69	99,62	99,55
Guaranteed (%)	-----	-----	-----	-----	-----

2 . 6 .	Variation of the secondary voltage		Load (%)	100	125
Guaranted PF=1.0 (%)	-----	-----	Measured (%)	1,06	1,33
Guaranted PF=0.8 (%)	-----	-----	Measured (%)	8,28	10,36

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TRANSFORMER TEST REPORT

After Short-circuit withstand test (IEC 60076-5)

Serial No. : 464170

TRANSFORMER TYPE : TRP 80000-145/E

Part No.: ET1036

3 . 0 . Measurement voltage ratio and vector group

Tap position	Phase 1U - 2U (%)	Phase 1V - 2V (%)	Phase 1W - 2W (%)	Voltage (V)	Calculated ratio
1	0,05	0,05	0,06	161042	2,801
2	0,05	0,05	0,06	158704	2,760
3	0,05	0,05	0,06	156336	2,719
4	0,05	0,05	0,06	154028	2,679
5	0,05	0,05	0,06	151690	2,638
6	0,05	0,05	0,06	149352	2,597
7	0,05	0,05	0,06	147014	2,557
8	0,05	0,05	0,06	144676	2,516
9	0,05	0,05	0,06	142338	2,475
10	0,05	0,04	0,05	140000 / 57500	2,435
11	0,05	0,05	0,06	137662	2,394
12	0,05	0,05	0,06	135324	2,353
13	0,05	0,05	0,06	132986	2,313
14	0,05	0,05	0,06	130648	2,272
15	0,05	0,05	0,06	128310	2,231
16	0,05	0,05	0,06	125972	2,191
17	0,05	0,05	0,06	123634	2,150
18	0,05	0,05	0,06	121296	2,109
19	0,05	0,05	0,06	118958	2,069
(HS / LS)	Vector group is :	YNd5			

Tap position	Phase 1U - Sr1 (%)	Phase 1V - Ss1 (%)	Phase 1W - St1 (%)	Voltage (V)	Calculated ratio
10	0,06	0,05	0,07	140000 / 467,4	299,529
(1 / Aux. Winding)	Vector group is :	YNyn0			

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Date: 23 AUG. 2019

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3 . 1 . Measurement of winding resistance (Ω) (measured at temperature 28°C)

Winding HS	1U - 1V	1U - 1W	1V - 1W
1	0,7193	0,7191	0,7191
10	0,5688	0,5682	0,5677
19	0,4589	0,4588	0,4586
Winding LS	**2U - 2V**	**2U - 2W**	**2V - 2W**
----	0,06502	0,06535	0,06495
Aux. winding	**Sr1 - Ss1**	**Sr1 - St1**	**Ss1 - St1**
----	0,004945	0,004950	0,004358

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TRANSFORMER TEST REPORT

After Short-circuit withstand test (IEC 60076-5)

Serial No. : 464170

TRANSFORMER TYPE : TRP 80000-145/E

Part No.: ET1036

3 . 1 .	Measurement of winding resistance (Ω)			(measured at temperature 28°C)	
Winding HS	1U - 1N	1V - 1N	1W - 1N		
1	0,3601	0,3597	0,3592		
2	0,3518	0,3514	0,3515		
3	0,3433	0,3431	0,3432		
4	0,3350	0,3348	0,3348		
5	0,3266	0,3264	0,3264		
6	0,3183	0,3181	0,3181		
7	0,3101	0,3097	0,3098		
8	0,3017	0,3014	0,3014		
9	0,2935	0,2932	0,2932		
10	0,2849	0,2841	0,2837		
11	0,2964	0,2960	0,2962		
12	0,2880	0,2876	0,2877		
13	0,2796	0,2793	0,2794		
14	0,2713	0,2710	0,2711		
15	0,2630	0,2627	0,2627		
16	0,2546	0,2543	0,2543		
17	0,2464	0,2460	0,2460		
18	0,2380	0,2376	0,2377		
19	0,2298	0,2294	0,2294		
Aux. winding	Sr1 - Sn	Ss1 - Sn	St1 - Sn		
----	0,00353	0,00294	0,00238		

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TRANSFORMER TEST REPORT

After Short-circuit withstand test (IEC 60076-5)

Serial No. : 464170
Ernst Hanique
Date: 23 AUG. 2019
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TRANSFORMER TYPE : TRP 80000-145/E — Part No.: ET1036

2 . 1 . Load losses and impedance voltage measurement

Combination **		HS / LS	HS / LS	HS / LS	Aux. winding / HS	Aux. winding / LS
Tap position		1	10	19	10	----
Temperature	(°C)	28	28	28	28	28
Frequency	(Hz)	50	50	50	50	50
Measured voltage	(u-v)	12699	10109	7595	3,12	3,23
	(u-w)	12723	10125	7611	3,69	3,81
	(v-w)	12718	10128	7617	3,29	3,40
Average		12713	10121	7608	3,37	3,48
Constant		1	1	1	1	1
VOLTAGE	(V)	12713	10121	7608	3,37	3,48
Measured current	(u)	164,5	189,5	211,6	210,8	213,5
	(v)	163,8	189,0	211,2	211,3	213,9
	(w)	163,5	188,2	210,2	208,8	211,3
Average		163,9	188,9	211,0	210,3	212,9
Constant		1	1	1	1	1
CURRENT	(A)	163,9	188,9	211,0	210,3	212,9
Measured power	(u)	25110	26440	25600	113,8	117,1
	(v)	17050	15610	14690	125,4	128,8
	(w)	22660	20430	17990	140,5	143,6
Total		64820	62480	58280	379,7	389,5
Constant		1	1	1	1	1
LOAD LOSSES	(W)	64820	62480	58280	379,7	389,5
Calculated to	(kVA	80000	80000	80000	200	200
	(A)	286,8	329,9	388,3	247,0	247,0
LOAD LOSSES	(W)	198406	190581	197345	524,0	524,5
I2 R losses	(W)	151751	155787	166756	435,5	435,3
Stray losses	(W)	46655	34794	30589	88,5	89,1
Impedance voltage	(V)	22242,4	17675,8	13999,2	3,95	4,04
	(%)	13,812	12,626	11,768	0,846	0,864
Temperature	(°C)	75	75	75	75	75
I2 R losses	(W)	178870	183627	196557	513,4	513,1
Stray losses	(W)	39582	29519	25951	75,1	75,6
LOAD LOSSES	(W)	218451	213146	222508	588,4	588,8
Impedance voltage	(V)	22243,2	17676,6	14000,1	4,00	4,09
	(%)	13,812	12,626	11,769	0,857	0,874

NOTE : Measuring equipement : YOKOGAWA Power Analyser
** : Connected / Short-circuit winding

2. 1. 1. Measurement of zero-sequence impedance

Winding / Tap	Voltage (V)	Current (A)	Imped. (Ω/phase)	Ro (Ω / phase)	Xo (Ω / phase)
HS / 1	1442,5	100,94	42,87	1,14	42,86
HS / 10	994,1	100,46	29,69	0,85	29,67
HS / 19	741,6	110,87	20,07	0,62	20,06

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TRANSFORMER TEST REPORT

After Short-circuit withstand test (IEC 60076-5)

Serial No. : 464170

TRANSFORMER TYPE : TRP 80000-145/E

Part No.: ET1036

2 . 3 .	No - load losses and no - load current measurement				
Voltage (%)	**90,0**	**100,0**	**105,0**	**110,0**	
RMS measured vltg. (u-v)	51760	57486	60341	63061	
(u-w)	51807	57536	60390	63111	
(v-w)	51736	57445	60278	62958	
Average	51768	57489	60336	63043	
Constant	1	1	1	1	
RMS VOLTAGE (V)	**51768**	**57489**	**60336**	**63043**	
Mean measured vltg. (u-v)	51702	57453	60357	63211	
(u-w)	51769	57536	60451	63313	
(v-w)	51710	57465	60371	63224	
Average	51727	57485	60393	63249	
Constant	1	1	1	1	
MEAN VOLTAGE (V)	**51727**	**57485**	**60393**	**63249**	
Form factor	1,111	1,110	1,109	1,106	
Measured current (u)	0,209	0,337	0,553	1,158	
(v)	0,286	0,400	0,602	1,178	
(w)	0,345	0,505	0,761	1,456	
Average	0,280	0,414	0,639	1,264	
Constant	1	1	1	1	
CURRENT (A)	**0,280**	**0,414**	**0,639**	**1,264**	
Measured power (u)	5131	6228	6619	6536	
(v)	7866	10836	13553	18202	
(w)	9103	11817	13723	16563	
Total	22100	28881	33895	41301	
Constant	1	1	1	1	
LOSSES (W)	**22100**	**28881**	**33895**	**41301**	
Correction (W)	**-17**	**-2**	**32**	**135**	
LOSSES (W)	**22083**	**28879**	**33927**	**41436**	

NOTE : Measuring equipement : YOKOGAWA Power Analyser

MEASUREMENT AT FREQUENCY 50 (Hz) ON WINDING : LS

The power was corrected to the sine - wave voltage basis .

2. 3. 1.	Single phase measurement of no - load current at 230 (V) and 50 (Hz)				
Winding	**Phase 1U (m A)**	**Phase 1V (m A)**	**Phase 1W (m A)**		
HS - tap position 10	1,3	0,7	1,6		

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Date: 23 AUG. 2019

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TRANSFORMER TEST REPORT

After Short-circuit withstand test (IEC 60076-5)

Serial No. : 464170

TRANSFORMER TYPE : TRP 80000-145/E

Part No.: ET1036

3 . 2 . Insulation resistance of the windings (MΩ)

(measured with 5000VDC at temperature 28°C)

Between	R 15 "	R 60 "	R 60 " / R 15 "		
HS - (LS + Aux. winding + core + core clamp + earth)	13800	17700	1,28		
LS - (HS + Aux. winding + core + core clamp + earth)	9100	18000	1,98		
Aux. winding - (HS + LS + core + core clamp + earth)	39000	57100	1,46		

Check of core insulation (MΩ)

(measured with 2500VDC at temperature 28°C)

Between	R 15 "	R 60 "	R 60 " / R 15 "		
core - (HS + LS + Aux. winding + core clamp + earth)	2850	6000	2,11		

3 . 3 . Dielectric test of the transformer

Lightning impulse test (LI + LIN) — Test report No.: U2922

	Between	Test voltage (kV)	Frequency (Hz)	Duration (sec)
Applied voltage (AV) test	HS - (LS + Aux. winding + core + core clamp + earth)	95	50	60
	LS - (HS + Aux. winding + core + core clamp + earth)	140	50	60
	Aux. winding - (HS + LS + core + core clamp + earth)	3	50	60
Line terminal AC withstand test (LTAC)	1U - (1V + 1W + earth)	230	200	30
	1V - (1U + 1W + earth)	230	200	30
	1W - (1U + 1V + earth)	230	200	30

NOTE : Winding HS - tap position 1.

1. Tap changer was tested in accordance with IEC 60076-1 (clause 11.7).
2. Functionally test of the auxiliary box has been done in accordance with drawing No.: CS5530.
3. Current transformers:

	Phase			
	1U	1V	1W	1N
ST1 - 500 / 2A; 10VA; 0.2sFs5; Ser.No.:	91006536	91006538	91006537	
ST2 - 500 / 1A; 20VA; 5P20; Ser.No.:				
ST3 - 390 / 2A; 10VA; 3Fs5; Ser.No.:				
ST4 - 500 / 1A; 20VA; 5P20; Ser.No.:				91006539
	2U	2V	2W	
ST5 - 1200 / 2A; 10VA; 0,2sFs5; Ser.No.:	91006540	91006542	91006541	
ST6 - 1200 / 1A; 20VA; 5P20; Ser.No.:				
ST7 - 805 / 2A; 10VA; 3Fs5; Ser.No.:				

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TRANSFORMER TEST REPORT

After Short-circuit withstand test (IEC 60076-5)

Serial No. : 464170

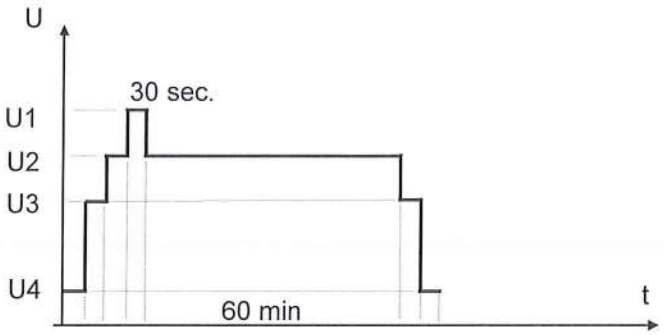
Page : 7 / 7

TRANSFORMER TYPE : TRP 80000-145/E

Part No.: ET1036

3 . 4 . 1. Induced voltage test with PD measurement (IVW, IVPD)

3 . 4 . 1. 1. Test sequence and levels



Standard:	IEC 60076-3
Supply	three-phase
Supplied terminals	2U - 2V - 2W
Tap position	10
Frequency (Hz)	200
U4 (kV)	56,0
U3 (kV)	168,0
U2 (kV)	221,2
U1 (kV)	275,0
Allowed PD at voltage level (pC)	
U3	<100
U2	<250

3 . 4 . 1. 2. Measuring equipement, calibration and background noise level

Measuring equipement:

PD detector: "Tettex" DDX9101

Calibrator: "Haefely" type 451

Calibration:

Calibraton performed with 100 pC

Calibration signal	1U	1V	1W
Measured (pC)			
1U	100	10	10
1V	10	100	10
1W	10	10	100

Background noise level with source connected and voltage 0 (V): < 10 pC

3 . 4 . 1. 3. Test and PD measurement

Voltage level	Duration (min)	Measured on phase (pC) 1U	1V	1W
U3	1,0	35	35	35
U2	5,0	45	45	45
U1	0,5	----	----	----
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U2	5,0	40	40	40
U3	1,0	40	40	40

3 . 4 . 1. 4. Results :

No collapse of voltage observed.

Measured level of PD is lower than in IEC 60076 - 3 specified.

TRANSFORMER PASSED IVPD TEST.

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Date: 23 AUG 2019

KEMA Laboratories

KONČAR - DISTRIBUTIVNI I SPECIJALNI TRANSFORMATORI d.d.
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E-mail: info@koncar-dst.hr, Internet: www.koncar-dst.hr

ISPITNI IZVJEŠTAJ br. 312/19
TEST REPORT No.

acc. to HRN EN 10204 2.2

ISPITIVANJE PROBOJNOG NAPONA TRANSFORMATORSKOG ULJA
BREAKDOWN VOLTAGE TEST OF TRANSFORMER OIL

PODACI O UZORKU I TRANSFORMATORU / SAMPLE AND TRANSFORMER IDENTIFICATION:

Naručitelj / Ordered by:	**SWEDEN**
Tip transformatora / Transformer type:	**TRP 80000-145/E**
Tvornički broj / Serial No.:	**464170**
Vrsta ulja / Type of oil:	**HYVOLT III**
Napomena / Note:	**water content: 3 ppm**

METODA I REZULTATI ISPITIVANJA / TEST METHOD AND RESULTS OF ANALYSIS:

Megger
OTS100AF
101171359

F/W Version: 1.15
Std. Lib. Version: 0.08

Test Id: 312/19

Date: 20/08/2019
Time: 14:32

BS EN 60156-96

Oil Type:
Mineral/Ester

Electrodes: Mushroom
Elec. Gap: 2.50mm
Stirrer: None
Test Freq: 61.8Hz
Max. Volt: 100.0kV
dV/dt Rate: 2.0kV/s

Results:
Oil Temp: 26.0°C

Test1: 84.9kV
Test2: 88.1kV
Test3: 84.1kV
Test4: 85.7kV
Test5: 85.4kV
Test6: 89.5kV
Avg. Voltage:
86.3kV

Dispersion s/x: 0.02
Std. Deviation: 2.07kV

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Date:
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INTERPRETACIJA REZULTATA / INTERPRETATION OF RESULTS:

Breakdown voltage of transformer oil fulfills requirements according to IEC 60422 tab. 3. "Mineral insulating oils after filling in new electrical equipment prior to energization":

	Highest voltage for equipment /kV		
Property	<72,5	72,5 to 170	>170
Breakdown voltage / kV	**>55**	**>60**	**>60**

Datum / Date:	Ispitao / Tested by:	Odobrio / Approved by:
21.08.2019.	Ivanka Radić, MSc.Chem. E.	Renata Jurišić, MSc.Chem. E.

Laboratorij Ulazne kontrole / Laboratory of Incoming Control : tel. +385 1 3783 829 , e-mail: ivanka.radic@koncar-dst.hr

KONČAR D&ST	**Izvještaj o ispitivanju nepropusnosti** **Oil leakage test report**	Ispitni izvještaj br.: Test report No.: OL464170

Tip transformatora: Transformer type:	TRP 80000-145/E ET1036	Tvornički broj: Serial number(s):	464170

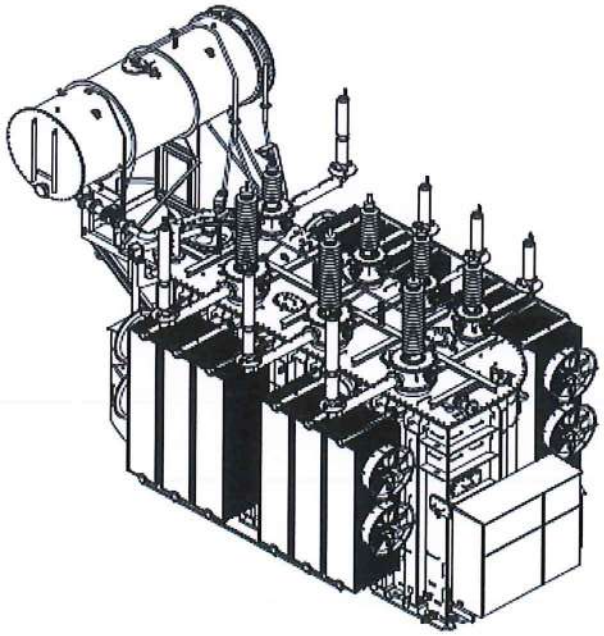
After Short-circuit withstand test (IEC 60076-5)

Uvjeti ispitivanja / Testing conditions

Ispitno sredstvo Testing media	Transformatorsko ulje Transformer oil	
Temperatura ispitnog sredstva Temperature of testing media	20°C	
Tlak Pressure kN/m^2	30kN/m2	na vrhu transformatora on the top of transformer
Trajanje ispitivanja Duration	24h	Begin: 20.08.2019. Finish: 21.08.2019.

Shema ispitivanja - Way of testing (scheme)

manometer



Nema curenja
Test result : No leakage

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Date:
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Laboratories

Datum /Date: 21.08.2019.

KONČAR Distributivni i specijalni transformatori d.d. Zagreb
ZAVRŠNA KONTROLA FINAL CONTROL 4

Ispitivanje proveo / Testing performed by : Saša Margetić

Margetić

KONČAR D&ST

AUXILIARY TRANSFORMER TEST REPORT

ELEKTROSKLOP d.o.o.

II Rakitski odvojak 17
10437 Bestovje

TRANSFORMER TEST REPORT — **Serial No. / Code:** 12971

Rated power:	200	kVA	Transformer type:	TPTO-A		Phase:	3	
Primary voltage:	467,45	V	Primary current:	247,02	A	Cooling:	AN	
Secondary voltage:	420 ±2x2,5%	V	Secondary current:	274,93	A	Protection:	IP00	
Frequency:	50	Hz	Insulation class:	F		Weight:	290	kg
Vector group:	YNa0		Temp. class:	F		Year:	05/2019	

Separate-source AC withstand voltage test according to IEC 60076-11 standard

HV-LV: - kVx1min HV-mass: 3 kVx1min LV-mass: 3 kVx1mi

Measurement of winding resistance according to IEC 60076-11 standard **Ambient tepmerature=21°C**

Position	mΩ	Position	mΩ	Position	mΩ	Position	mΩ	Position	mΩ	Position	mΩ
R1-S1:	86,9	r-s -5%:	83,29	r-s -2,5%:	84,1	r-s 0:	84,5	r-s +2,5%	85,2	r-s +5%:	85,7
R1-T1:	87,8	r-t -5%:	83,3	r-t -2,5%:	83,8	r-t 0:	84,7	r-t +2,5%	85,1	r-t +5%:	85,8
S1-T1:	86,4	s-t -5%:	82,8	s-t -2,5%:	83,6	s-t 0:	84,3	s-t +2,5%	84,9	s-t +5%:	85,7

Measurement of no-load loss, current, voltage ratio and phase displacement according to IEC 60076-11 standard

Position	Pri. Voltage [V]	Current [A]	No load loss [W]	Sec. Voltage [V]	Voltage ratio	cos_f
-5%	467,075	0,268	131	400,33	1,167	
-2,5%	468,808	0,27	131,9	409,96	1,144	
0	467,018	0,269	131	421,2	1,109	
+2,5%	467,305	0,268	131,1	429,3	1,089	
+5%	467,076	0,268	131	441,93	1,057	

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Date:
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Measurement of short circuit impedance and loss according to IEC 60076-11 standard

Position	Isc [A]	Usc [V]	Psc [W]	Usc - Isc [V]	Usc20°C [%]	Ur20°C [V]	Ux [V]	Usc75°C [%]	Psc75°C [W]	Ur75°C [V]	cos_f
-5%	246,4	3,4	666,7	3,4	0,73	1,57	3,03	0,76	814,8	1,9	0,459
-2,5%	247,7	2,9	584,8	2,9	0,62	1,36	2,58	0,65	706,8	1,65	0,466
0	246,9	1,8	437	1,8	0,4	1,02	1,58	0,43	531,9	1,24	0,542
+2,5%	247,4	1,17	346	1,17	0,25	0,81	0,85	0,27	419,5	0,98	0,685
+5%	248,5	0,94	254,9	0,94	0,2	0,59	0,73	0,21	306,4	0,71	0,626

Induced AC withstand voltage test according to IEC 60076-11 standard

Voltage: 935 V Frequency: 100 Hz Time: 60 s

Measurement of insulation resistance [20°C]

LV-HV: - MΩ Mass-NN: >2000 MΩ Mass-VN: >2000 MΩ

Note:

Tested: Marijo Martinko

Approved:

ELEKTROSKLOP d.o.o.
II. Rakitski odvojak 17
Sveta Nedelja

Date: 28.05.2019

KONČAR D&ST

LIGHTNING IMPULSE TEST REPORT

After Short-circuit withstand test (IEC 60076-5)

Test report no. U2922

Page: 1/12

Transformer type		Serial number		
TRP 80000-145/E		ET1036 - 464170		
Winding HS		Winding LS	Hjälplindning	
Tap position	Voltage (V)	Voltage (V)	Voltage (V)	
1	161042	-	-	
10	140000	57500	467,4	
19	118958	-	-	
Connection symbol	**YNd5+syn0**	Rated short-circuit impedance	12,0%	

1. Specified test voltages — Standard: IEC 60076 - 3

Terminals	Full wave		Chopped wave	
	$\hat{}$ kV	Wave shape (µs)	$\hat{}$ kV	Time to chopping (µs)
1U, 1V, 1V	550	1.2/50	-	-
1N	250	1.2/50	-	-
2U, 2V, 2W	325	1.2/50	-	-
-	-	-	-	-
-	-	-	-	-

2. Measurements

Applied voltage was measured with capacitive voltage divider HIGH VOLT SMC670/1200 and measuring device for recording impulse voltage and current HIGH VOLT MIAS 100-14/4B in accordance with IEC 60060.

3. Result

By comparing the voltage and current records it has been proved that the transformer withstood the test.

4. Remarks

a) Voltage and current wave records are stored by Manufacturer in files: 464170

The test was carried out in presence of:

Mr. Ernst HANIQUE, Senior Inspector, KEMA Laboratories Arnhem Energy

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Ernst Hanique

Date: 23 AUG. 2019

KEMA Laboratories

KONČAR Distributivni i specijalni transformatori d.d. Zagreb

ISPITNA STANICA TESTING STATION 4

Tested by: Darko Bistrički, dipl.ing.

Approved by: Vedran Maljković, dipl.ing.

Date and stamp: 20.08.2019.

5. Testing of Winding HS

5.1. Connection of terminals

line terminal under test	connected to the impulse voltage generator
other line terminals of the winding under test	directly earthed
neutral terminal 1N	earthed through shunt S1
2U, 2V, 2W	short circuited and directly earthed
S_{r1}, S_{s1}, S_{t1}	short circuited and directly earthed

5.2. Order of tests

Terminal	Tap position	Description	Page
1U	19	Applied voltage and current through shunt S1 oscillograms	3
1V	10	Applied voltage and current through shunt S1 oscillograms	4
1W	1	Applied voltage and current through shunt S1 oscillograms	5

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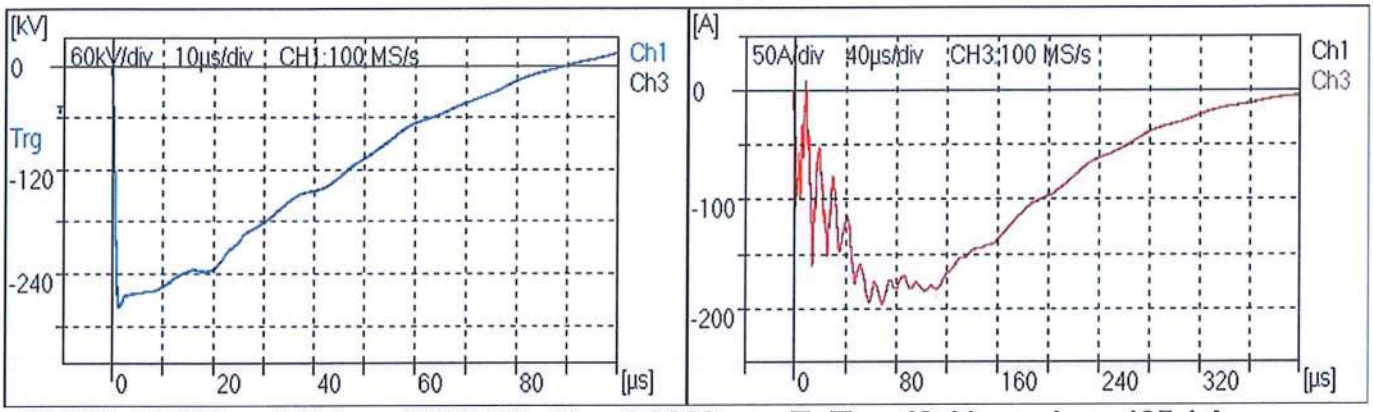
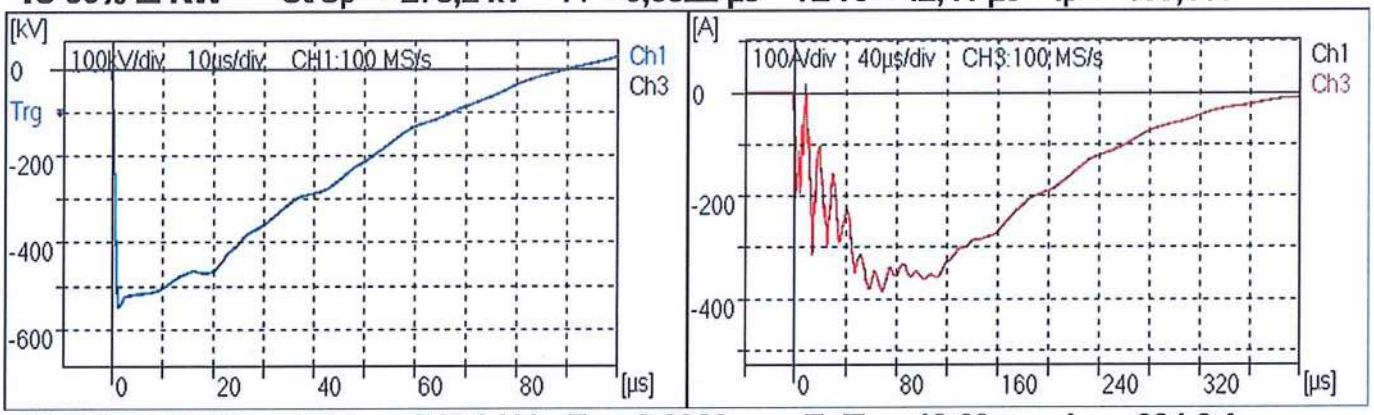
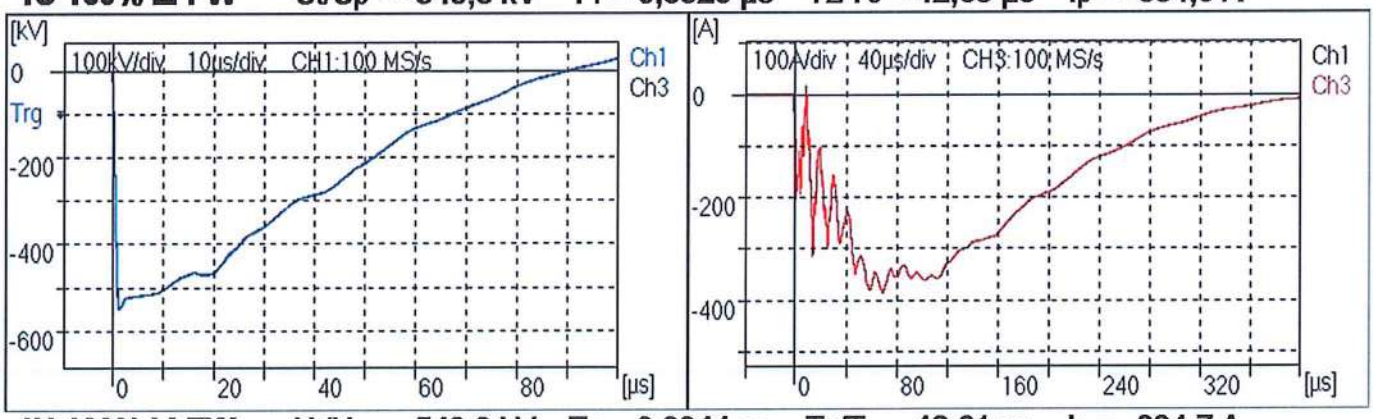


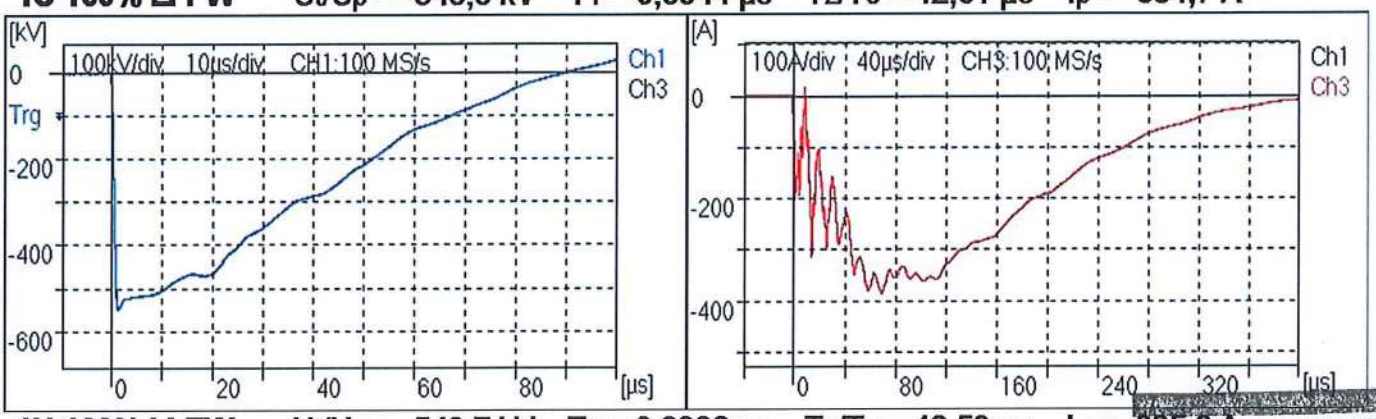
1U 50% LI RW Ut/Up = -278,2 kV T1 = 0,9822 µs T2/Tc = 42,41 µs Ip = -195,1 A



1U 100% LI FW Ut/Up = -548,3 kV T1 = 0,9929 µs T2/Tc = 42,63 µs Ip = -384,9 A



1U 100% LI FW Ut/Up = -548,9 kV T1 = 0,9944 µs T2/Tc = 42,61 µs Ip = -384,7 A



1U 100% LI FW Ut/Up = -548,7 kV T1 = 0,9932 µs T2/Tc = 42,59 µs Ip = -385,0 A

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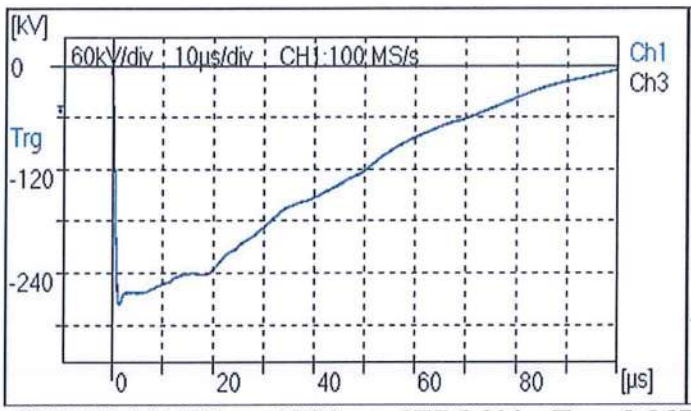
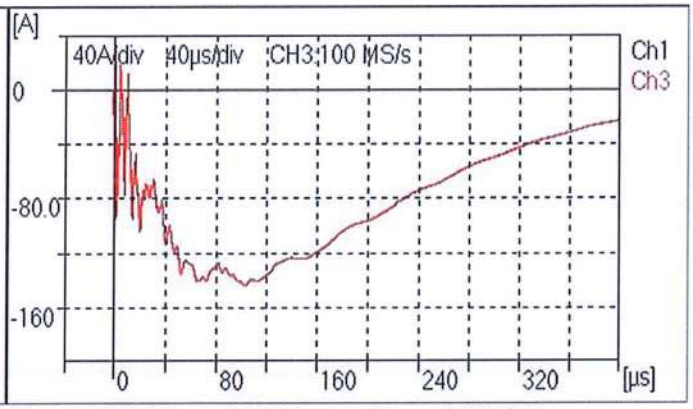
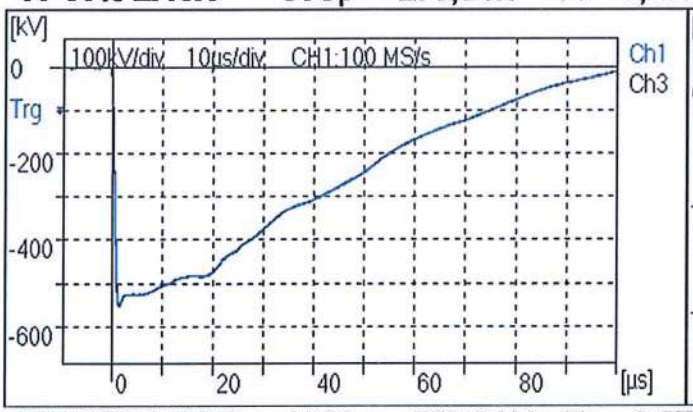
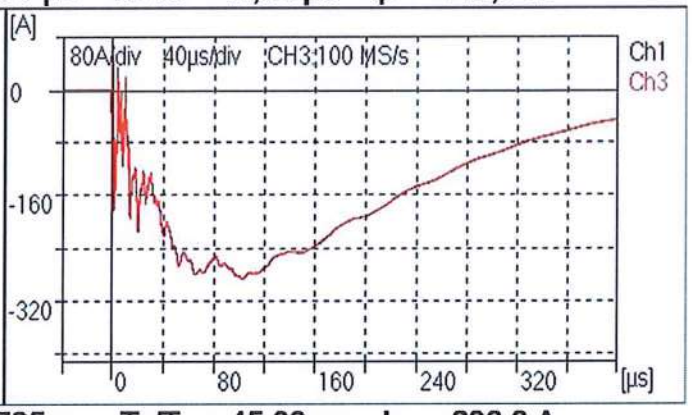


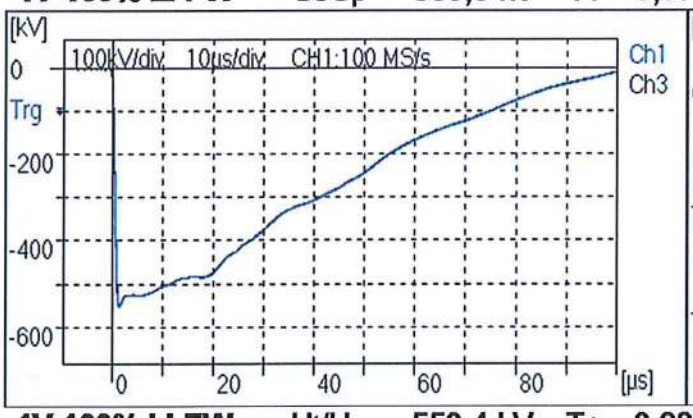


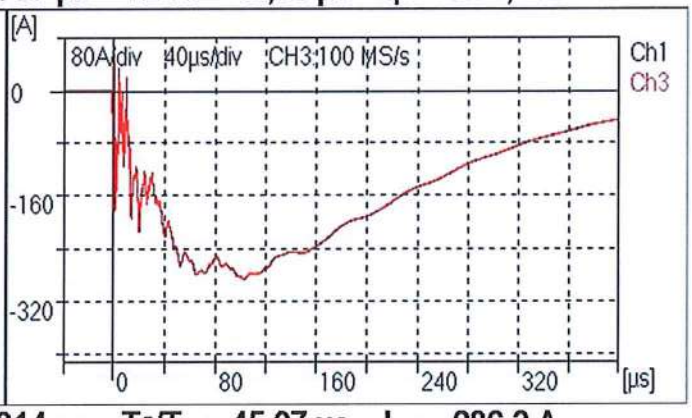
1V 50% LI RW Ut/Up = -275,3 kV T1 = 0,9670 µs T2/Tc = 44,89 µs Ip = -143,6 A



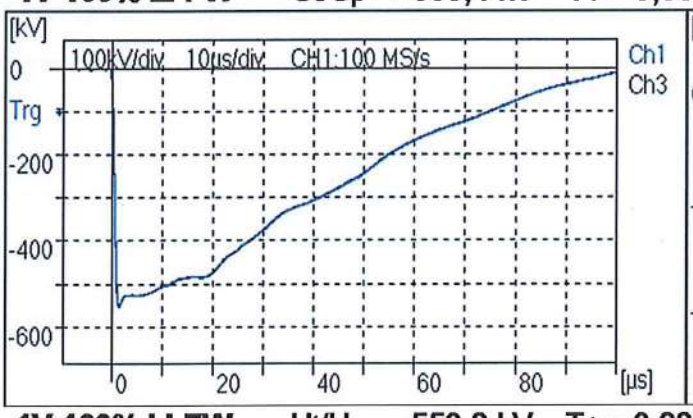


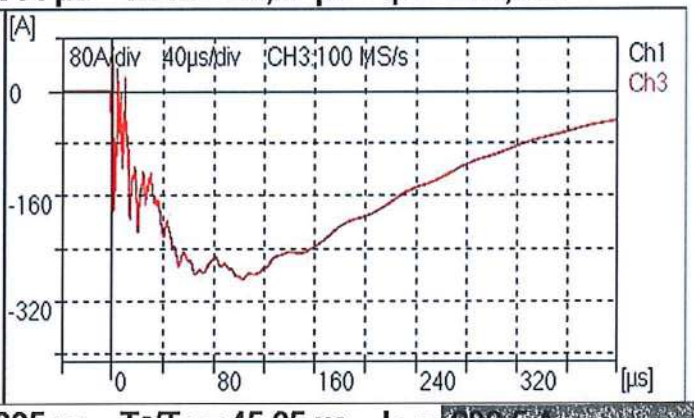
1V 100% LI FW Ut/Up = -550,0 kV T1 = 0,9785 µs T2/Tc = 45,06 µs Ip = -286,3 A





1V 100% LI FW Ut/Up = -550,4 kV T1 = 0,9814 µs T2/Tc = 45,07 µs Ip = -286,3 A





1V 100% LI FW Ut/Up = -550,8 kV T1 = 0,9805 µs T2/Tc = 45,05 µs Ip = -286,5 A

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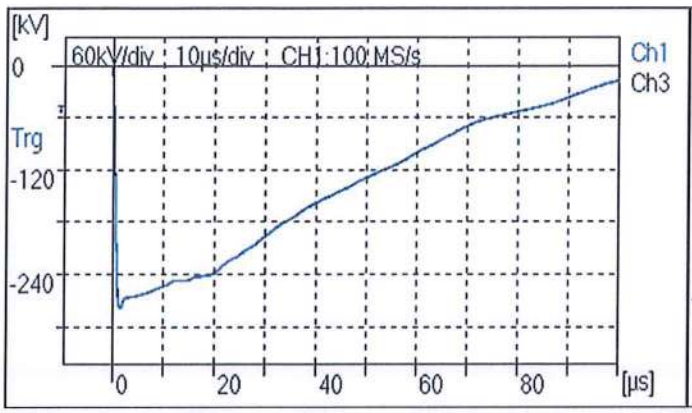
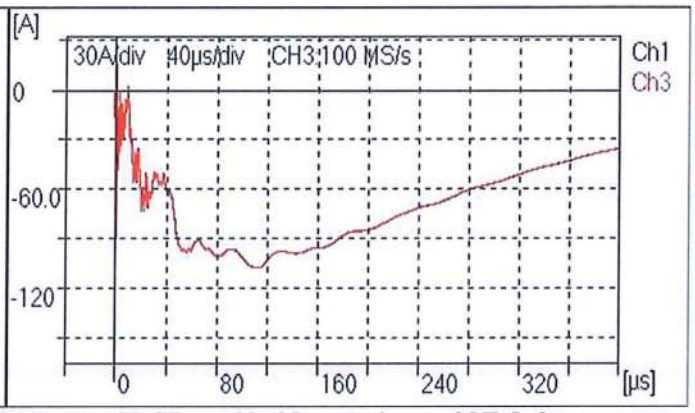
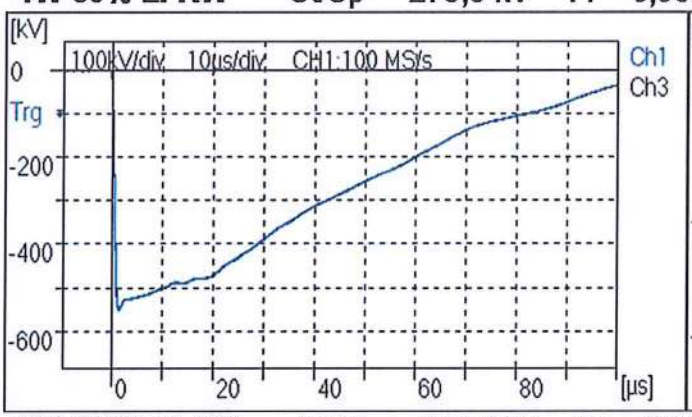
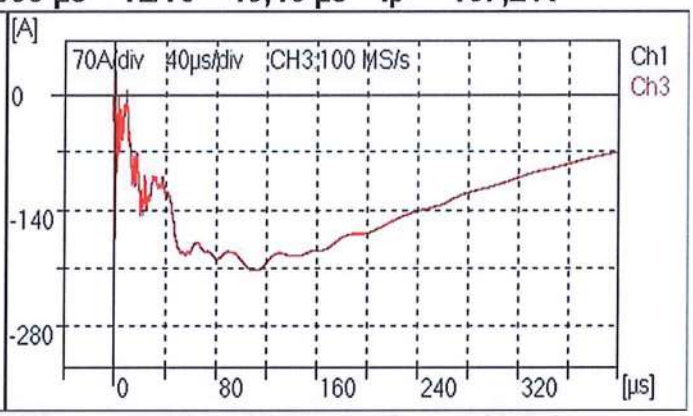


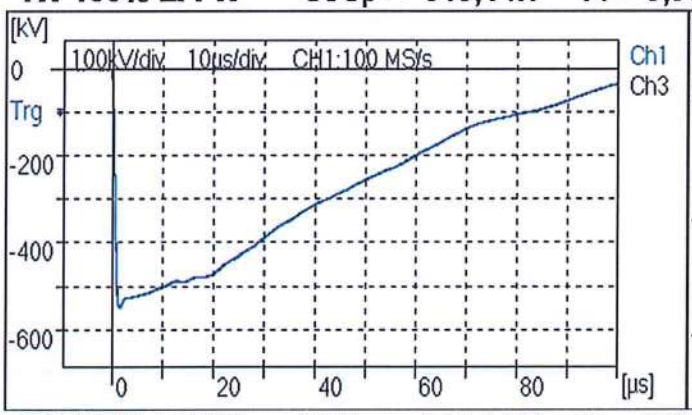


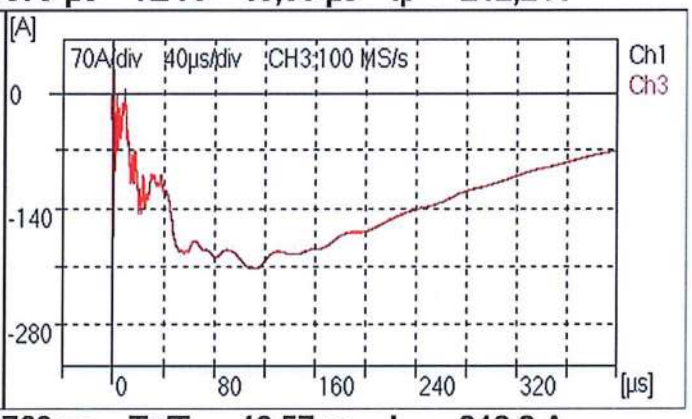
1W 50% LI RW Ut/Up = -278,5 kV T1 = 0,9563 µs T2/Tc = 46,40 µs Ip = -107,2 A



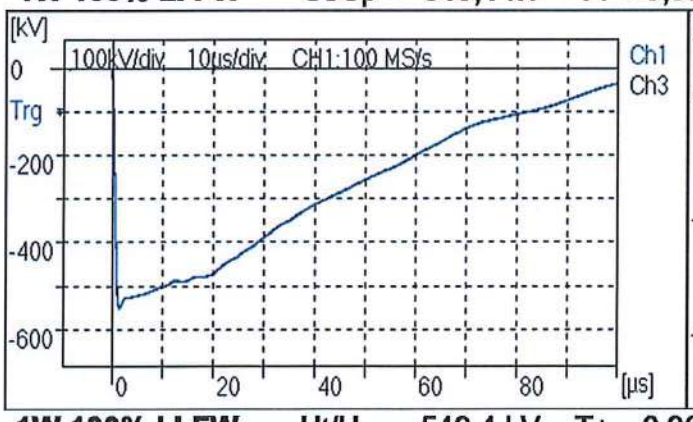


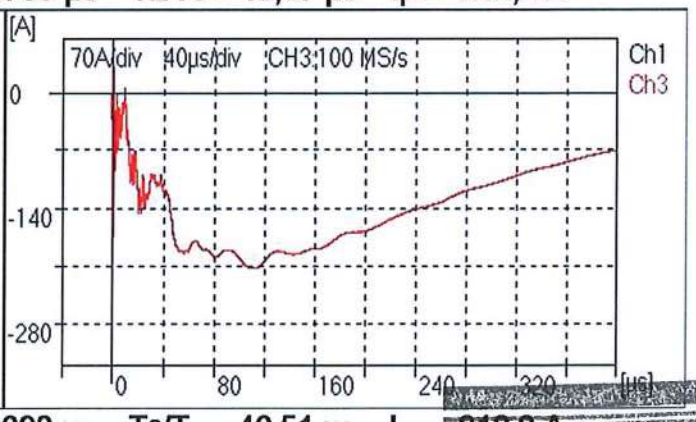
1W 100% LI FW Ut/Up = -549,1 kV T1 = 0,9679 µs T2/Tc = 46,53 µs Ip = -212,2 A





1W 100% LI FW Ut/Up = -549,1 kV T1 = 0,9703 µs T2/Tc = 46,57 µs Ip = -212,2 A





1W 100% LI FW Ut/Up = -549,4 kV T1 = 0,9698 µs T2/Tc = 46,51 µs Ip = -212,2 A

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6. Testing of neutral terminal 1N of Winding HS

6.1. Connection of terminals

neutral terminal 1N	connected to the impulse voltage generator
line terminals of the winding under test	short circuited and earthed through shunt S1
2U, 2V, 2W	short circuited and directly earthed
S_{r1}, S_{s1}, S_{t1}	short circuited and directly earthed

6.2. Order of tests

Terminal	Tap position	Description	Page
1N	1	Applied voltage and current through shunt S1 oscillograms	7

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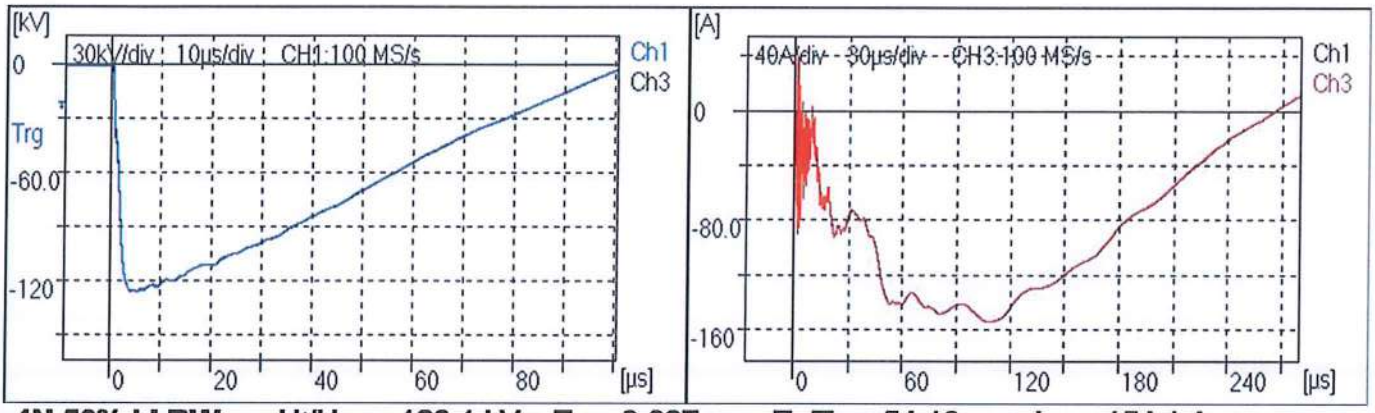
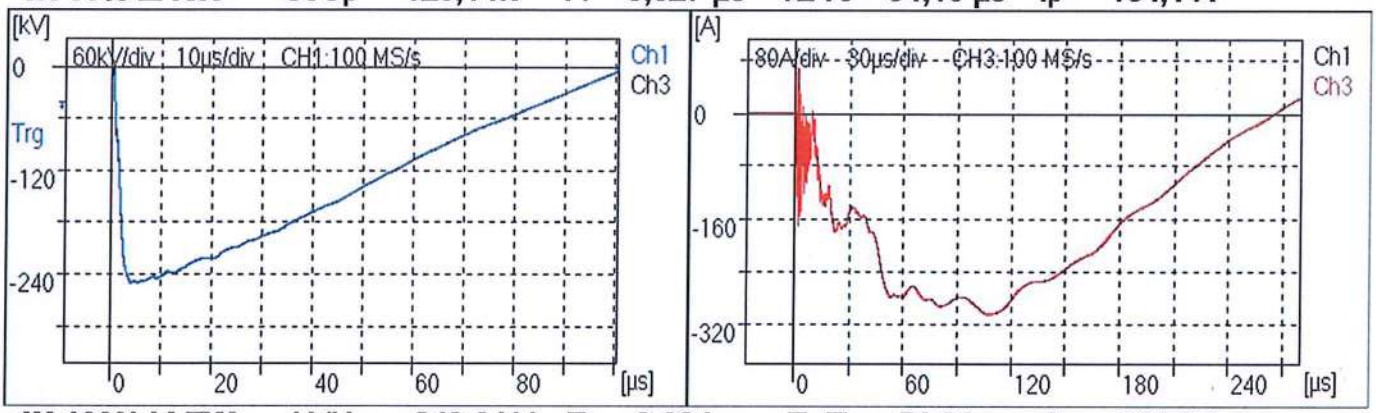
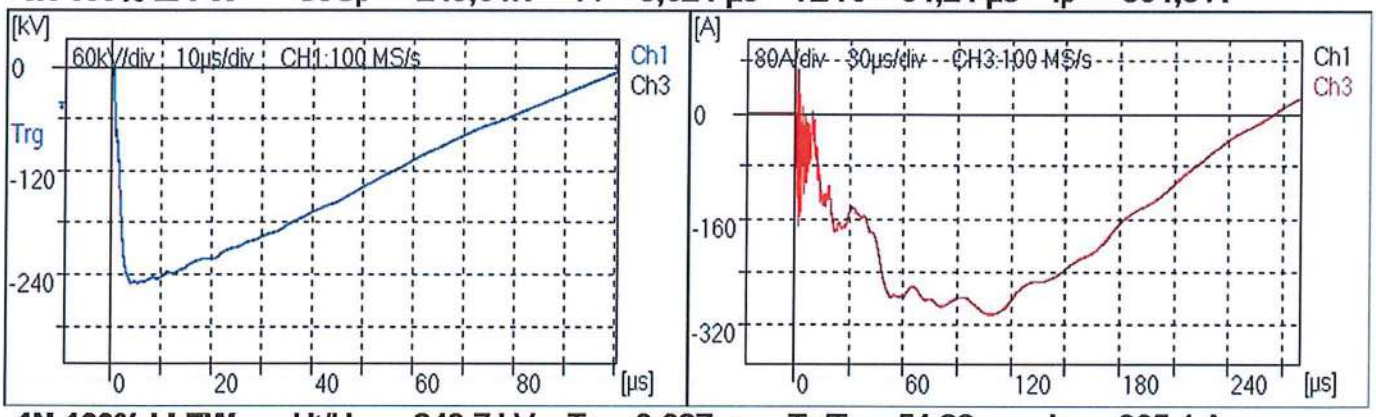


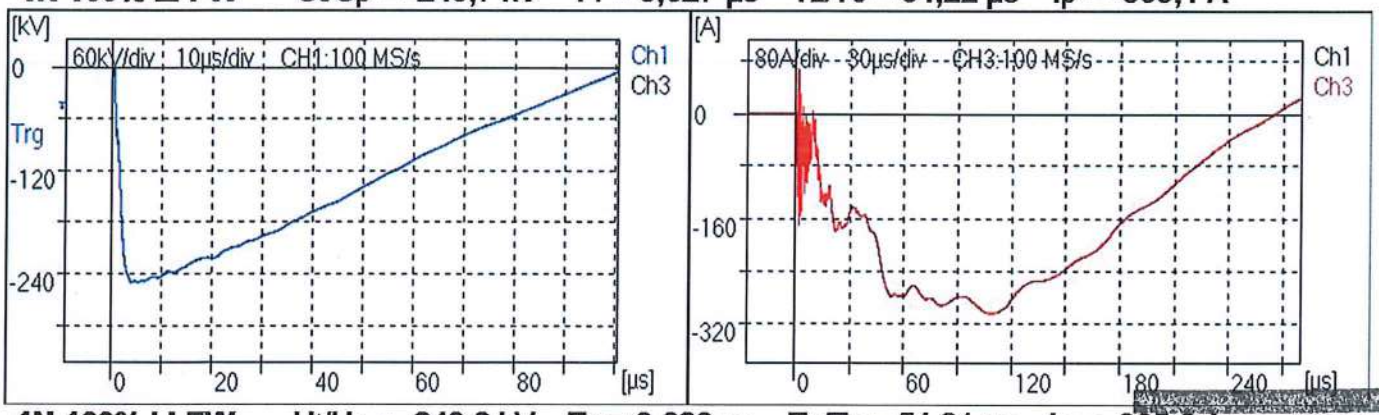
1N 50% LI RW Ut/Up = -126,1 kV T1 = 3,027 µs T2/Tc = 54,16 µs Ip = -154,1 A



1N 100% LI FW Ut/Up = -249,6 kV T1 = 3,024 µs T2/Tc = 54,24 µs Ip = -304,9 A



1N 100% LI FW Ut/Up = -249,7 kV T1 = 3,027 µs T2/Tc = 54,22 µs Ip = -305,1 A



1N 100% LI FW Ut/Up = -249,8 kV T1 = 3,029 µs T2/Tc = 54,21 µs Ip = -305,2 A

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7. Testing of Winding LS

7.1. Connection of terminals

line terminal under test	connected to the impulse voltage generator
other line terminals of the winding under test	earthed through shunt S1
1U, 1V, 1W, 1N	short circuited and directly earthed
S_{r1}, S_{s1}, S_{t1}	short circuited and directly earthed

7.2. Order of tests

Terminal	Tap position	Description	Page
2U	-	Applied voltage and current through shunt S1 oscillograms	9
2V	-	Applied voltage and current through shunt S1 oscillograms	10
2W	-	Applied voltage and current through shunt S1 oscillograms	11

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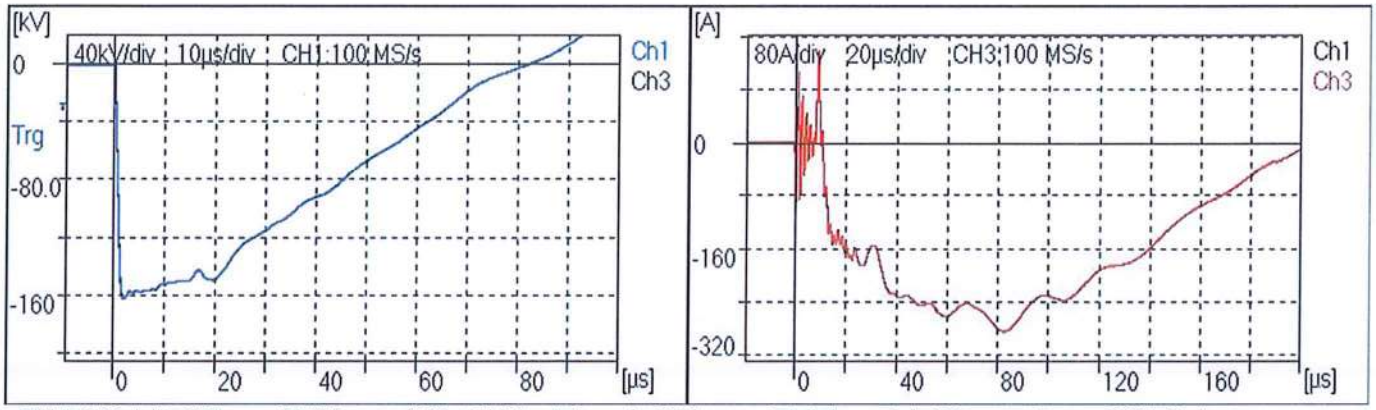
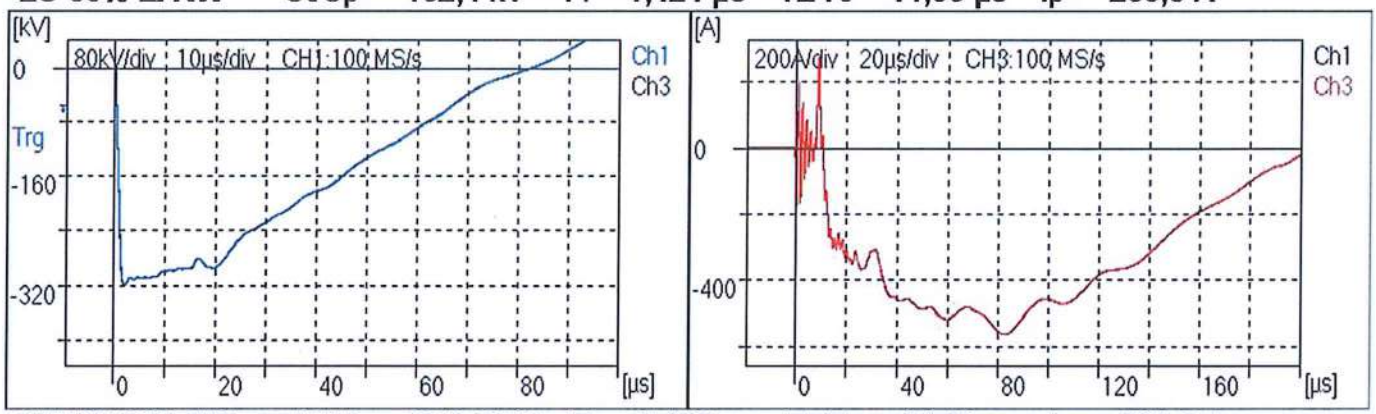
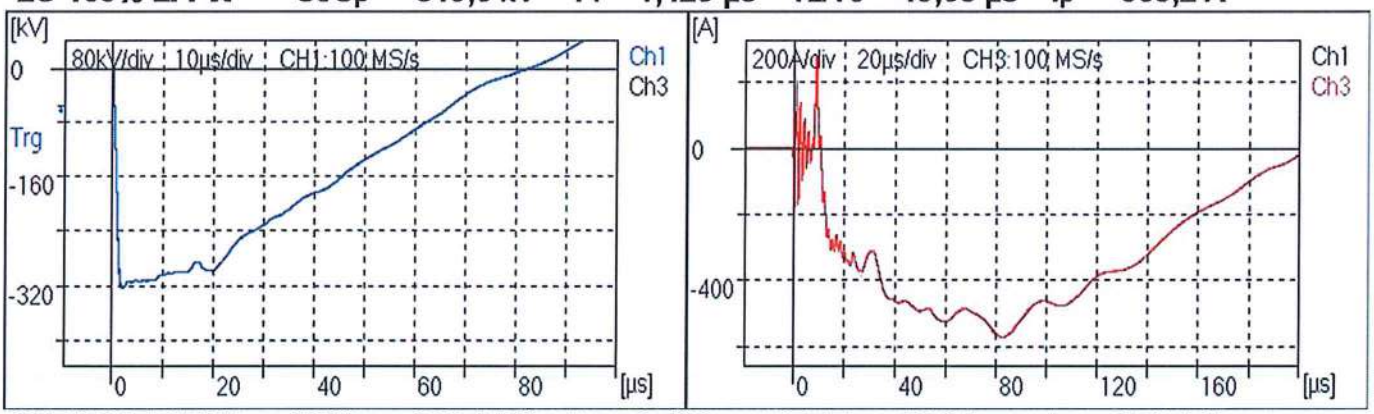


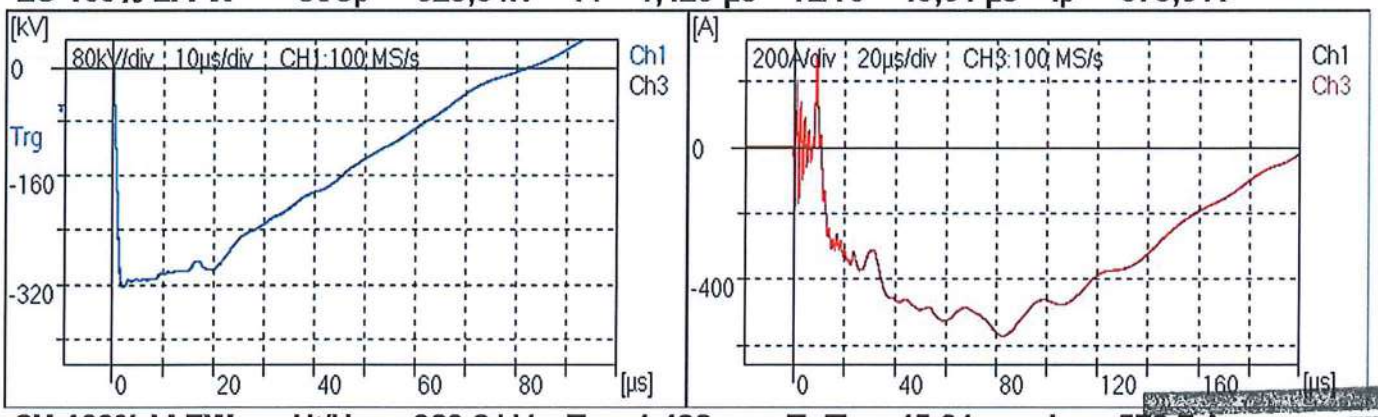
2U 50% LI RW Ut/Up = -162,4 kV T1 = 1,424 µs T2/Tc = 44,96 µs Ip = -285,3 A



2U 100% LI FW Ut/Up = -319,0 kV T1 = 1,429 µs T2/Tc = 45,03 µs Ip = -565,2 A



2U 100% LI FW Ut/Up = -323,3 kV T1 = 1,429 µs T2/Tc = 45,04 µs Ip = -573,0 A



2U 100% LI FW Ut/Up = -323,2 kV T1 = 1,428 µs T2/Tc = 45,04 µs Ip = -572,7 A

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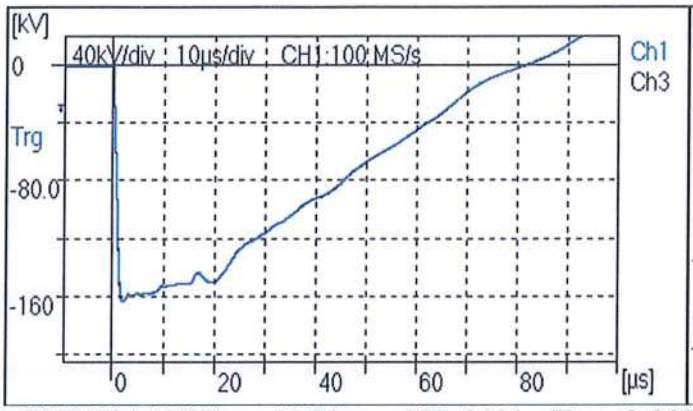
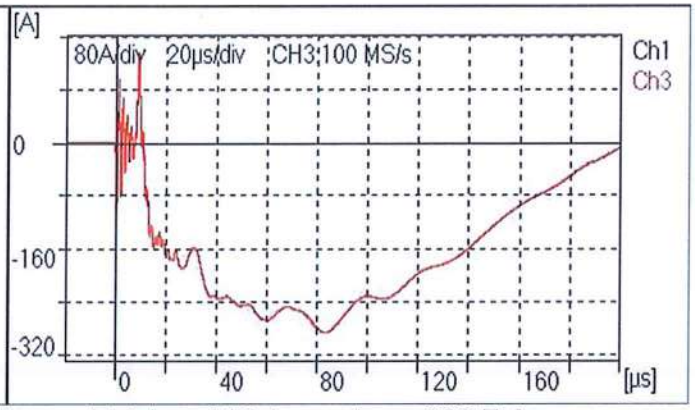
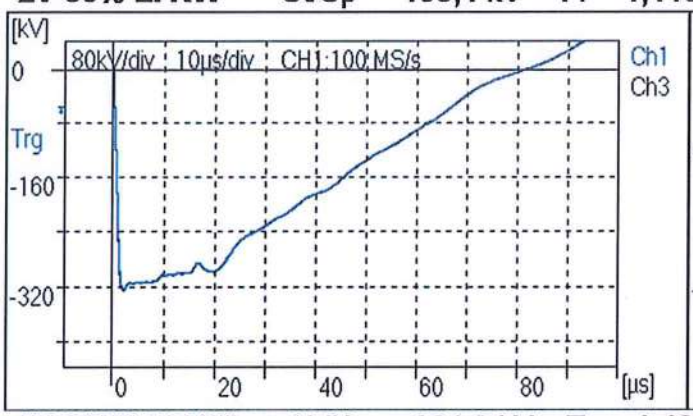
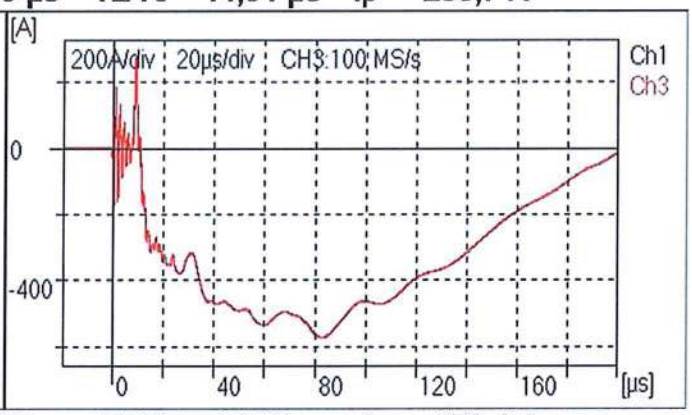


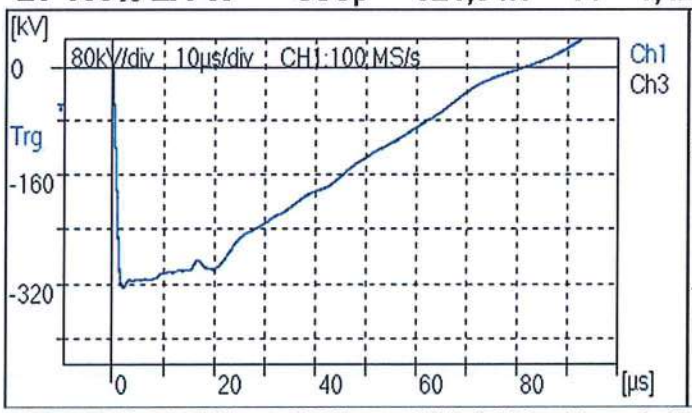


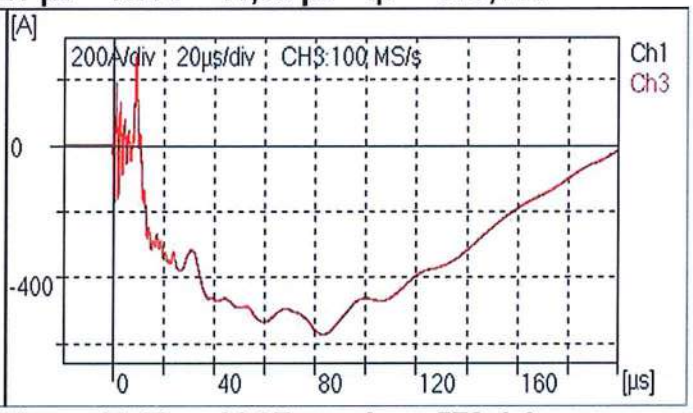
2V 50% LI RW Ut/Up = -163,4 kV T1 = 1,416 µs T2/Tc = 44,91 µs Ip = -286,7 A



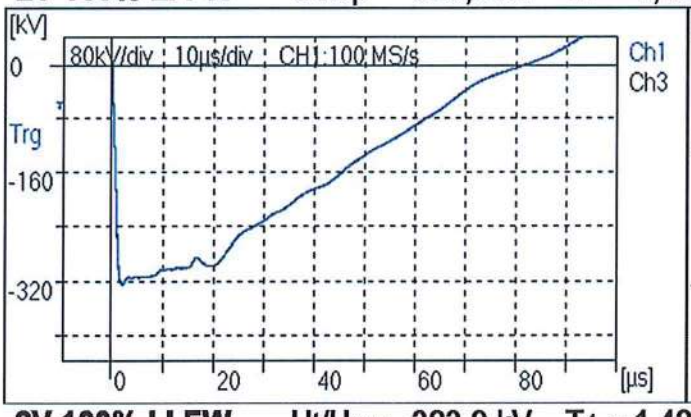


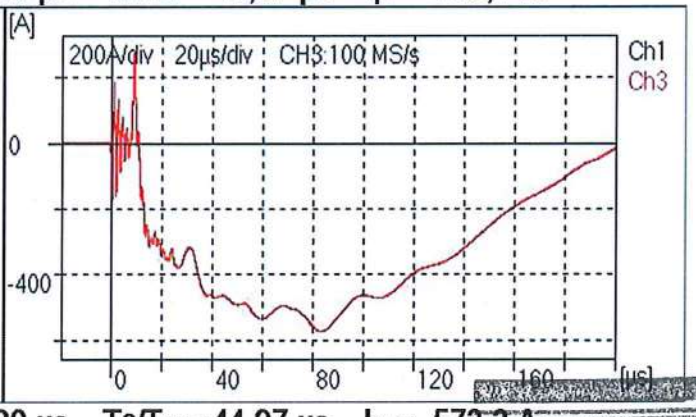
2V 100% LI FW Ut/Up = -324,0 kV T1 = 1,421 µs T2/Tc = 44,95 µs Ip = -573,1 A





2V 100% LI FW Ut/Up = -323,9 kV T1 = 1,420 µs T2/Tc = 44,97 µs Ip = -573,4 A





2V 100% LI FW Ut/Up = -323,9 kV T1 = 1,420 µs T2/Tc = 44,97 µs Ip = -573,4 A

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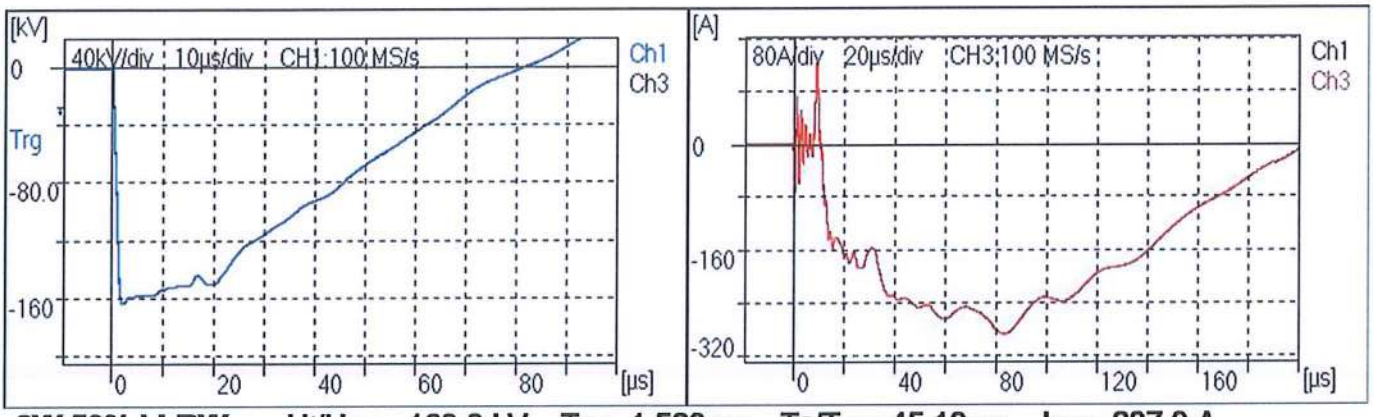
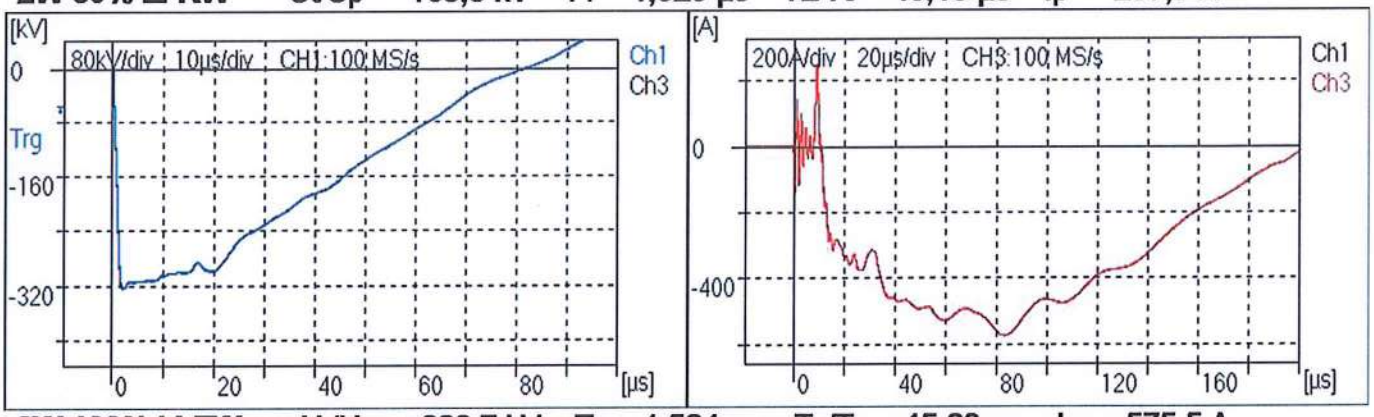
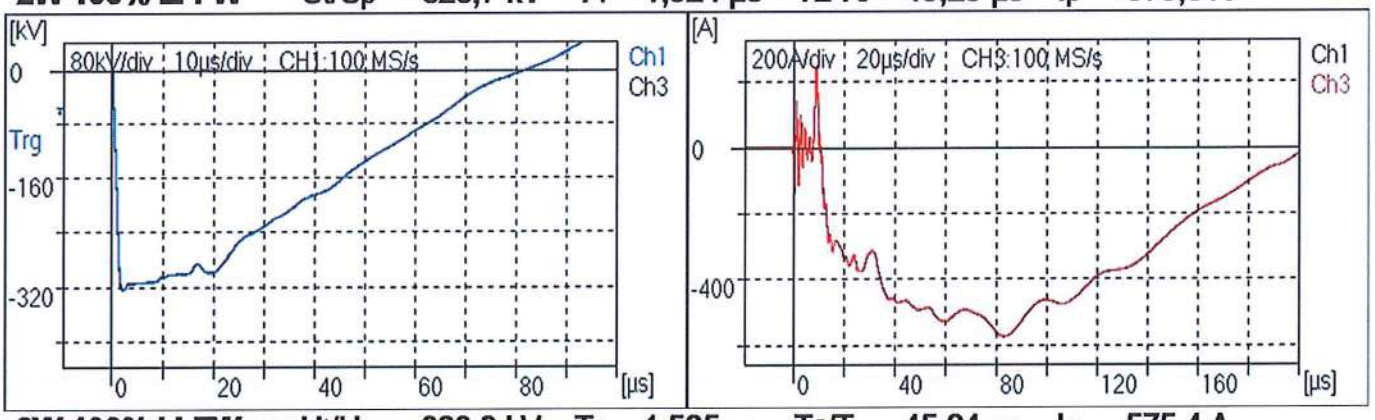


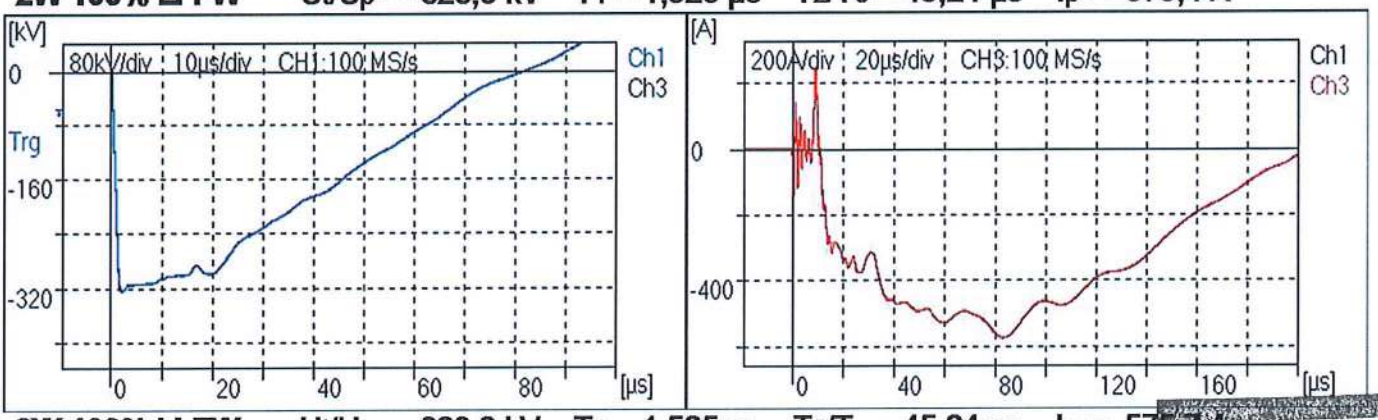
2W 50% LI RW Ut/Up = -163,3 kV T1 = 1,520 µs T2/Tc = 45,19 µs Ip = -287,9 A



2W 100% LI FW Ut/Up = -323,7 kV T1 = 1,524 µs T2/Tc = 45,23 µs Ip = -575,5 A



2W 100% LI FW Ut/Up = -323,9 kV T1 = 1,525 µs T2/Tc = 45,24 µs Ip = -575,4 A



2W 100% LI FW Ut/Up = -323,8 kV T1 = 1,525 µs T2/Tc = 45,24 µs Ip = -575,7 A

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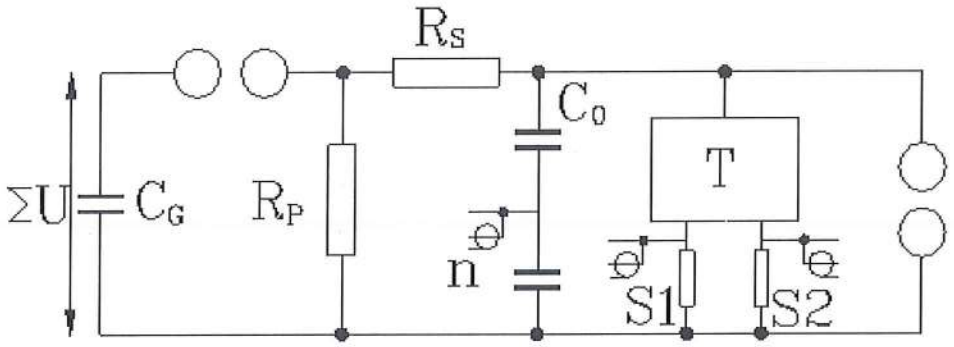
8.1 Equivalent lightning impulse circuit



8.2 Impulse circuit´s constants

	Winding HS	Neutral terminal 1N	Winding LS	
C_G (pF)	166667	166667	166667	
R_S (Ω)	140	140	140	
R_P (Ω)	396	948	948	
C_0 (pF)	670	670	670	
C_1 (pF)	-	-	-	
S1 (Ω)	0,5	0,5	0,5	

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MEASUREMENT OF CAPACITANCES AND DISSIPATION FACTOR OF WINDINGS

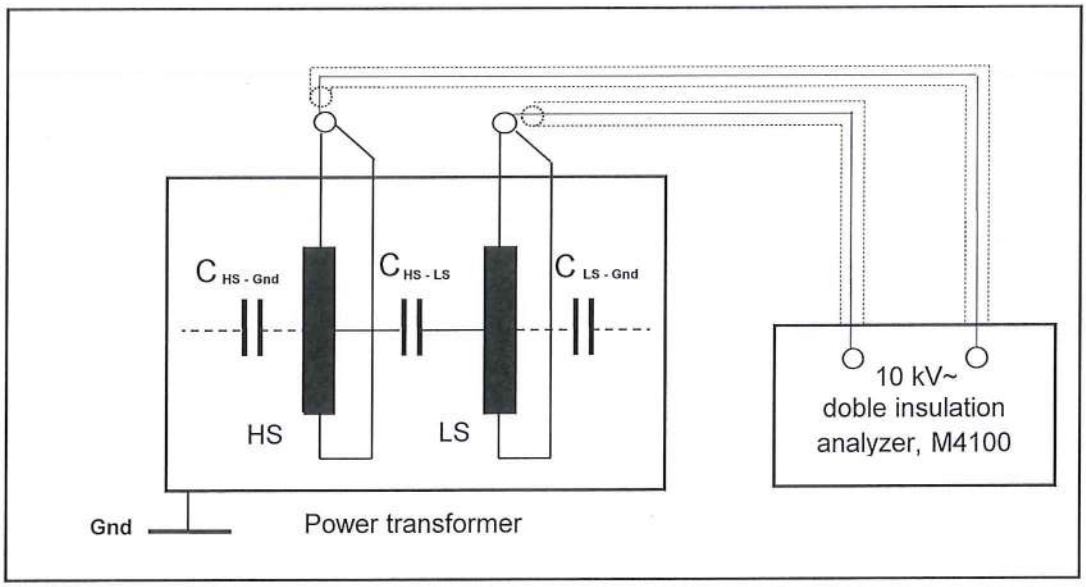
Test report No :	K1249
Page :	1 / 1

NOTE : After Short-circuit withstand test (IEC 60076-5)

1 . 0 . RATING VALUES

Transformer type :	TRP 80000-145/E	Vector Group :	YNd5+syn0
Rated power (kVA) :	80000	Type of cooling :	ONAN/ONAF
Rated voltage (kV) :	140 / 57,5 / 0,4674	Frequency (Hz) :	50
Serial No. :	ET1036 - 464170	Tested in accordance :	IEC 60076-1

2 . 0 . TEST CIRCUIT



3 . 0 . TEST RESULTS

Measured combination	HS - Gnd	HS - LS	LS - Gnd	HS - (LS + Gnd)	LS - (HS + Gnd)	
Measured at oil temperature 28 °C						
tanδ (%)	0,306	0,202	0,306	0,233	0,264	
C (pF)	4857,3	9557,4	15404,4	14412,9	24961,6	
Ut (kV)	10	10	10	10	10	
Corrected values to 20 °C						
tanδ (%)	0,260	0,172	0,260	0,198	0,225	

NOTE: During the test hjälplindning was short-circuited and grounded

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Ernst Hanique

Date: 23 AUG. 2019

KEMA Laboratories

The test was carried out in the presence of :

Mr. Ernst HANIQUE, Senior Inspector, KEMA Laboratories Arnhem Energy

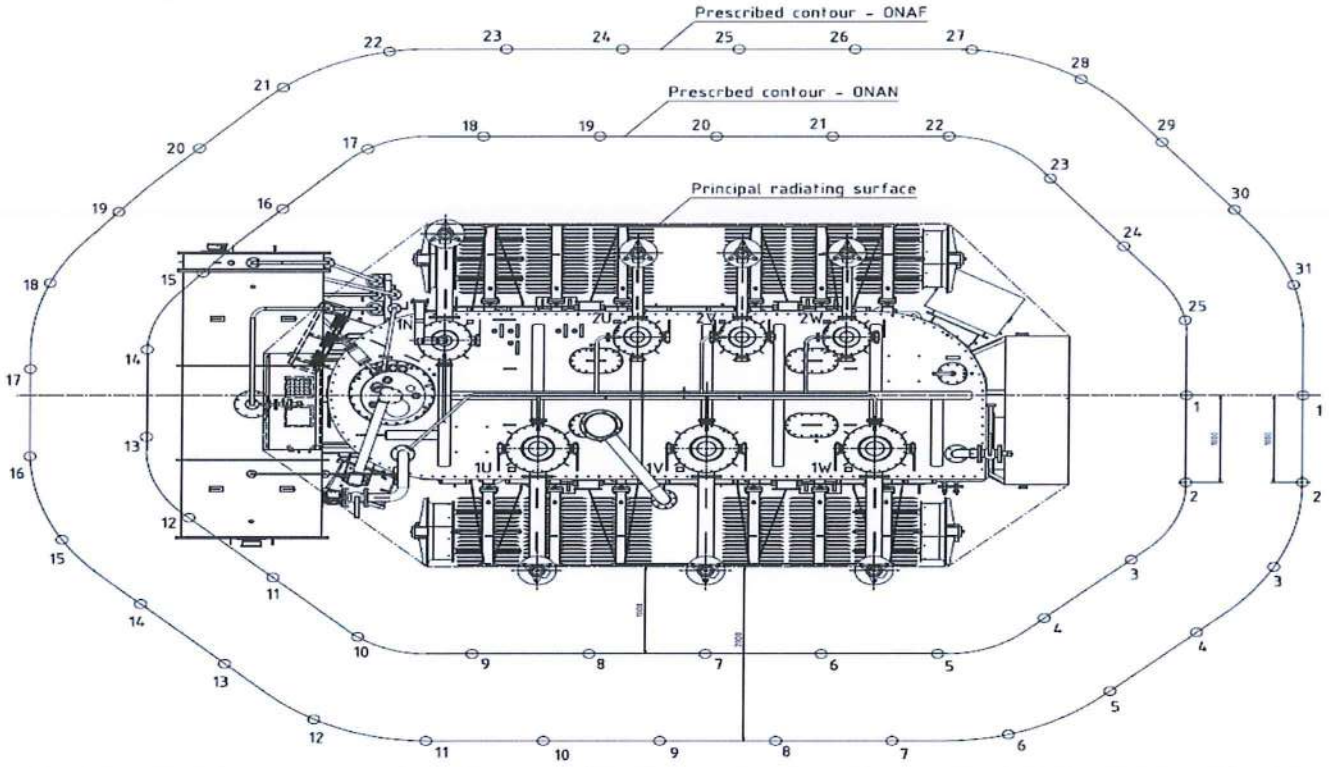
KONČAR Distributivni i specijalni transformatori d.d. Zagreb

ISPITNA STANICA TESTING STATION 4

Tested by :	Approved by :	Date and stamp :
Vedran Gojević, dipl.ing.	Vedran Maljković, dipl.ing.	20.08.2019.

KONČAR D&ST	REPORT OF SOUND LEVEL MEASUREMENT After Short-circuit withstand test (IEC 60076-5)	Test report No B2027 Page : 1

1 . 0	RATING VALUES		
Transformer type :	TRP 80000-145/E	Connections :	YNd5+syn0
Rated power (kVA)	80000	Type of cooling :	ONAN
Rated voltage (kV)	140,0 / 57,5 / 467,4	Frequency (Hz) :	50
Serial No. :	ET1036 - 464170	Tested in acc. :	IEC 60076-10



Test conditions :		Guaranted dB(A)	Measured dB(A)
Type of cooling : ONAN, measured at 100% Ur	Sound intensity level - (LiA) - ONAN at 100% Ur	---	55,3
Distance of measurement contour : X = 1m	Sound power level - (LwA) - ONAN at 100% Ur	80,0	76,1
Lenght of prescribed contour : Lm= 25m			

Distance between measurement points : D = 1m	Instrument Type:	Brüel & Kjaer 2260 Investigator
Height of the transformer : h = 3,293m	**Test result :**	**P A S S E D**

Note: Measured with walk-around method

The test was carried out in the presence of:

Mr. Ernst HANIQUE, Senior Inspector, KEMA Laboratories Arnhem Energy

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Ernst Hanique

Date: 23 AUG. 2019

KEMA Laboratories

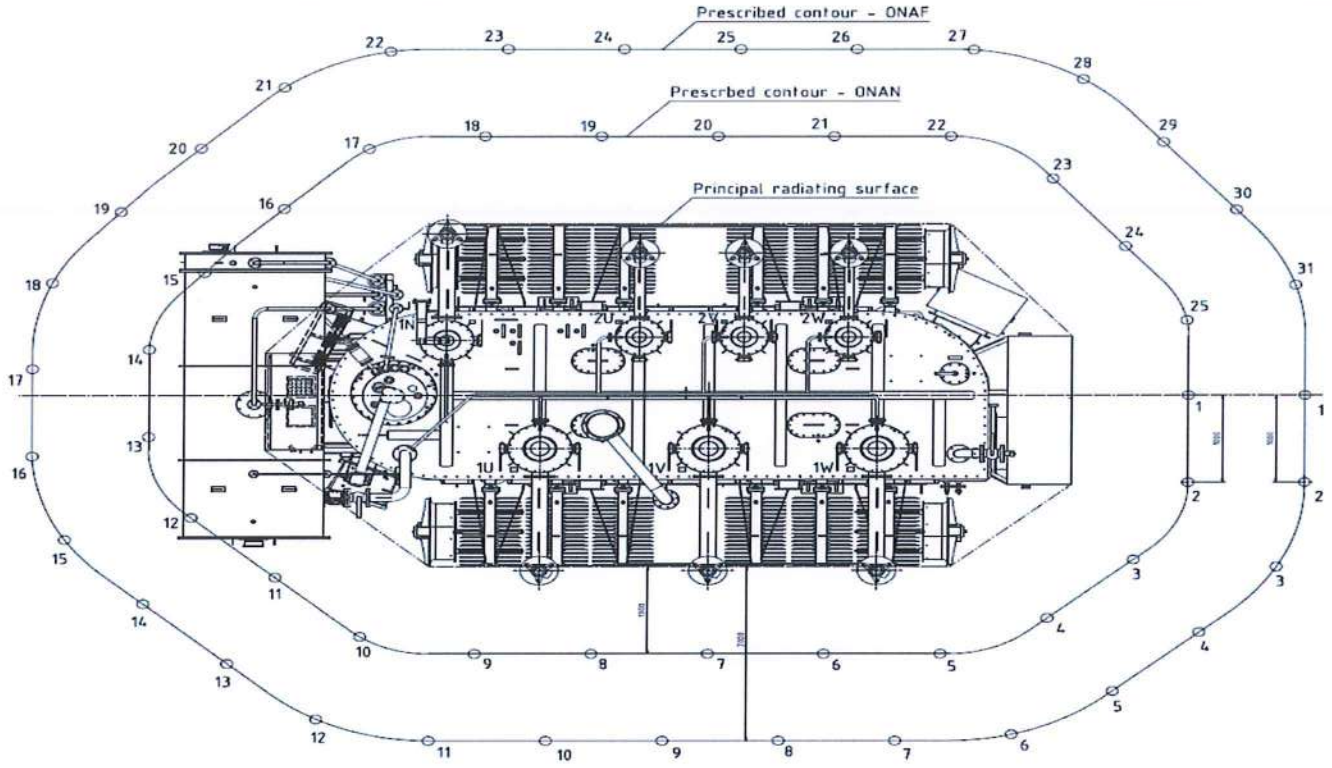
KONČAR Distributivni i specijalni transformatori d.d. Zagreb

ISPITNA STANICA TESTING STATION 4

Tested by :	Approved by :	Date of measurement:
D. Bistrički, dipl.ing.	Vedran Maljković, dipl.ing.	21.08.2019.

KONČAR D&ST	REPORT OF SOUND LEVEL MEASUREMENT After Short-circuit withstand test (IEC 60076-5)	Test report No B2027 Page : 2

1 . 0	RATING VALUES		
Transformer type :	TRP 80000-145/E	Connections :	YNd5+syn0
Rated power (kVA)	80000	Type of cooling :	ONAF
Rated voltage (kV)	140,0 / 57,5 / 467,4	Frequency (Hz) :	50
Serial No. :	ET1036 - 464170	Tested in acc. :	IEC 60076-10



Test conditions :		Guaranted dB(A)	Measured dB(A)
Type of cooling : ONAF, measured at 100% Ur	Sound intensity level - (LiA) - ONAF at 100% Ur	---	55,2
Distance of measurement contour : X = 2m	Sound power level - (LwA) - ONAF at 100% Ur	80,0	77,7
Lenght of prescribed contour : Lm= 31m			

Distance between measurement points : D = 1m	Instrument Type:	Brüel & Kjaer 2260 Investigator
Height of the transformer : h = 3,293m	**Test result :**	**P A S S E D**

Note: Measured with walk-around method

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Date: 23 AUG. 2019

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KONCAR - DISTRIBUTION & SPECIAL TRANSFORMERS
ZAGREB, CROATIA

TEMPERATURE RISE TEST REPORT

After Short-circuit withstand test (IEC 60076-5)

TRANSFORMER TYPE :	TRP 80000-145/E
SERIAL No. :	ET1036 - 464170
RATED VOLTAGE (kV):	140,0 / 57,5 / 0,4674
VECTOR GROUP :	YNd5+syn0
RATED FREQUENCY :	50
COOLING METHOD :	ONAF / ONAN
TEST METHOD :	SHORT - CIRCUIT METHOD
TAP POSITION :	19

MEASURED VALUES :

		ONAF	ONAN
RATED POWER :	(MVA)	*80,0*	*63,0*
TOP OIL TEMPERATURE RISE :	(K)	51,0	54,5
WINDING HS TEMPERATURE RISE :	(K)	51,2	51,5
WINDING LS TEMPERATURE RISE :	(K)	51,9	53,0

SPECIFIED TEMPERATURE RISE LIMITS :

FOR OIL (K) :	< 60
FOR WINDINGS (K) :	< 65
WINDING 'HOT - SPOT' (K) :	< 78

APPLIED STANDARD : IEC 60076-2

TEST RESULT : **PASSED**

Note: During the test, transformer is checked with thermo-camera and all temperatures are in normal limits.

The test was carried out in the presence of:

Mr. Ernst HANIQUE, Senior Inspector, KEMA Laboratories Arnhem Energy

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Ernst Hanique
Date: 23 AUG. 2019
KEMA Laboratories

Checked by :

V. Gojević,dipl.ing.

KONČAR Distributivni i specijalni transformatori d.d. Zagreb
ISPITNA STANICA TESTING STATION 4

ZAGREB, 22.08.2019.

Approved by :

V. Maljković,dipl.ing.

TEST RESULTS

TRANSFORMER TYPE :	TRP 80000-145/E
SERIAL No. :	ET1036 - 464170
COOLING METHOD :	ONAF
TEST METHOD :	SHORT - CIRCUIT METHOD
TAP POSITION :	19
RATED POWER (MVA) :	80,0

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Oil temperature rises (steady state)		Test losses	Total losses
	(k W)	251,390	251,390
TOP OIL TEMPERATURE RISE	(K)	51,0	51,0
ENTRY OF COOLER	(K)	46,5	46,5
EXIT OF COOLER	(K)	24,0	24,0
AVERAGE	(K)	36,4	36,4

Winding temperature rises		HS	LS
TEMPERATURE AT THE BEGINING	(°C)	27,6	27,6
WINDING RESISTANCE AT BEGINING	(Ω)	0,229430	0,065022
WINDING RESISTANCE AT THE END	(Ω)	0,281441	0,079932
AVERAGE OIL TEMP. AT SHUTDOWN	(°C)	72,3	72,3
WINDING TEMP. AT SHUTDOWN	(°C)	87,2	87,8
TEST CURRENT (I t)	(A)	388,3	803,3
AVERAGE WINDING TO AVERAGE OIL TEMPERATURE RISE AT It	(K)	14,8	15,5
RATED CURRENT (I r)	(A)	388,3	803,3
AVERAGE WINDING TO AVERAGE OIL TEMPERATURE RISE AT Ir	(K)	14,8	15,5
AVERAGE WINDING TEMPERATURE RISE	(K)	51,2	51,9
WINDING HOT-SPOT TO TOP OIL TEMPERATURE RISE (HOT-SPOT FACTOR = 1,3)	(K)	19,3	20,2
WINDING HOT-SPOT TEMPERATURE RISE	(K)	70,3	71,1

TEST RESULTS

TRANSFORMER TYPE :	TRP 80000-145/E
SERIAL No. :	ET1036 - 464170
COOLING METHOD :	ONAN
TEST METHOD :	SHORT - CIRCUIT METHOD
TAP POSITION :	19
RATED POWER (MVA) :	63,0

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Oil temperature rises (steady state)		Test losses	Total losses
	(k W)	166,870	166,870
TOP OIL TEMPERATURE RISE	(K)	54,5	54,5
ENTRY OF COOLER	(K)	47,4	47,4
EXIT OF COOLER	(K)	28,3	28,3
AVERAGE	(K)	39,6	39,6

Winding temperature rises		HS	LS
TEMPERATURE AT THE BEGINING	(°C)	27,6	27,6
WINDING RESISTANCE AT BEGINING	(Ω)	0,229430	0,065022
WINDING RESISTANCE AT THE END	(Ω)	0,276443	0,078718
AVERAGE OIL TEMP. AT SHUTDOWN	(°C)	69,6	69,6
WINDING TEMP. AT SHUTDOWN	(°C)	81,4	82,9
TEST CURRENT (I t)	(A)	305,8	632,6
AVERAGE WINDING TO AVERAGE OIL TEMPERATURE RISE AT It	(K)	11,9	13,4
RATED CURRENT (I r)	(A)	305,8	632,6
AVERAGE WINDING TO AVERAGE OIL TEMPERATURE RISE AT Ir	(K)	11,9	13,4
AVERAGE WINDING TEMPERATURE RISE	(K)	51,5	53,0
WINDING HOT-SPOT TO TOP OIL TEMPERATURE RISE (HOT-SPOT FACTOR = 1,3)	(K)	15,4	17,4
WINDING HOT-SPOT TEMPERATURE RISE	(K)	69,9	71,9

Time (h)	Temperature measurements (°C)					
	Top oil	Entry of cooler 1	Entry of cooler 2	Exit of cooler 1	Exit of cooler 2	Average ambient
0,25	29,1	29,1	28,7	24,5	24,4	24,0
0,50	36,5	36,1	35,6	25,1	24,9	24,1
0,75	44,1	42,3	41,9	27,2	26,9	24,3
1,00	49,4	47,0	46,6	29,8	29,5	24,7
1,25	53,4	50,5	50,2	32,1	31,9	25,1
1,50	56,8	53,9	53,4	34,2	34,1	25,6
1,75	59,8	56,8	56,1	36,2	36,1	26,1
2,00	62,3	59,3	58,3	38,0	38,0	26,7
2,25	64,5	61,5	60,4	39,7	39,6	27,2
2,50	66,3	63,3	62,1	41,2	41,1	27,9
2,75	68,0	64,9	63,8	42,5	42,4	28,3
3,00	69,5	66,3	65,4	43,8	43,7	28,8
3,25	70,8	67,6	66,8	44,9	44,7	29,2
3,50	72,0	68,9	67,8	45,9	45,7	29,5
3,75	73,2	69,9	69,0	46,9	46,6	29,9
4,00	74,2	70,8	70,0	47,7	47,4	30,2
4,25	75,2	71,9	70,8	48,5	48,2	30,6
4,50	76,0	72,4	71,7	49,2	48,9	30,9
4,75	76,8	73,3	72,3	49,9	49,6	31,2
5,00	77,5	74,1	73,1	50,6	50,2	31,5
5,25	78,1	74,8	73,7	51,2	50,8	31,8
5,50	78,8	75,3	74,2	51,8	51,4	32,1
5,75	79,4	75,8	74,8	52,4	52,0	32,3
6,00	79,9	76,3	75,2	52,9	52,5	32,6
6,25	80,5	76,9	75,8	53,4	53,0	32,8
6,50	81,0	77,3	76,2	53,8	53,5	33,0
6,75	81,5	77,9	76,8	54,3	54,0	33,3
7,00	82,0	78,3	77,2	54,8	54,5	33,5
7,25	82,5	78,7	77,6	55,2	54,9	33,7
7,50	82,9	79,1	78,1	55,6	55,3	33,9
7,75	83,3	79,4	78,4	56,0	55,7	34,2
8,00	83,7	79,7	78,8	56,4	56,1	34,4
8,25	84,0	80,0	79,2	56,8	56,4	34,6
8,50	84,4	80,2	79,5	57,1	56,8	34,8
8,75	84,7	80,4	79,9	57,4	57,0	34,8
9,00	84,9	80,7	79,9	57,6	57,2	35,0
9,25	85,2	80,9	80,3	57,9	57,5	35,1
9,50	85,5	81,2	80,6	58,2	57,7	35,2
9,75	85,7	81,3	80,9	58,4	58,0	35,3
10,00	85,9	81,6	81,0	58,6	58,1	35,4
10,25	86,1	81,8	81,0	58,8	58,4	35,6
10,50	86,3	82,1	81,3	59,0	58,6	35,7
10,75	86,5	82,2	81,7	59,2	58,8	35,9
11,00	86,8	82,4	81,8	59,4	59,0	36,1
11,25	86,9	82,6	82,2	59,7	59,2	36,2
11,50	87,1	82,8	82,3	59,9	59,5	36,4
11,75	87,2	82,9	82,4	60,1	59,6	36,5

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Time (h)	Temperature measurements (°C)						
	Top oil	Entry of cooler 1	Entry of cooler 2	Exit of cooler 1	Exit of cooler 2	Average ambient	
12,00	87,5	81,7	81,7	59,5	58,8	36,0	ONAN
12,25	88,4	82,0	81,7	59,6	58,9	35,4	
12,50	89,1	82,1	81,5	60,9	60,3	34,9	
12,75	88,9	81,7	81,3	61,2	60,8	34,5	
13,00	88,7	81,3	81,0	61,3	61,0	34,2	
13,25	88,3	81,1	80,7	61,4	61,1	34,0	
13,50	88,1	81,0	80,5	61,5	61,1	33,8	
13,75	88,0	80,7	80,4	61,5	61,1	33,7	
14,00	87,9	80,6	80,5	61,5	61,2	33,6	
14,25	87,8	80,6	80,5	61,6	61,2	33,6	
14,50	87,8	80,7	80,4	61,6	61,4	33,5	
14,75	87,8	80,7	80,5	61,7	61,3	33,5	
15,00	87,8	80,8	80,4	61,6	61,4	33,4	
15,25	87,9	80,7	80,4	61,6	61,4	33,4	
15,50	87,9	80,8	80,3	61,6	61,4	33,3	
15,75	87,8	80,6	80,5	61,6	61,4	33,2	
16,00	88,7	82,1	81,9	62,1	61,6	34,9	Irated ONAF
16,25	88,7	82,2	82,1	61,4	60,9	35,4	
16,50	88,5	81,9	81,7	60,8	60,4	35,3	
16,75	87,9	81,4	81,1	60,0	59,5	34,8	
17,00	87,6	80,1	79,8	59,2	59,0	34,5	Irated ONAN
17,25	86,0	78,8	78,6	58,6	58,4	34,2	
17,50	84,8	77,8	77,6	58,4	58,2	34,0	
17,75	84,3	77,2	77,0	58,6	58,2	33,7	
18,00	84,1	77,1	76,9	58,5	58,4	33,6	

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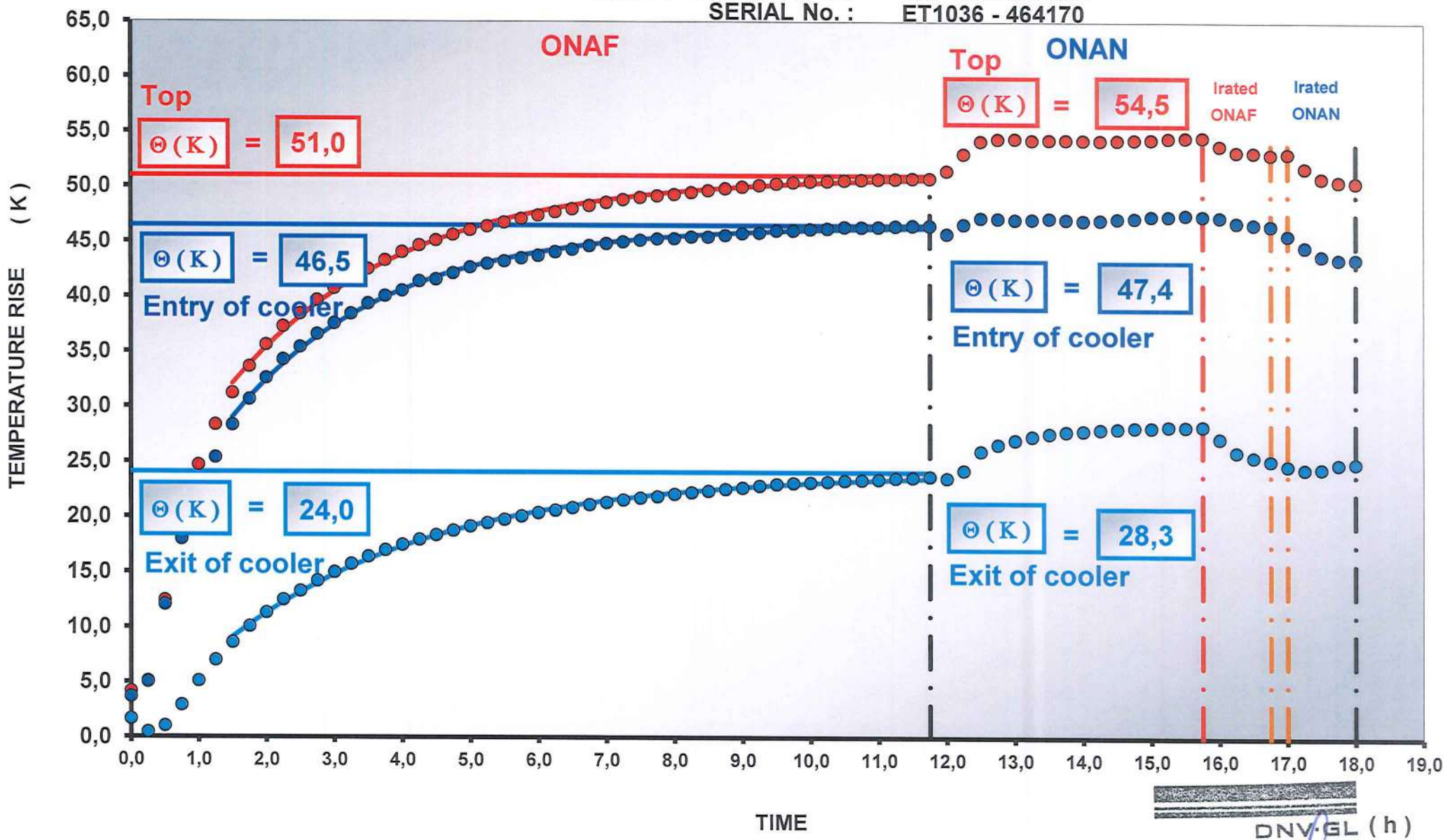
OIL TEMPERATURE RISE

TRANSFORMER TYPE : TRP 80000-145/E
SERIAL No. : ET1036 - 464170



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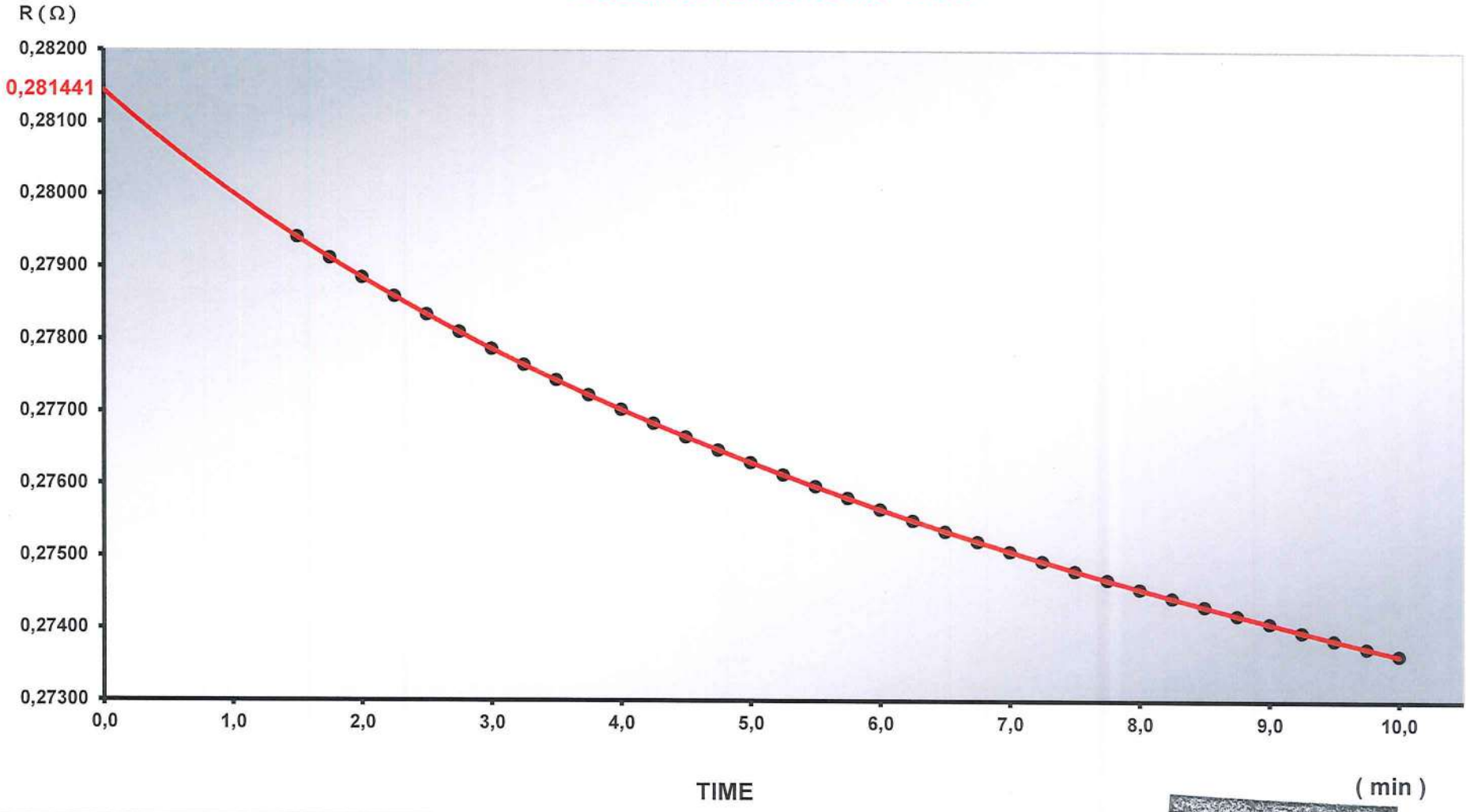
COOLING WINDING HS- ONAF



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Date:

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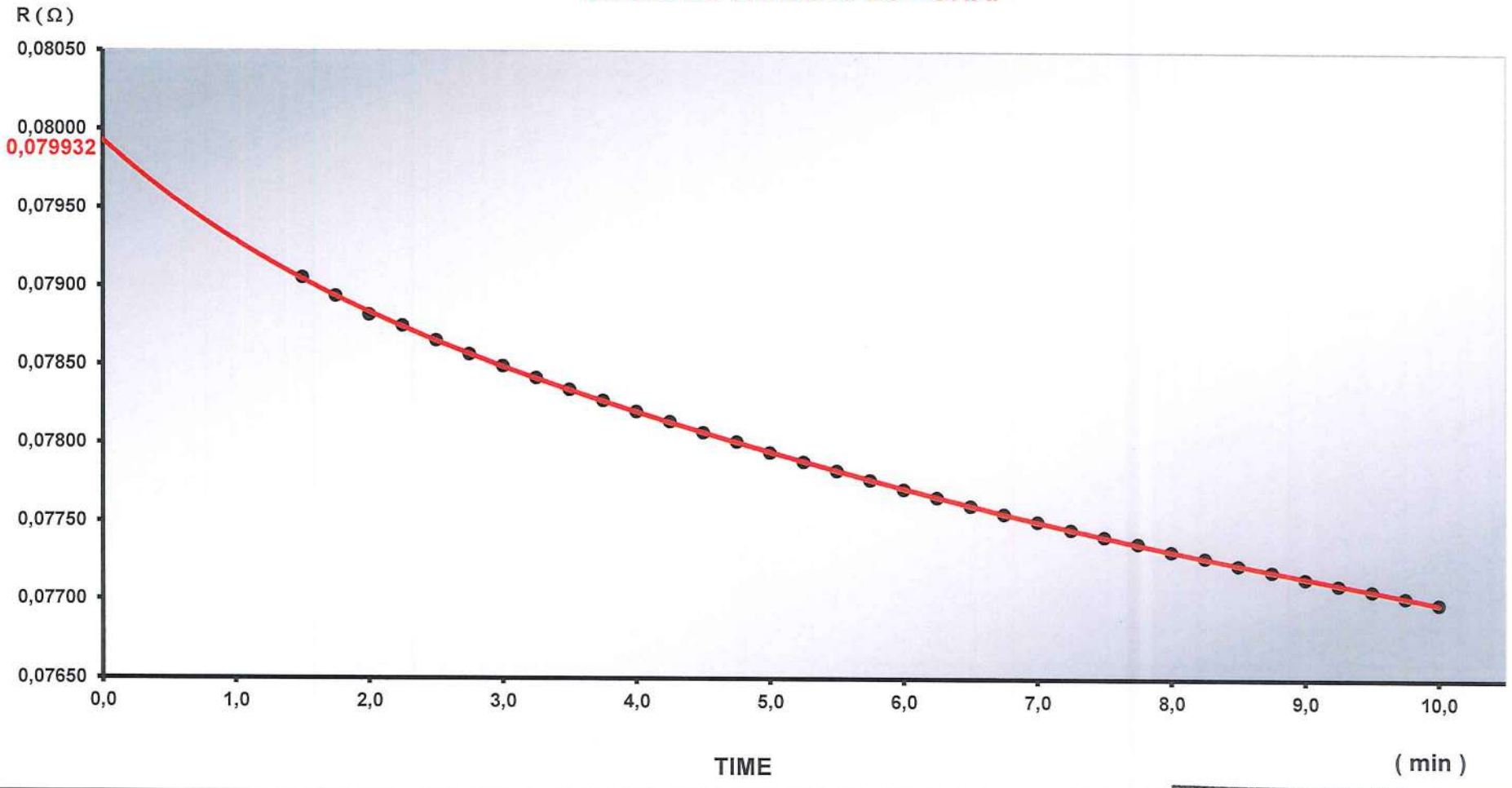
COOLING WINDING LS - ONAF



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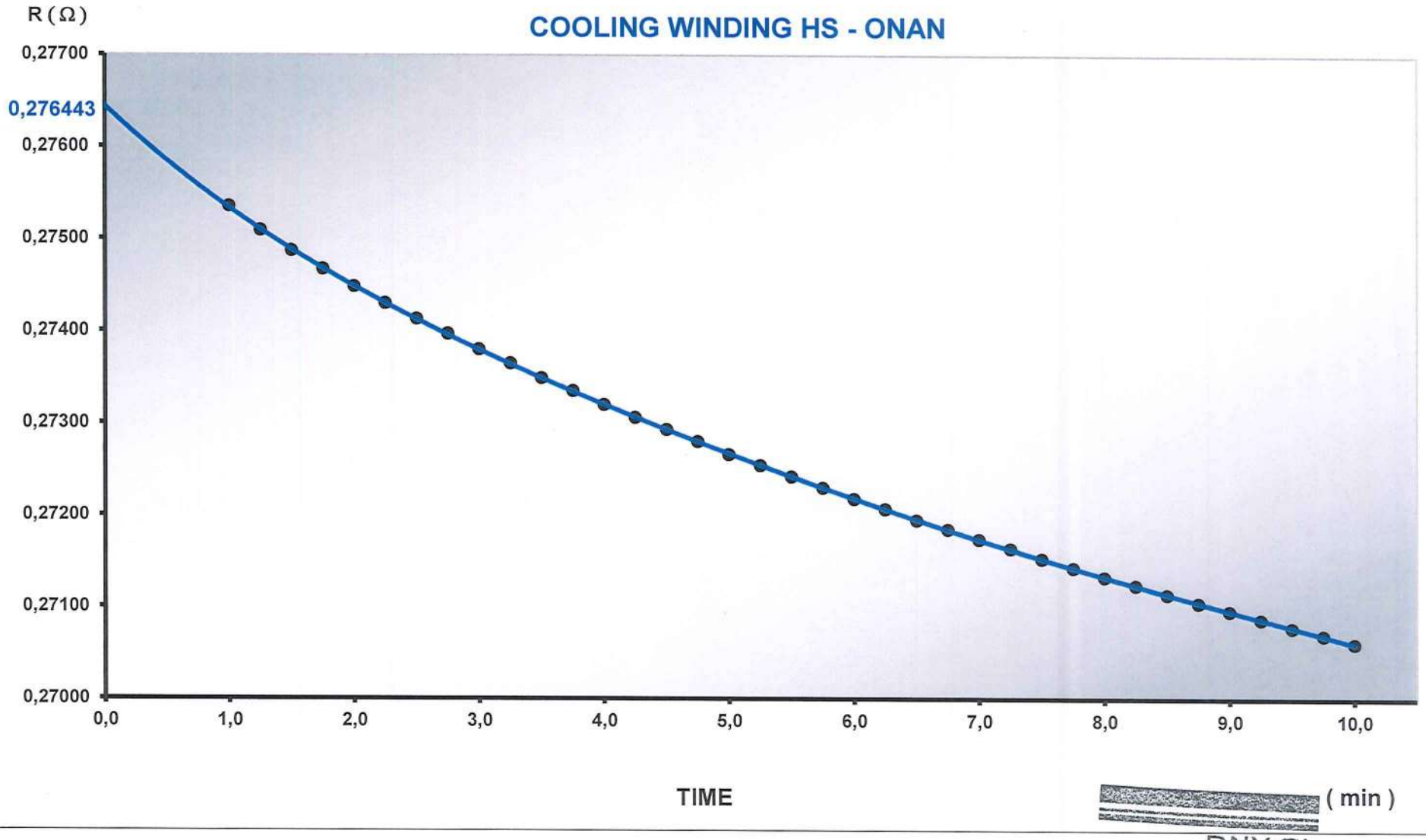

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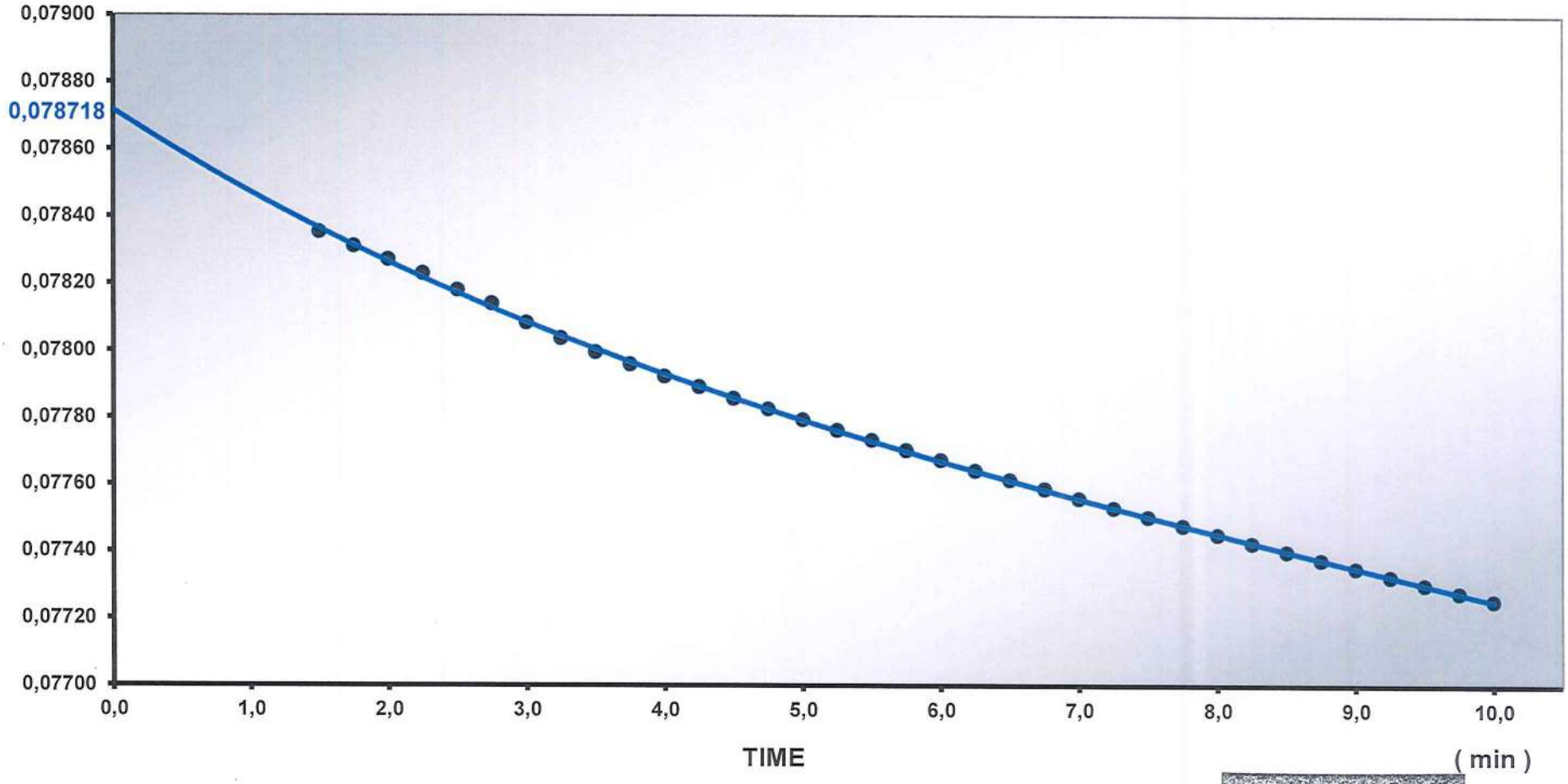
COOLING WINDING LS - ONAN



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Winding resistance measurement (Ω)				
Time (min)	ONAF		ONAN	
	HS	LS	HS	LS
0,00				
0,50				
1,00	0,28008		0,27535	
1,25	0,27972		0,27509	
1,50	0,27941	0,079054	0,27487	0,078354
1,75	0,27912	0,078938	0,27467	0,078312
2,00	0,27885	0,078816	0,27448	0,078273
2,25	0,27859	0,078747	0,2743	0,078231
2,50	0,27834	0,078654	0,27413	0,078181
2,75	0,27810	0,078567	0,27397	0,078140
3,00	0,27787	0,078491	0,2738	0,078083
3,25	0,27765	0,078416	0,27365	0,078037
3,50	0,27744	0,078341	0,27349	0,077996
3,75	0,27723	0,078271	0,27335	0,077960
4,00	0,27703	0,078201	0,2732	0,077924
4,25	0,27684	0,078138	0,27306	0,077892
4,50	0,27665	0,078068	0,27293	0,077858
4,75	0,27647	0,07801	0,2728	0,077827
5,00	0,27630	0,07794	0,27266	0,077795
5,25	0,27613	0,077882	0,27254	0,077763
5,50	0,27597	0,077824	0,27242	0,077734
5,75	0,27581	0,077766	0,2723	0,077703
6,00	0,27565	0,077708	0,27218	0,077674
6,25	0,27550	0,077656	0,27207	0,077643
6,50	0,27535	0,077604	0,27195	0,077615
6,75	0,27521	0,077552	0,27185	0,077588
7,00	0,27507	0,077505	0,27174	0,077560
7,25	0,27494	0,077453	0,27164	0,077531
7,50	0,27480	0,077407	0,27153	0,077504
7,75	0,27468	0,077366	0,27143	0,077478
8,00	0,27455	0,077314	0,27133	0,077452
8,25	0,27443	0,077273	0,27124	0,077426
8,50	0,27431	0,077227	0,27114	0,077401
8,75	0,27419	0,077186	0,27105	0,077376
9,00	0,27408	0,07714	0,27096	0,077351
9,25	0,27396	0,077099	0,27087	0,077326
9,50	0,27385	0,077065	0,27078	0,077302
9,75	0,27374	0,077024	0,2707	0,077278
10,00	0,27364	0,076983	0,27061	0,077255

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Ernst Hanique

Date: 23 AUG. 2019

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TEST REPORT

acc.to: HRN EN10204 2.2

No.: 19/436

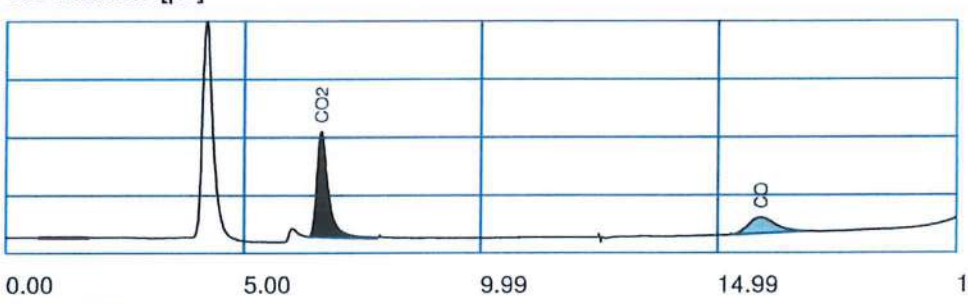
Date: 21.08.2019

ISO 9001 ISO 14001 OHSAS 18001 BUREAU VERITAS Certification

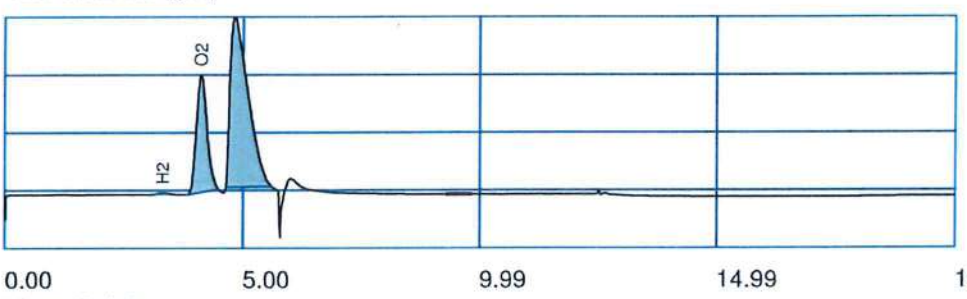
CHROMATOGRAPHIC ANALYSIS OF GASES DISSOLVED IN OIL

Transformer data:	TRP 80000-145/E; ET1036; 464170; SWEDEN
Instrument data:	TOGA GC, full vacum degassing, Energy support
Test method:	IEC 60567, IEC 60599, IEC 61181
Note:	before all factory acceptance tests

FID channel: [µV]



TCD channel: [µV]



Component		Ref. value ppm	Meas. value ppm	Nom. value ppm	Exceed. nom. val. %
Hydrogen	H_2	-	2.5	15.0	-
Methane	CH_4	-	-	5.0	-
Ethine	C_2H_2	-	-	1.0	-
Ethene	C_2H_4	-	-	2.0	-
Ethane	C_2H_6	-	-	5.0	-
Carbon monoxide	CO	-	16.3	80.0	-
Carbon dioxide	CO_2	-	50.2	200	-
Nitrogen	N_2	-	11906	-	-
Oxygen	O_2	-	3646	-	-
Total gas	TG	-	15621	-	-

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Date: 23 AUG 2019

INTERPRETATION OF TEST RESULTS: All gas concentrations are low and according with typical manufacturer's gas values acc. RU-OP--DST-Q15-8-605-01

Tested by: Ivanka Radić, MSc.Chem.E.
Branka Jakopović, MSc.Chem.E.

Approved by: Renata Jurišić, MSc.Chem.E.

Končar Distribution&Special Transformers, tel. + 385 1 3783 777, fax:+ 0385 1 3794 051, e-mail: info@koncar-dst.hr, www.koncar-dst.hr
Laboratory of Incoming control, tel.+385 1 3783 829, e-mail:ivanka.radic@koncar-dst.hr

KONČAR D&ST

TEST REPORT

acc.to: HRN EN10204 2.2

No.: 19/437

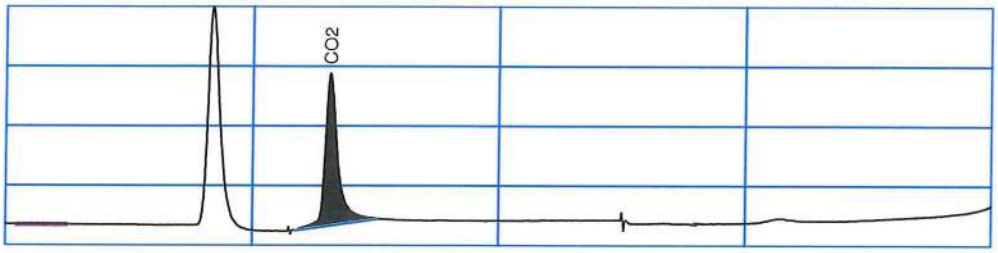
Date: 23.08.2019

ISO 9001 ISO 14001 OHSAS 18001 BUREAU VERITAS Certification

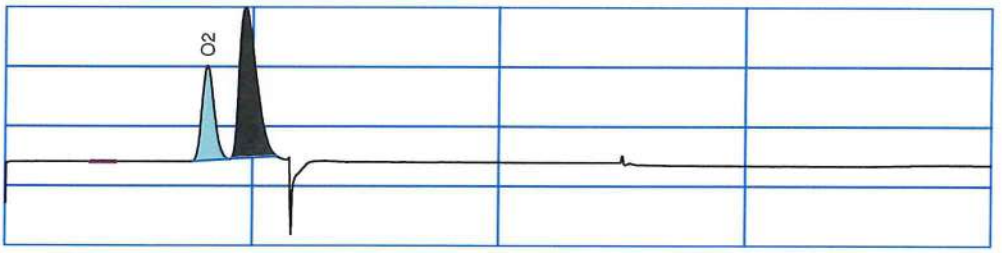
CHROMATOGRAPHIC ANALYSIS OF GASES DISSOLVED IN OIL

Transformer data:	TRP 80000-145/E; ET1036; 464170; SWEDEN
Instrument data:	TOGA GC, full vacum degassing, Energy support
Test method:	IEC 60567, IEC 60599, IEC 61181
Note:	after all factory acceptance tests

FID channel: [µV]



TCD channel: [µV]



Component		Ref. value ppm	Meas. value ppm	Nom. value ppm	Exceed. nom. val. %
Hydrogen	H_2	-	-	15.0	-
Methane	CH_4	-	-	5.0	-
Ethine	C_2H_2	-	-	1.0	-
Ethene	C_2H_4	-	-	2.0	-
Ethane	C_2H_6	-	-	5.0	-
Carbon monoxide	CO	-	-	80.0	-
Carbon dioxide	CO_2	-	32.2	200	-
Nitrogen	N_2	-	5344	-	-
Oxygen	O_2	-	1812	-	-
Total gas	TG	-	7188	-	-

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Ernst Hanique

Date:

KEMA Laboratories 23 AUG. 2019

INTERPRETATION OF TEST RESULTS: All gas concentrations are low and according with typical manufacturer's gas values acc. RU-OP--DST-Q15-8-605-01

Tested by: Ivanka Radić, MSc.Chem.E.
Branka Jakopović, MSc.Chem.E.

Approved by: Renata Jurišić, MSc.Chem.E.

OB-0278 2013-08-26

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Laboratory of Incoming control, tel.+385 1 3783 829, e-mail:ivanka.radic@koncar-dst.hr

Location:	**KONČAR D&ST factory**
Tested by :	**Marko Haramustek**
Date:	**14.06.2019 & 21.06.2019.**
Manufacturer:	**KONČAR D&ST**
Type:	**TRP80000-145/E**
Serial number:	**ET1036-464170**
Tested object:	**------**
Cause of testing:	**Lx measurement before and after Short-circuit withstand test**
Contract:	**3216230**

Datum Date	Izradio Designed	Odobrio Approved	Promjena Revision
22.08.2019.	M.Haramustek	M. Krainz	

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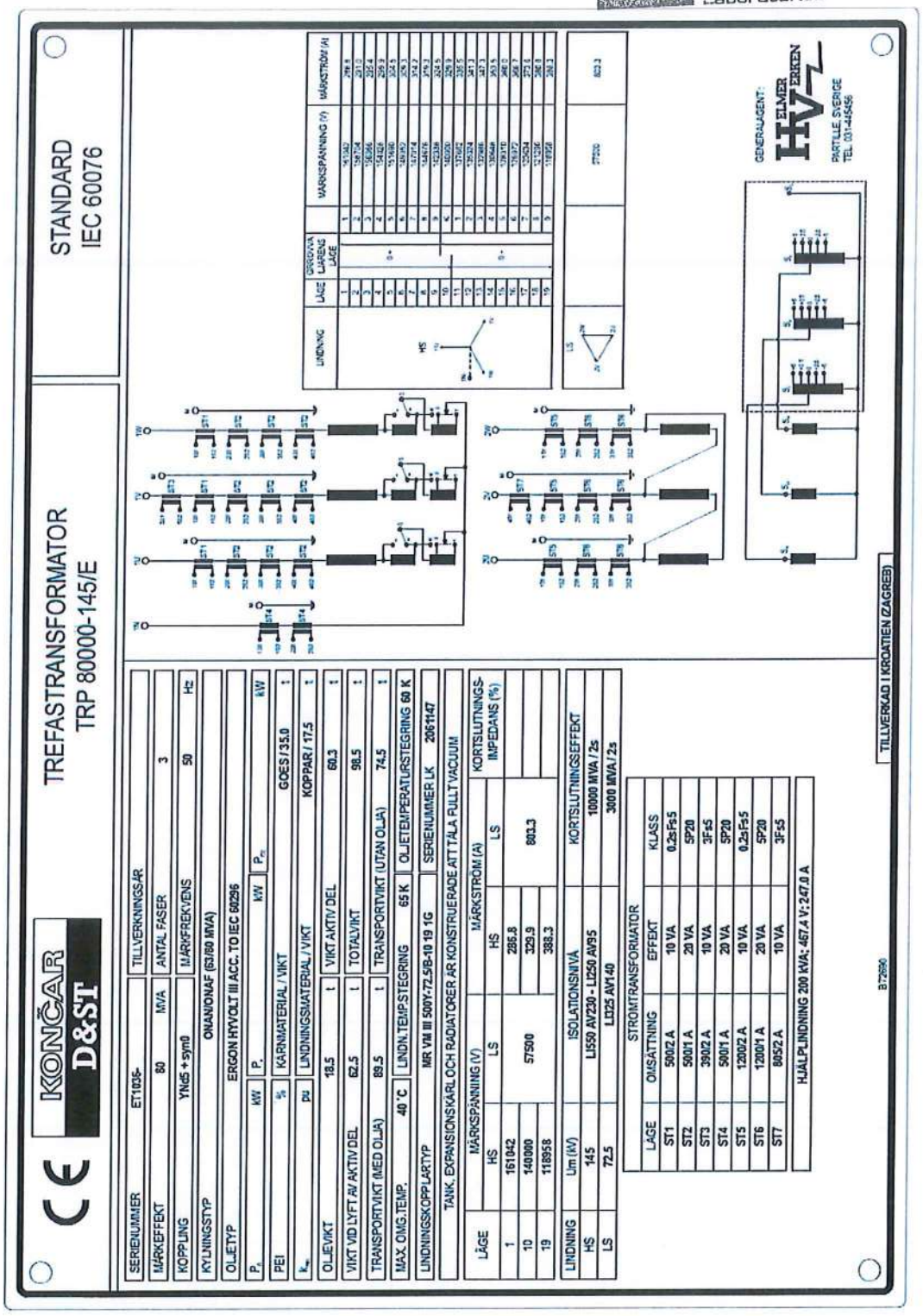
1 Transformer nameplate



Datum Date	Izradio Designed	Odobrio Approved	Promjena Revision
22.08.2019.	M.Haramustek	M. Krainz	

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2 Cause of testing

Leakage reactance measurement before and after Short-circuit withstand test

3 Content and testing metods

A) Leakage reactance measurement before Short-circuit withstand test
Test device: OMICRON CPC100

B) Leakage reactance measurement after Short-circuit withstand test
Test device: OMICRON CPC100

Conclusion

Measurements before and after Short-circuit withstand test are without significant deviations, thus indicating that there are no winding deformations.

Datum Date	Izradio Designed	Odobrio Approved	Promjena Revision
22.08.2019.	M.Haramustek	M. Krainz	

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Date:
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A) Leakage reactance measurement before Short-circuit withstand test

Power supply	Short circuit	Tap position	Lx [mH]	Asimetry [%]
1U – 1V	2U – 2V – 2W	1	285,285	0,60
1V – 1W			283,569	
1W – 1U			284,308	
1U – 1V	2U – 2V – 2W	10	197,101	0,80
1V – 1W			195,539	
1W – 1U			196,734	
1U – 1V	2U – 2V – 2W	19	132,643	0,90
1V – 1W			131,459	
1W – 1U			132,494	
1U – 1N	2U – 2W	1	141,107	1,76
1V – 1N	2U – 2V		138,658	
1W – 1N	2V – 2W		139,844	

Asimetrija = $(Lx_{max} - Lx_{min}) * 100 / Lx_{min} < 2,5\%$

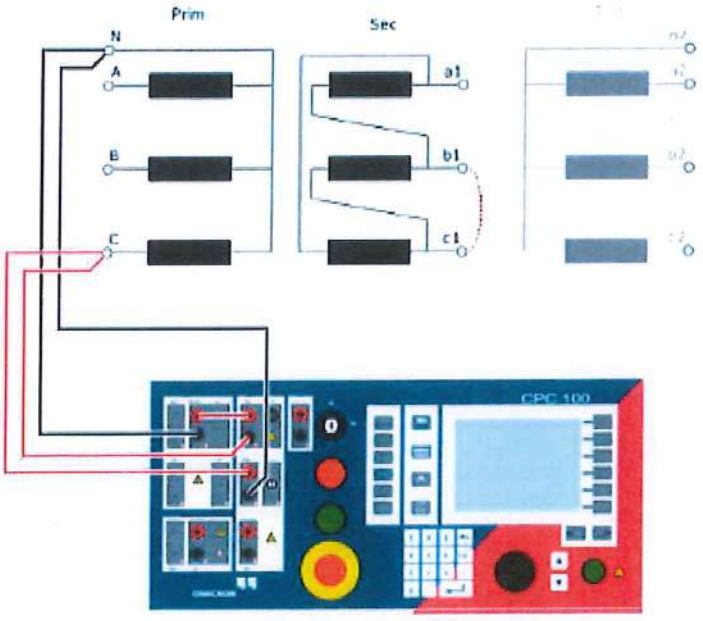

Figure 1 *Connection diagram*

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e-mail: info@koncar-dst.hr

B) Leakage reactance measurement after Short-circuit withstand test

Power supply	Short circuit	Tap position	Lx [mH]	Asimetry [%]
1U – 1V	2U – 2V – 2W	1	285,405	0,60
1V – 1W			283,664	
1W – 1U			284,409	
1U – 1V	2U – 2V – 2W	10	197,199	0,80
1V – 1W			195,630	
1W – 1U			196,830	
1U – 1V	2U – 2V – 2W	19	132,706	0,90
1V – 1W			131,524	
1W – 1U			132,575	
1U – 1N	2U – 2W	1	141,149	1,80
1V – 1N	2U – 2V		138,648	
1W – 1N	2V – 2W		139,841	

Asimetry = $(Lx_{max} - Lx_{min}) * 100 / Lx_{min} < 2,5\%$

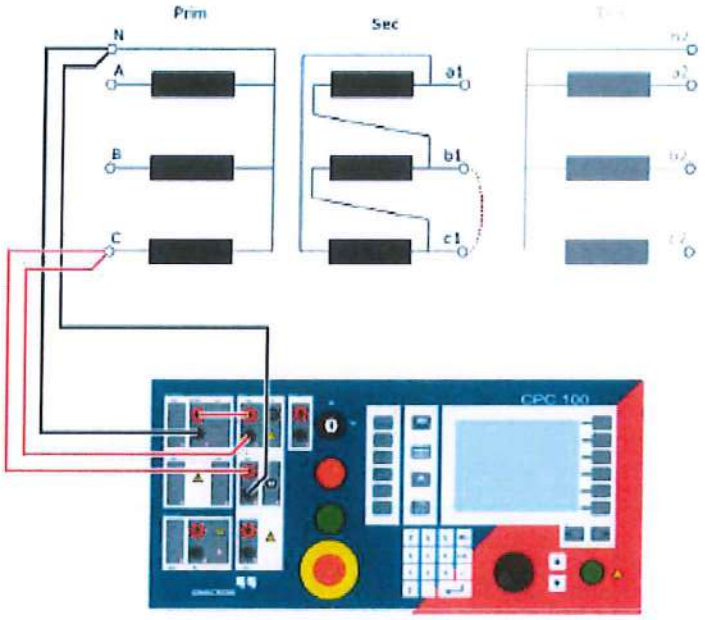

Figure 2 Connection diagram

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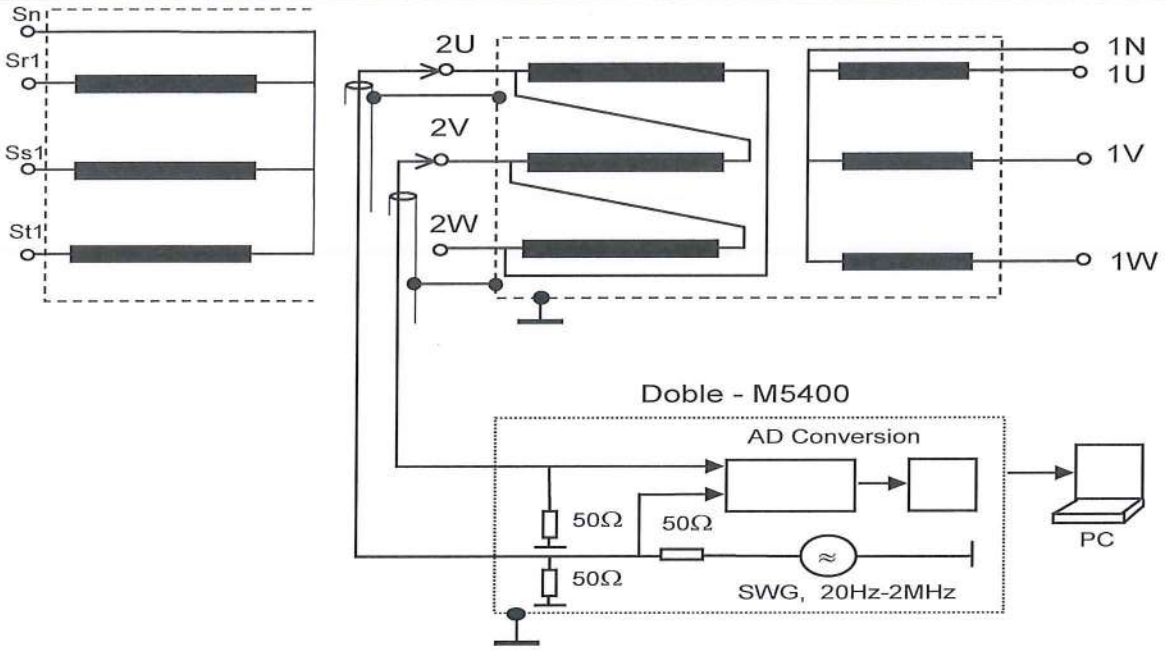
KONČAR D&ST	MEASUREMENT OF FREQUENCY RESPONSE After Short-circuit withstand test (IEC 60076-5)	Test report No : F528 Page No. : 1

	RATING VALUES		
Transformer type :	TRP 80000-145/E	Connections :	YNd5+syn0
Rated power (kVA)	80000 / 80000 / 200	Type of cooling :	ONAN / ONAF
Rated voltage (kV)	140 / 57,5 / 0,4674	Frequency (Hz) :	50
Serial No. :	ET1036 - 464170	Tested in acc. :	IEC 60076-18



Winding under test	Winding vector group	Tap positions - windings HS / LS / Aux. winding	Voltage applied	Response	Graph №	Description
HS	YN	1 / - / -	1U	1N	1	Winding LS - open Aux. winding - open
			1V	1N		
			1W	1N		
HS	YN	10(9) / - / -	1U	1N	1a	Winding LS - open Aux. winding - open
			1V	1N		
			1W	1N		
LS	d	1 / - / -	2U	2V	2	Winding HS - open Aux. winding - open
			2V	2W		
			2W	2U		

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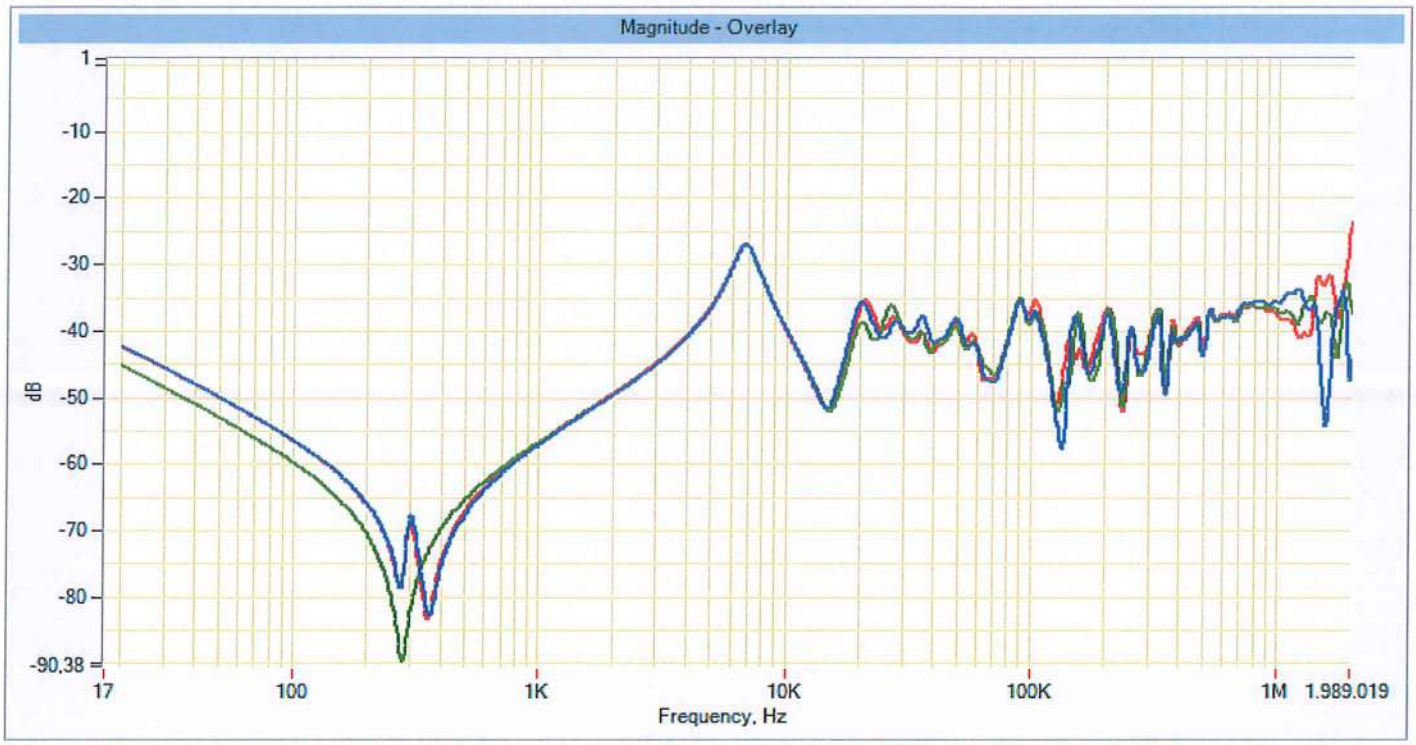
Date: 23 AUG. 2019
KEMA Laboratories

The test was carried out in the presence of :

Mr. Ernst HANIQUE, Senior Inspector, KEMA Laboratories Arnhem Energy

KONČAR Distributivni i specijalni transformatori d.d. Zagreb
ISPITNA STANICA TESTING STATION 4

Tested by :	Approved by :	Date of measurement :
D. Bistrički, dipl.ing.	Vedran Maljković, dipl.ing.	22.08.2019.



Graph 1.

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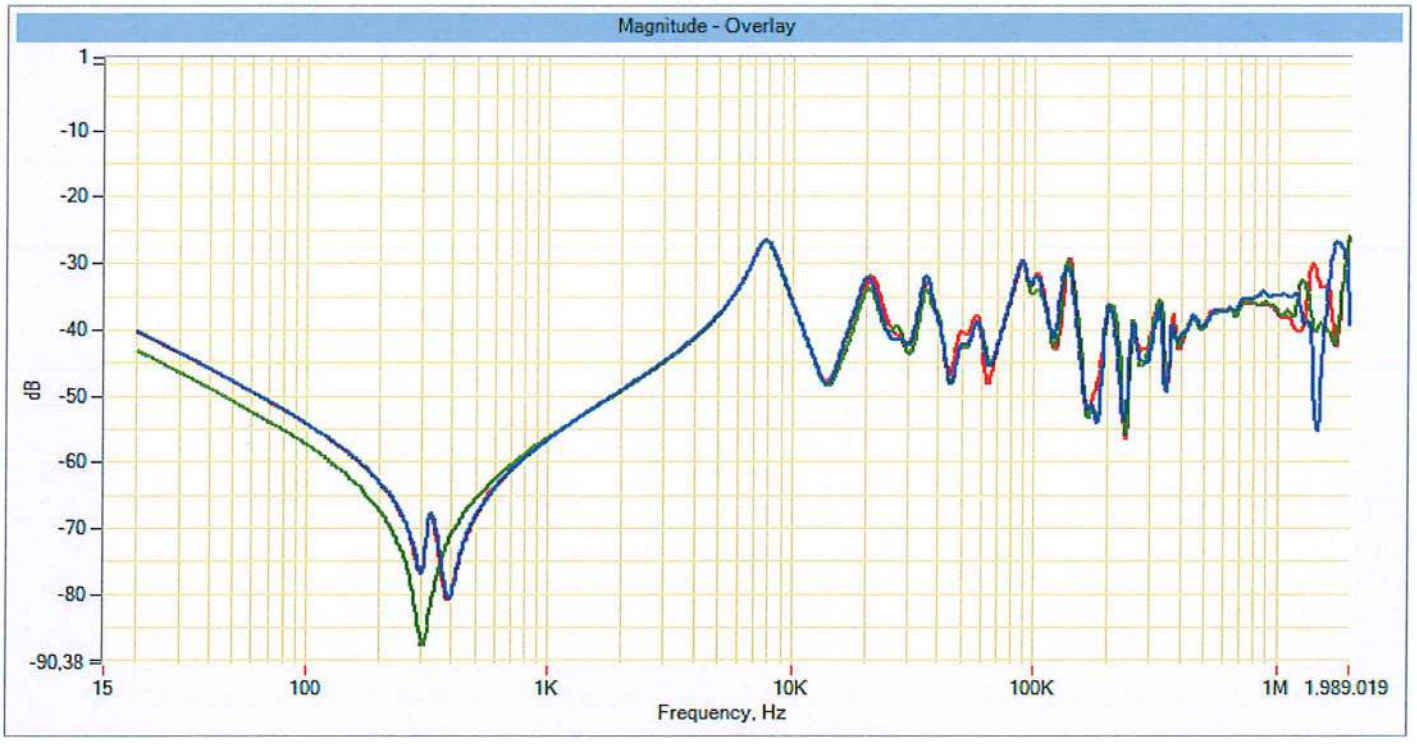
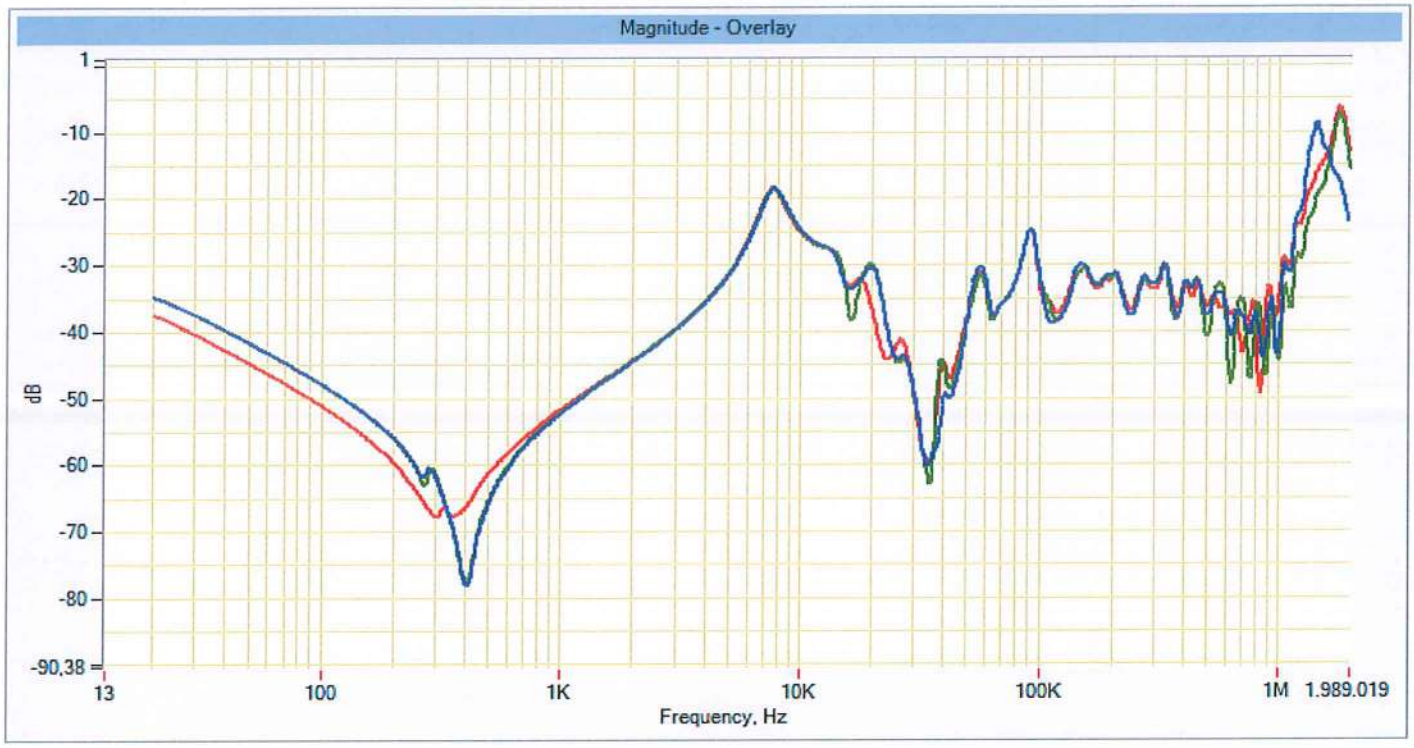


Graph 1a.



Graph 2.

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EC DECLARATION OF CONFORMITY

CE

Manufacturer: **KONČAR DISTRIBUTIVNI I SPECIJALNI TRANSFORMATORI d.d.**

Address: **Josipa Mokrovića 8, P.O. Box 100, HR-10090 Zagreb**

We hereby declare that:

Description of transformer:	Three phase oil immersed transformer, rated power 80000 kVA, with ONAN / ONAF cooling, rated voltage 140 / 57,5 kV
Type:	TRP 80000-145/E
Part number:	ET1036
Serial number:	464170

is in conformity with the provisions of the following EC directive(s), including the latest amendments, and with national legislation implementing this/these directives:

1. Ecodesign Directive 2009/125/EC
2. Ecodesign Regulation (EU) No.548 / 2014

and that the following harmonized standards have been applied:

Ref.	***Title***	***Edition/Date***
IEC 60076-1	Power transformers – Part 1: General	Ed.3 / 04.2011.
IEC 60076-2	Power transformers – Part 2: Temperature rise for liquid immersed transformers	Ed.3 / 02.2011.
IEC 60076-3	Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air	Ed.3 / 07.2013.
IEC 60076-5	Power transformers – Part 5: Ability to withstand short circuit	Ed.3 / 02.2006.
IEC 60076-10	Power transformers – Part 10: Determination of sound levels	Ed.2 / 03.2016.
EN 50629	Energy performance of large power transformers	Ed.1 / 06.2015.

Routine test report No's	*ET1036 - 464170*

Date:	*23.08.2019.*	*Place:*	*Zagreb*
Responsible / Quality control manager	*Vedran Maljković*	*Signature:*	N. Mal

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Ernst Hanique
Date: 23 AUG. 2019
REMA Laboratories