



DECLARATION OF CONFORMITY

No: 20/2021

Power Engineering Transformatory

83, Gdynska, 62-004 Czerwonak,

**Three-winding oil power transformer type
PTRP 25000-123/A with the serial number 116253214508**

We hereby declare that the power transformer described above is in conformity
with the requirements of the following documents:

1. IEC 60076-1:2011 – Power transformers – Part 1: General,
2. IEC 60076-2:2011 – Power transformers – Part 2: Temperature rise for liquid-immersed transformers,
3. IEC 60076-3:2013 – Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air,
4. IEC 60076-10:2016 – Power transformers – Part 10: Determination of sound levels,
5. IEC 60296:2012 – Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear,
6. IEC 61181:2007/AMD1:2012 – Mineral oil-filled electrical equipment – Application of dissolved gas analysis (DGA) to factory tests on electrical equipment,
7. Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products.

Czerwonak, 12.10.2021
Kamil Lewandowski
Quality Control Manager

Dział Kontroli Jakości
Kierownik

Kamil Lewandowski

.....
(Signature)



DECLARATION OF CONFORMITY

No: 20/2021

Power Engineering Transformatory

83, Gdynska, 62-004 Czerwonak,

**Three-winding oil power transformer type
PTRP 25000-123 / TATH-25000/110-Y3 with the serial
number 116253214508**

We hereby declare that the power transformer described above is in conformity
with the requirements of the following documents:

1. IEC 60076-1:2011 – Power transformers – Part 1: General,
2. IEC 60076-2:2011 – Power transformers – Part 2: Temperature rise for liquid-immersed transformers,
3. IEC 60076-3:2013 – Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air,
4. IEC 60076-10:2016 – Power transformers – Part 10: Determination of sound levels,
5. IEC 60296:2012 – Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear,
6. IEC 61181:2007/AMD1:2012 – Mineral oil-filled electrical equipment – Application of dissolved gas analysis (DGA) to factory tests on electrical equipment,
7. Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products.

Czerwonak, 12.10.2021
Kamil Lewandowski
Quality Control Manager

Dział Kontroli Jakości
Kierownik

Kamil Lewandowski

.....
(Signature)

Quality Department

Phone: (061) 892 88 16
e-mail: k.lewandowski@pettransformatory.pl

TRANSFORMER TEST REPORT NO. 161/QD/T/21

ORDER:3214508

Type: PTRP 25000-123/A Rated power: 25000 / 25000 / 25000 kVA Serial no.: 116253214508 Producer: PET
Rated voltage: 115000 $\pm 16\%$ ± 9 taps / 22000 $\pm 5\%$ ± 2 taps / 6600 V Rated current: 125,5 / 656,1 / 2186,9 A
Short circuit impedance refer to power 25 MVA: HV-LV: + 19,33% 0 18,32% - 17,61%
Short circuit impedance refer to power 25 MVA: HV-MV: + 10,85% 0 9,88% - 9,18%
Short circuit impedance refer to power 25 MVA: MV-LV: 0 6,49% - 6,85%
Load losses refer to power 25 MVA: HV-LV: 157424 W HV-MV: 127563 W MV-LV: 108404 W
Type of work: C Vector group: YNyd11 No-load losses: 18168 W No-load current: 0,11 %
Type of cooling: ONAF Year of production: 2021 Frequency: 50 Hz
Tested in acc.: PN-EN 60076-1:2011 Total mass: 53500 kg Oil mass: 13500 kg Transport mass: 36500 kg

Lightning Impulse Test

1. Test conditions

Measuring equipment:

- HighVolt Impulse Generator type IPF 100/1000M,
- HighVolt HiRES measuring equipment with serial number 928447,
- HighVolt HiCOS Basic with serial number 927857.

The test was carried out with full LI voltage for each terminal of LV (3U, 3V, 3W), MV (2U, 2V, 2W) and HV windings (1U, 1V, 1W).

Test voltages applied during the test:

- HV line terminals - 480 kV (LI),
- MV line terminals - 125 kV (LI),
- LV line terminals - 60 kV (LI).

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

- IEC 60076-1: 2011. Power transformers – Part 1: General ,
- IEC 60076-3: 2013. Power transformer – Part 3: Insulation levels, dielectric tests and external clearances in air,
- IEC 60076-4: 2002 – Power transformers – Part 4: Guide to the lightning impulse and switching impulse testing – Power transformers and reactors,
- IEC 60060-1: 2010 – High-voltage test techniques - Part 1: General definitions and test requirements.

The measurement results are presented in the Annex 1

2. Test result

**There were no differences in recorded waveforms
that may indicate a defect.**

Test result: positive.

Tested by:

- Kamil Lewandowski electrical license No.: 6/D/2677/2018, 6/E/2678/2018,
- Andrii Voskoboinyk electrical license No.: 6/D/406/2021, 6/E/407/2021.

Prepared by: **Dział Kontroli Jakości**
Andrii Voskoboinyk
[Signature]
Inżynier testów Elektrycznych

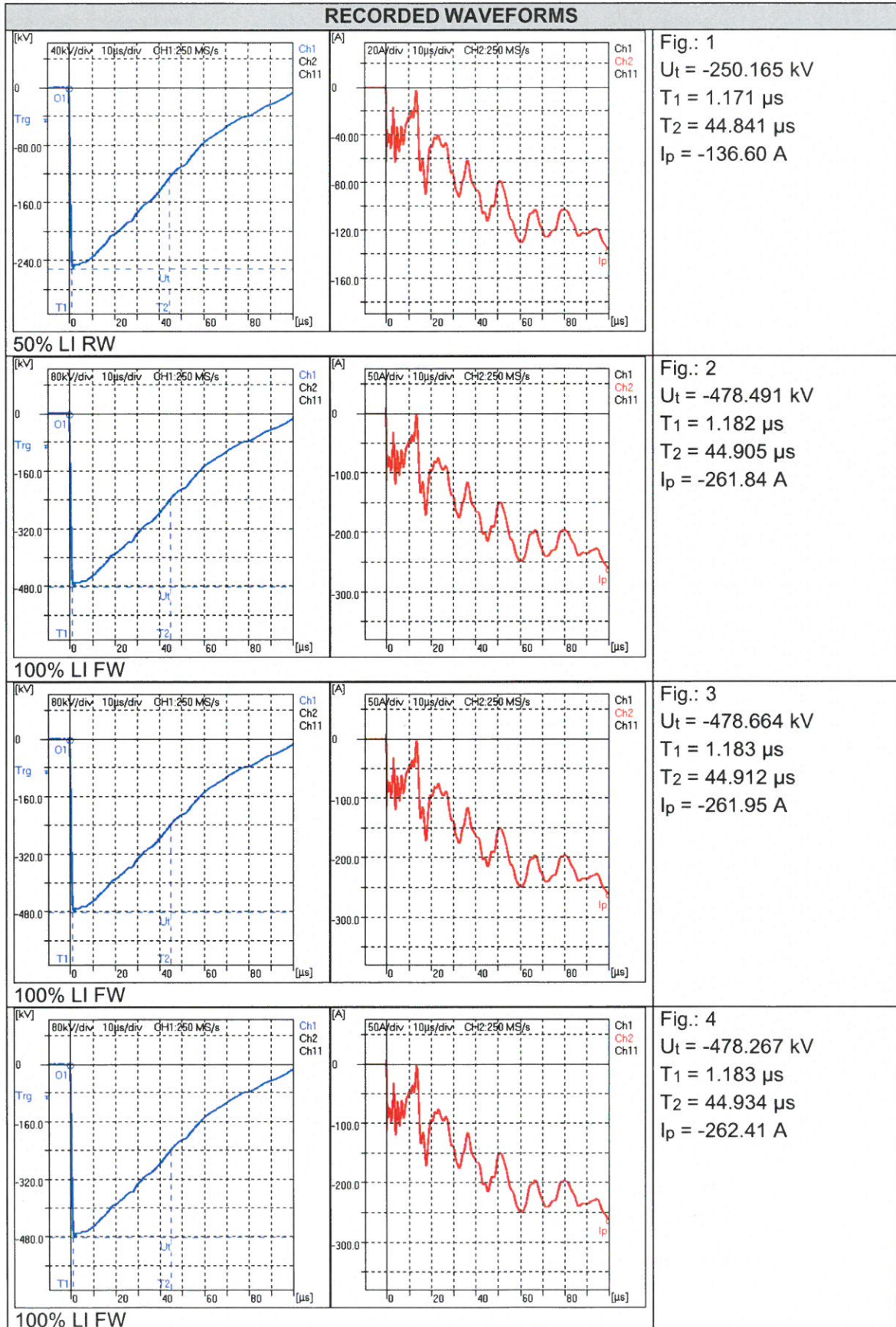
Approved by: **Dział Kontroli Jakości**
Kierownik
[Signature]
Kamil Lewandowski

Test date: 01.10.2021

Annex 1 Waveforms recorded during LI tests

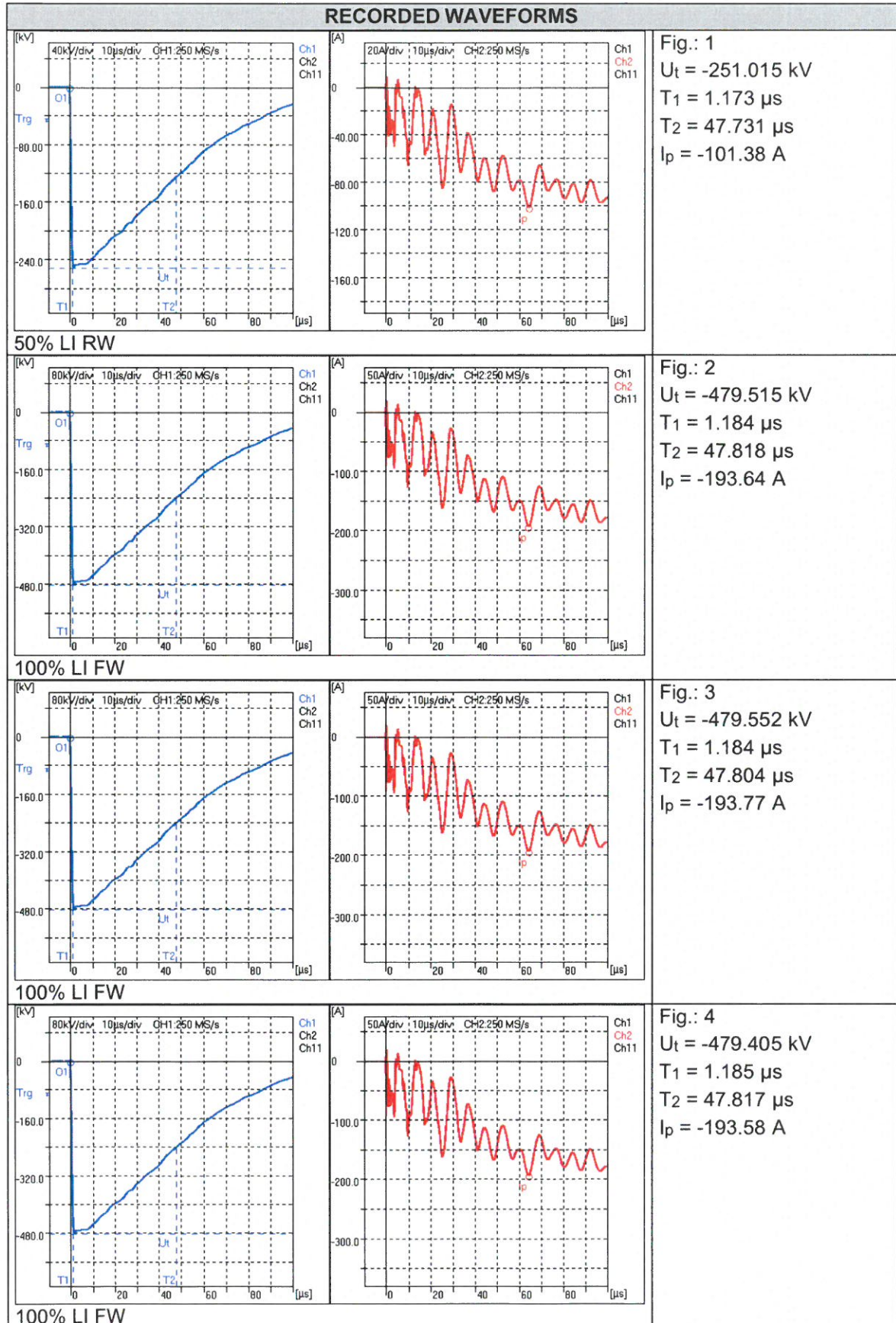
Tested terminal: 1U – HV tap number 1

MEASUREMENTS RESULTS					
Fig.	Note	U_t / kV	T_1 / μ s	T_2 / μ s	I_p / A
1	50% LI RW	-250.165	1.171	44.841	-136.60
2	100% LI FW	-478.491	1.182	44.905	-261.84
3	100% LI FW	-478.664	1.183	44.912	-261.95
4	100% LI FW	-478.267	1.183	44.934	-262.41



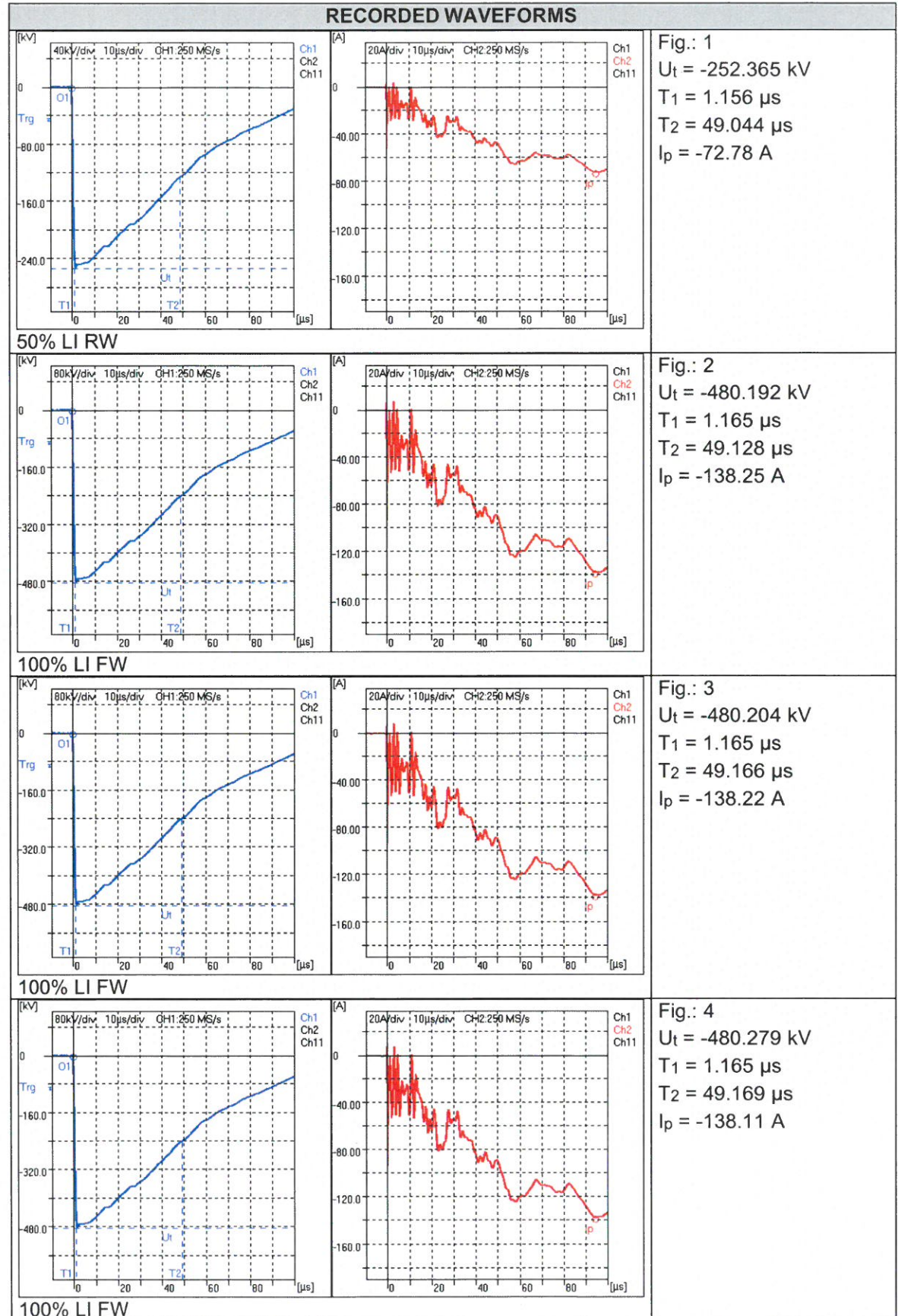
Tested terminal: 1V – HV tap number 10 (from 9)

MEASUREMENTS RESULTS						
Fig.	Note	U_t / kV	T_1 / μ s	T_2 / μ s	I_p / A	
1	50% LI RW	-251.015	1.173	47.731	-101.38	
2	100% LI FW	-479.515	1.184	47.818	-193.64	
3	100% LI FW	-479.552	1.184	47.804	-193.77	
4	100% LI FW	-479.405	1.185	47.817	-193.58	



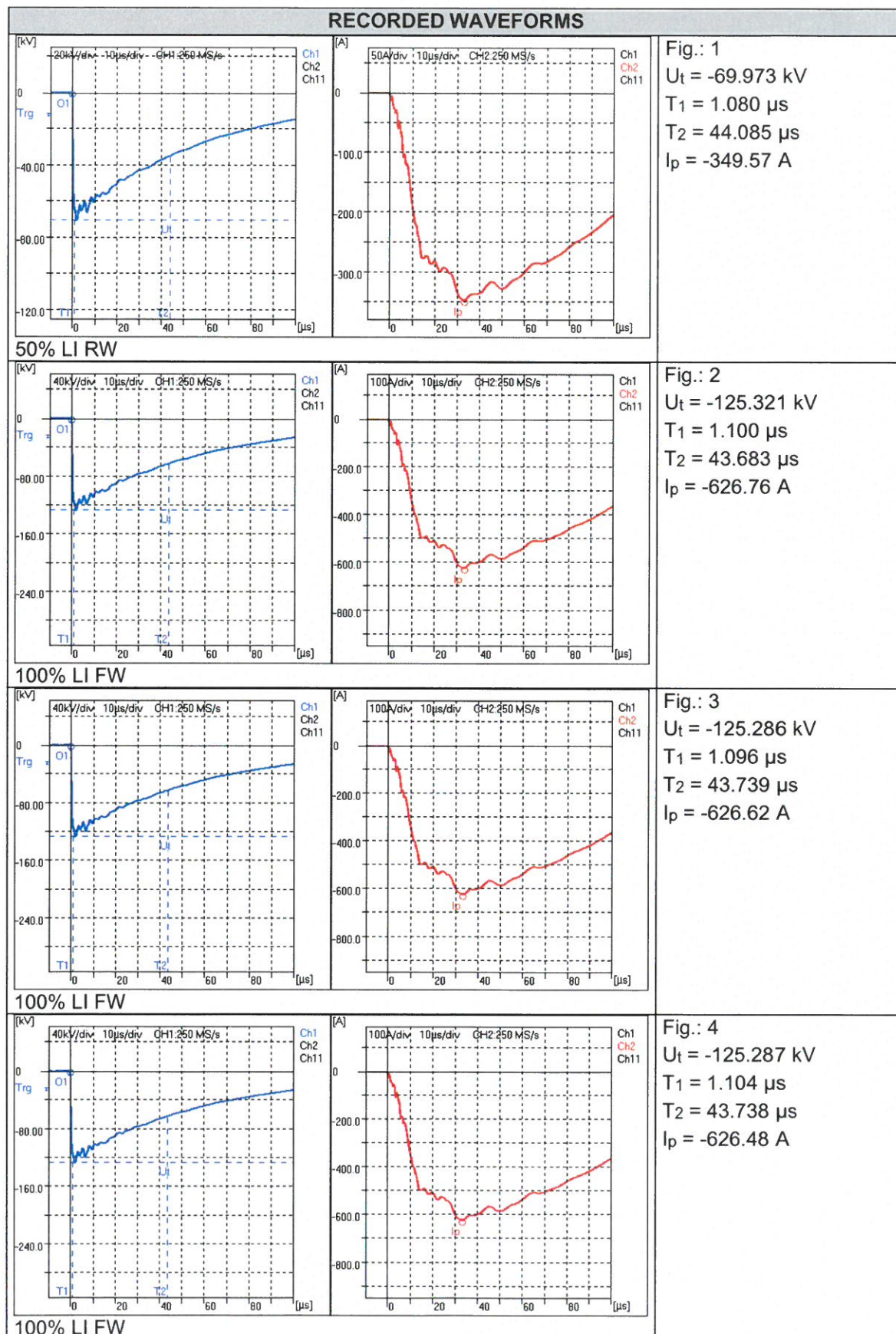
Tested terminal: 1W – HV tap number 19

MEASUREMENTS RESULTS					
Fig.	Note	U_t / kV	T_1 / μ s	T_2 / μ s	I_p / A
1	50% LI RW	-252.365	1.156	49.044	-72.78
2	100% LI FW	-480.192	1.165	49.128	-138.25
3	100% LI FW	-480.204	1.165	49.166	-138.22
4	100% LI FW	-480.279	1.165	49.169	-138.11



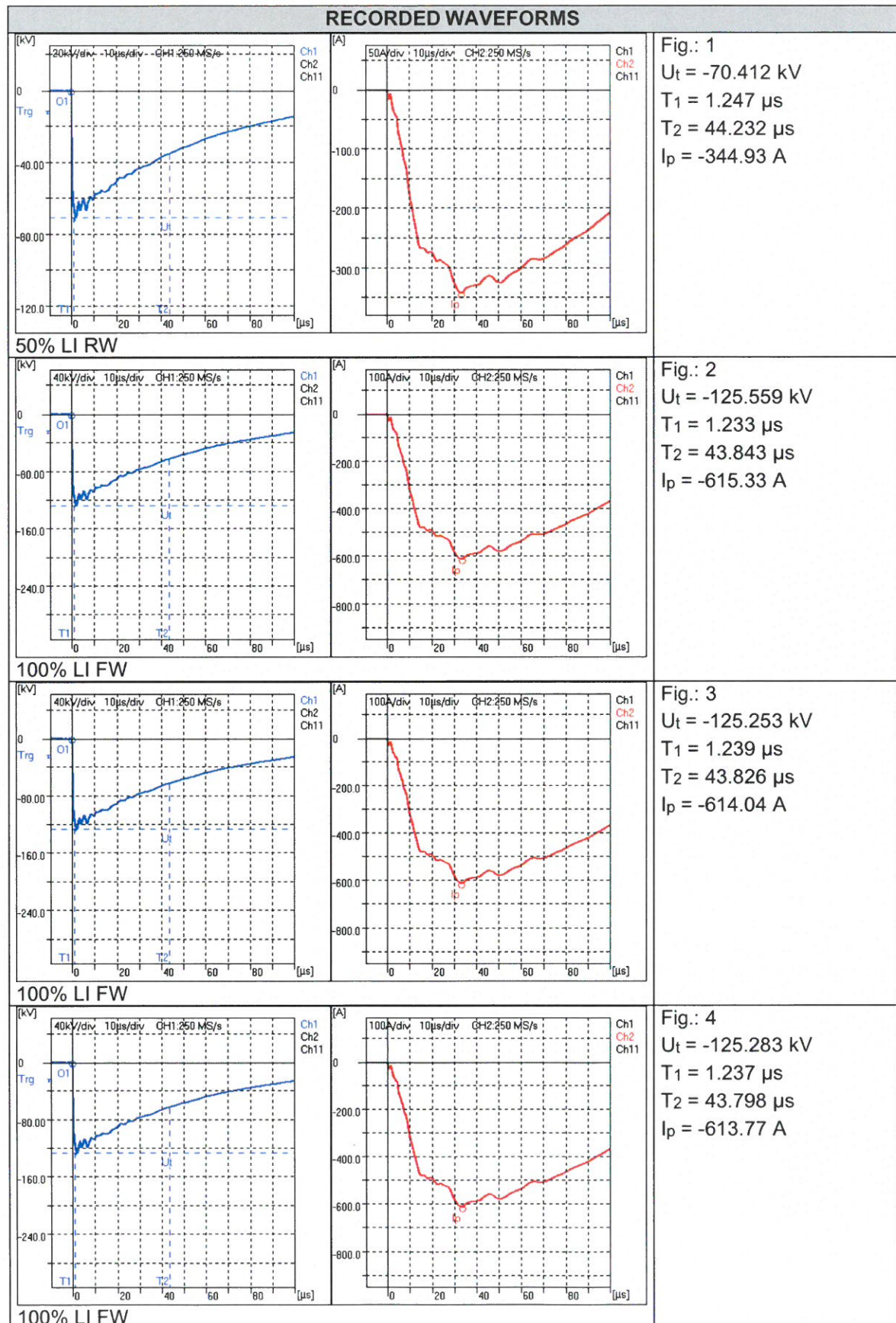
Tested terminal: 2U – MV tap number 1

MEASUREMENTS RESULTS						
Fig.	Note	U_t / kV	T_1 / μ s	T_2 / μ s	I_p / A	
1	50% LI RW	-69.973	1.080	44.085	-349.57	
2	100% LI FW	-125.321	1.100	43.683	-626.76	
3	100% LI FW	-125.286	1.096	43.739	-626.62	
4	100% LI FW	-125.287	1.104	43.738	-626.48	



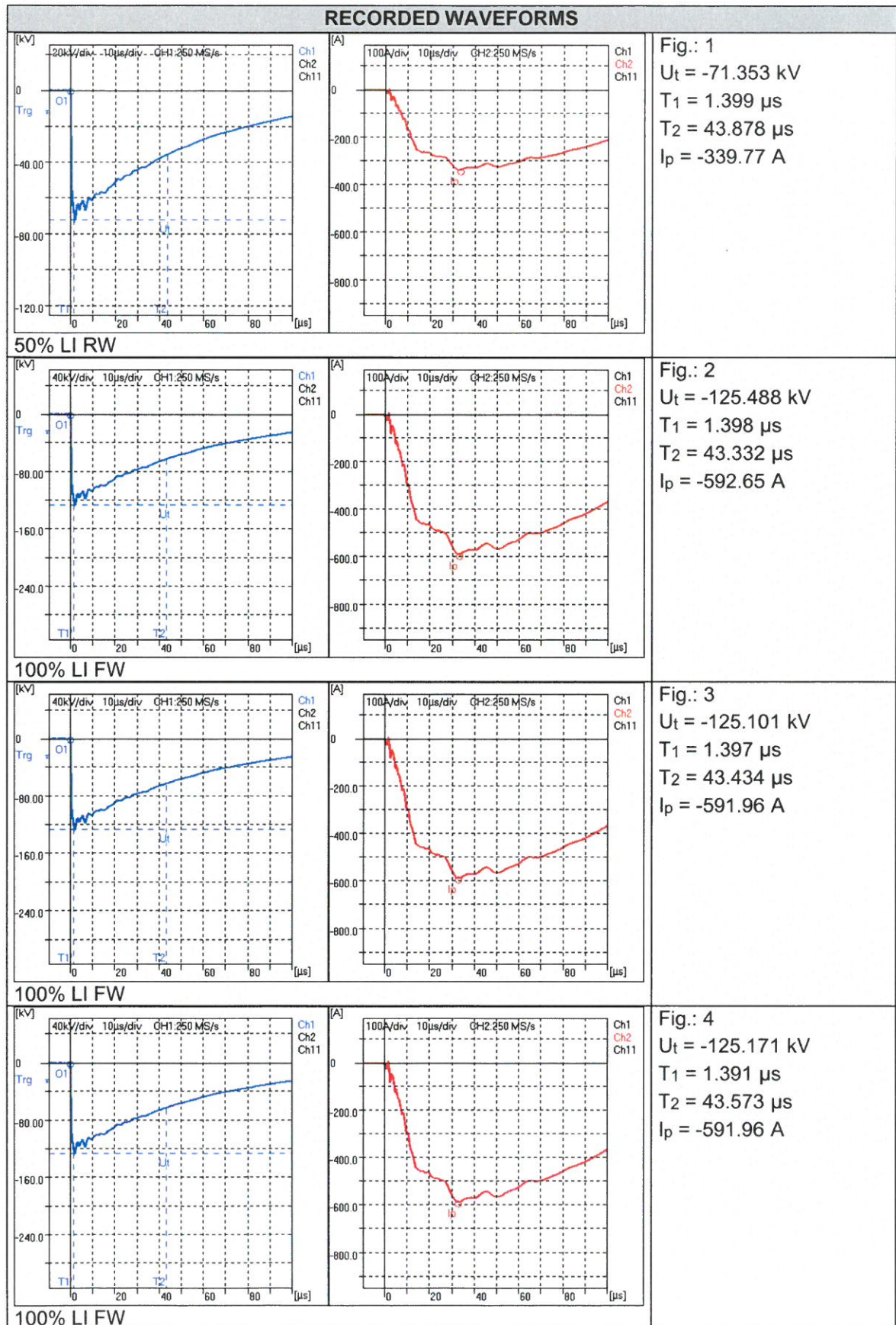
Tested terminal: 2V – MV tap number 3

MEASUREMENTS RESULTS					
Fig.	Note	U_t / kV	T_1 / μ s	T_2 / μ s	I_p / A
1	50% LI RW	-70.412	1.247	44.232	-344.93
2	100% LI FW	-125.559	1.233	43.843	-615.33
3	100% LI FW	-125.253	1.239	43.826	-614.04
4	100% LI FW	-125.283	1.237	43.798	-613.77



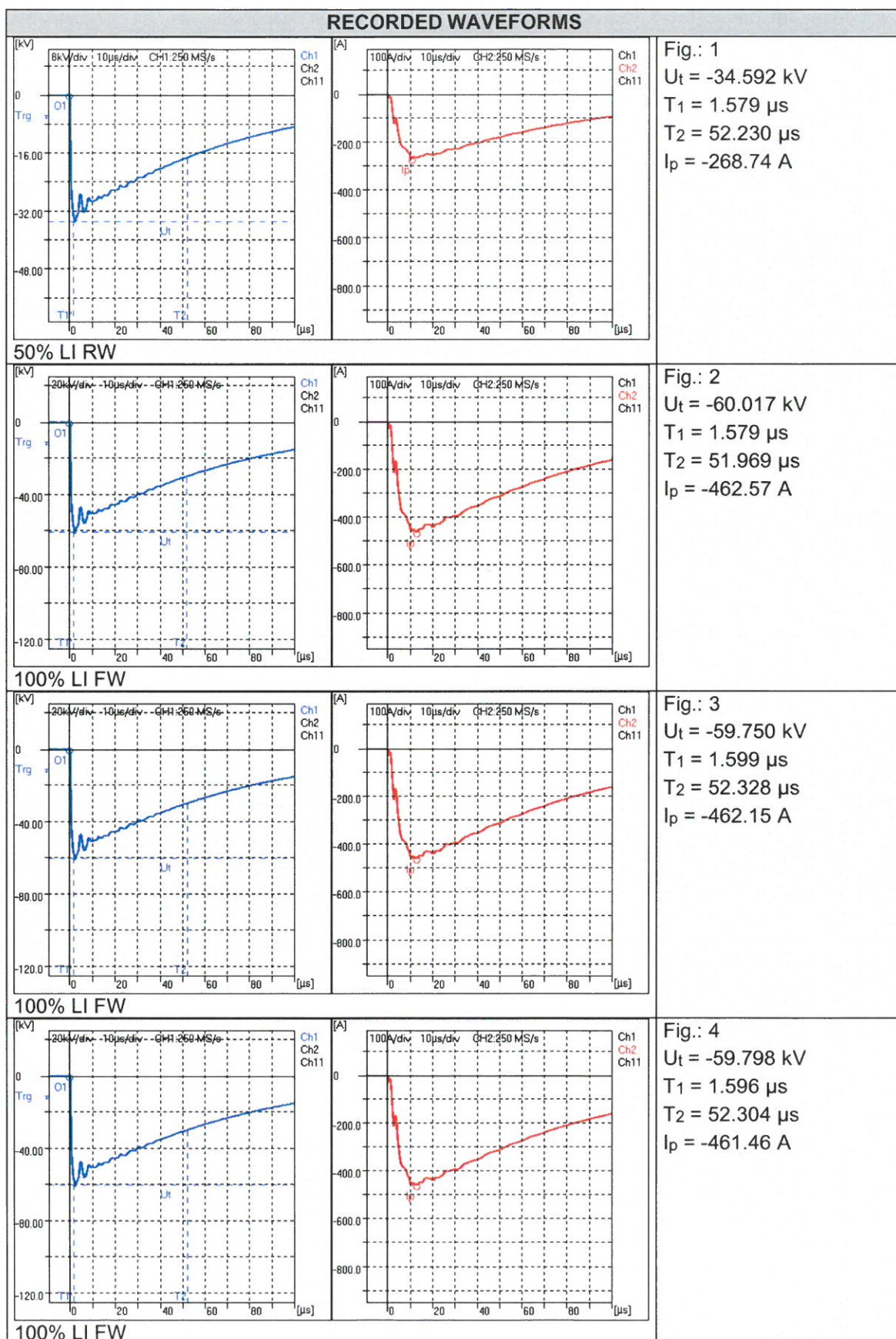
Tested terminal: 2W – MV tap number 5

MEASUREMENTS RESULTS						
Fig.	Note	U_t / kV	T_1 / μ s	T_2 / μ s	I_p / A	
1	50% LI RW	-71.353	1.399	43.878	-339.77	
2	100% LI FW	-125.488	1.398	43.332	-592.65	
3	100% LI FW	-125.101	1.397	43.434	-591.96	
4	100% LI FW	-125.171	1.391	43.573	-591.96	



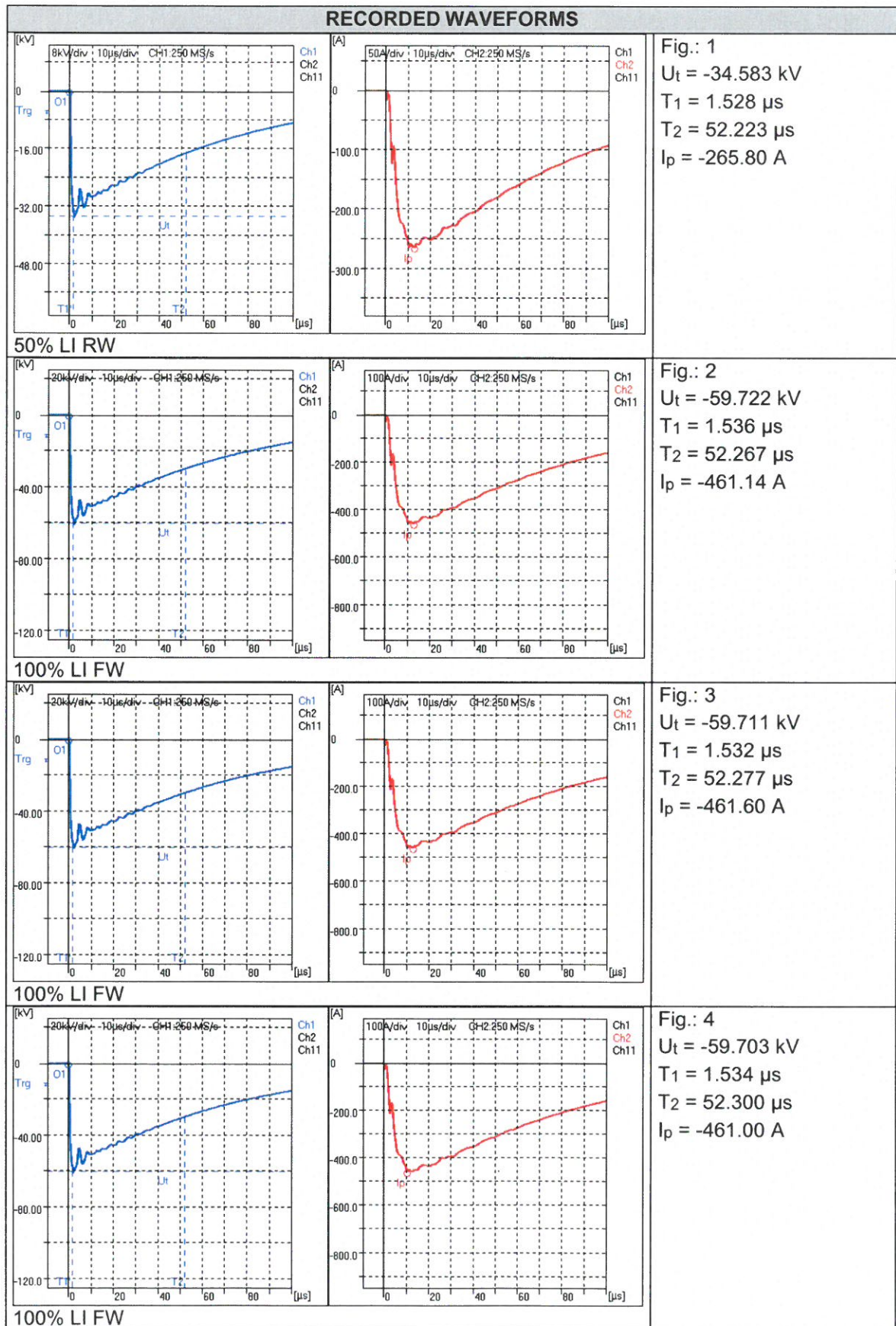
Tested terminal: 3U

MEASUREMENTS RESULTS					
Fig.	Note	U_t / kV	T_1 / μ s	T_2 / μ s	I_p / A
1	50% LI RW	-34.592	1.579	52.230	-268.74
2	100% LI FW	-60.017	1.579	51.969	-462.57
3	100% LI FW	-59.750	1.599	52.328	-462.15
4	100% LI FW	-59.798	1.596	52.304	-461.46



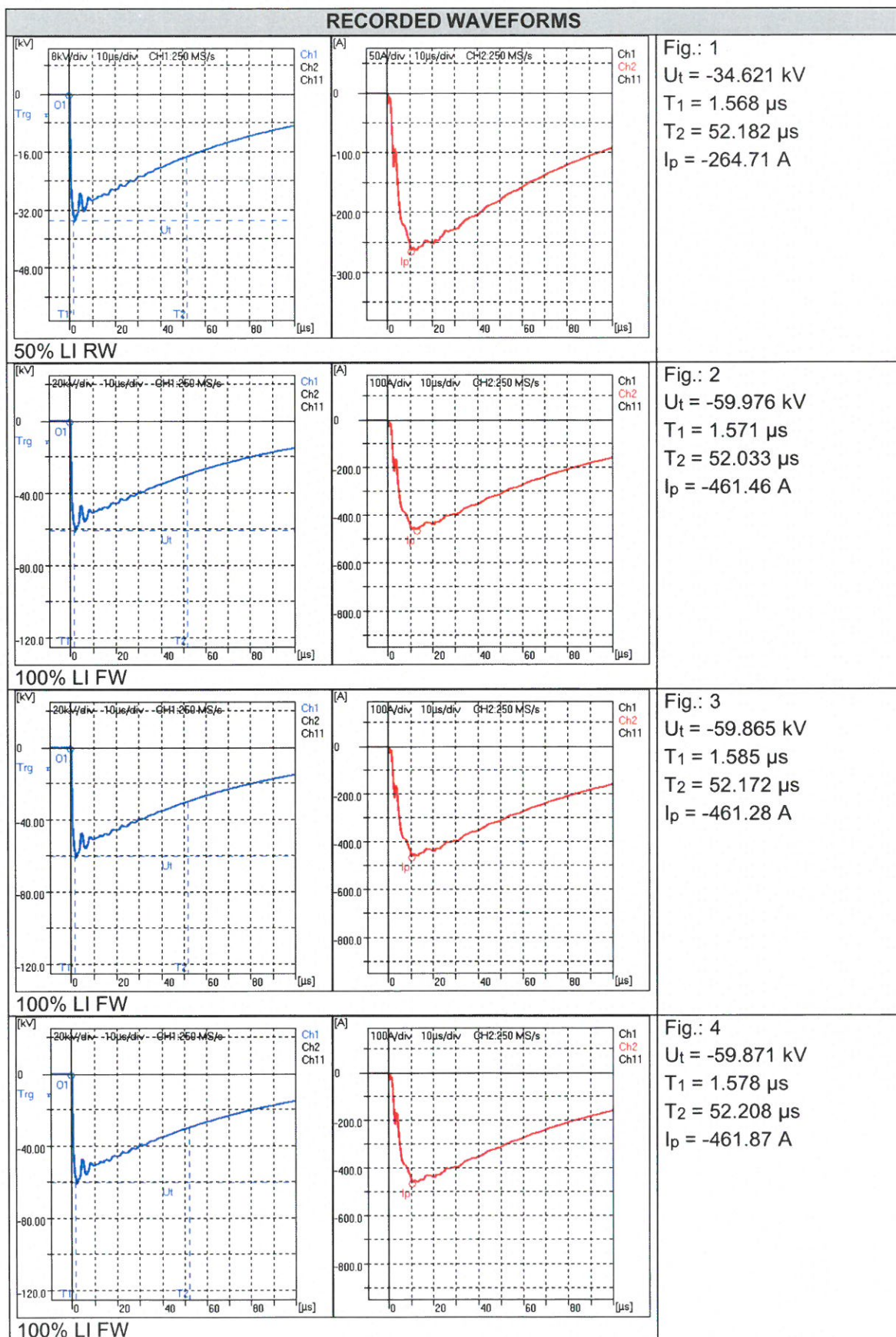
Tested terminal: 3V

MEASUREMENTS RESULTS						
Fig.	Note	U_t / kV	T_1 / μ s	T_2 / μ s	I_p / A	
1	50% LI RW	-34.583	1.528	52.223	-265.80	
2	100% LI FW	-59.722	1.536	52.267	-461.14	
3	100% LI FW	-59.711	1.532	52.277	-461.60	
4	100% LI FW	-59.703	1.534	52.300	-461.00	



Tested terminal: 3W

MEASUREMENTS RESULTS					
Fig.	Note	U_t / kV	T_1 / μ s	T_2 / μ s	I_p / A
1	50% LI RW	-34.621	1.568	52.182	-264.71
2	100% LI FW	-59.976	1.571	52.033	-461.46
3	100% LI FW	-59.865	1.585	52.172	-461.28
4	100% LI FW	-59.871	1.578	52.208	-461.87





CERTIFICATE OF ANALYSIS

Product	Transformer oil NYTRO 11 GX, inhibited insulating oil meeting IEC 60296 Ed.4 (2012) General specification
Customer	Brenntag Polska sp. z o.o.
Destination	Poland
Delivered from	Nynas Tallinn depot - shoretank n° 2403
Batch n°	88-T2403-08042021
Truck	RZ 8091X ; SK 824YC
Contract n°	4500217097
Ref. n°	SO 794373

Test	Unit	Result	Method
Density at 15°C	kg/m ³	878,8	ISO 12185
Density at 20°C	kg/m ³	875,7	ISO 12185
Appearance at 15°C		Clear & Bright	ASTM D1524
Colour ASTM		L 0.5	ASTM D1500
Flash Point	°C	148	ISO 2719
Viscosity at 40°C	cSt	8,481	ISO 3104
Water Content	mg/kg	13	IEC 60814
Acidity	mgKOH/g	< 0,01	IEC 60201-2
Dielectr. Strenght untreated*	kV	58,0	IEC 60156
Dielectr. Dissipation Factor Tan Delta 90°C*		< 0,00074	IEC 60247
Interfacial tension, 25°C	mN/m	43,7	EN 14210
PCB	mg/kg	none	IEC 61619

Analysis from representative sample, shore tank n°2403, Nynas Tallinn depot
Inspectorate Antwerp NV laboratory on 08.04.2021.

*Analysis from representative sample, container tank after loading Nynas Tallinn laboratory on 18.08.2021.

Nynas AB, respective Product Data Sheet specify that PCB compounds shall be none detectable, in accordance with methods ASTM D4059 or IEC 61619. For the latest edition, please visit www.nynas.com or contact your local sales contact.

Product approved for delivery
V. Drozdov
Operator



AS Nynas
Õli 5
EE-74115 Maardu Telephone
ESTONIA +372 631 9422

CHEMICAL LABORATORY

FAX: 061/892-88-73

PHONE: 061/892-88-17

Czerwonak: 04.10.2021

Protocol no. 01/10/21 Analysis of transformer oil after factory tests

GENERAL INFORMATION

Transformer made by: PET Sp. z o.o.	Type: PTRP 25000-123/A
Serial No.: 116253214508	Power: 25/25/25 MVA
Voltage: 115000/22000/6600 V	Year of production: 2021
Amount of oil: 13500 kg	
Place of sampling: transformer tank	Order: 3214508
Oil temperature during sampling: 21,5°C	
Sampling by M. Lewandowski in day: 04.10.2021	
Oil status: new, inhibited mineral oil Nynas Nytro 11 GX	
More information about oil source: from Belgium	
Range of analysis: full	

Test results are provided on the other side

Test results

Date of analysis: 04.10.2021

Performed by: Michał Lewandowski

No	TYPE OF TEST	RESULT sample from top	RESULT sample from bellow	REQUIREMENTS by IEC 60422:2013 Table 3
1.	Appearance IEC 60296	Clear, free from sediment and suspended matter	Clear, free from sediment and suspended matter	Clear, free from sediment and suspended matter
2.	Acidity mg KOH/g (titration method for indicators) ISO 6618	0,01	0,01	≤ 0,03
3.	Flash-point °C (Pensky Martens method) ISO 2719	148	148	-----
4.	Dielectric dissipation factor (measurement device: Megger OTD) in temp. 90°C & freq. 50 Hz IEC 60247	0,001279	0,001128	≤ 0,015
5.	Spec. resistant Gohmm (measurement device Megger OTD) in temp. 90°C IEC 60247	639	643	≥ 60
6.	Water content mg/kg (ppm) (K. Fischer – Coulometer KF 831) IEC 60814	2	2	< 10
7.	Breakdown voltage kV/2,5 mm (measurement device Megger OTS80AF with magnetic stirrer) IEC 60156	78	77	> 60

Interpretation of results:

Transformer oil meets the requirements of IEC 60422:2013 Table 3.

Notes: according to the quality certificate from Nynas of 18.08.2021 the oil does not contain PCBs.

Drawn up: Specialista ds. Analiz Chemicznych  Michał Lewandowski	Confirmed: Szef Kontroli Jakości Kierownik  Michał Lewandowski
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CHEMICAL LABORATORY

FAX: 061/892-88-73

PHONE: 061/892-88-17

Czerwonak: 04.10.2021

Protocol no. 02/10/21/CH
Chromatographic analysis of gases dissolved in oil
after factory tests

GENERAL INFORMATION

Transformer made by: PET Sp. z o.o.	Type: PTRP 25000-123/A
Serial No.: 116253214508	Power: 25/25/25 MVA
Voltage: 115000/22000/6600 V	Year of production: 2021
Amount of oil: 13500 kg	
Place of sampling: transformer tank	Order: 3214508
Sampling by M. Lewandowski in day: 04.10.2021	
Oil status: new, inhibited mineral oil Nynas Nyltro 11 GX	
More information about oil source: from Belgium	
Range of analysis: full	

1. Chromatographic analysis includes:
 - Determination of the total amount of gases dissolved in the transformer oil,
 - Testing the composition of the gas separated from transformer oil
2. Research basis and evaluation criteria:
 - IEC 61181 "Mineral oil-filled electrical equipment – Application of dissolved gas analysis (DGA) to factory test on electrical equipment"
 - IEC 60567 "Oil-filled electrical equipment – Sampling of gases and analysis of free and dissolved gasses – Guidance"
 - IEC 60599 "Mineral oil-filled electrical equipment in service - Guidance on the interpretation of dissolved and free gases analysis"
3. Analyzes were performed on a Agilent 7890B chromatograph with FID & TCD detector and Agilent 7697A Headspace Sampler. Device is calibrated with Air Products certified gas and a set of liquid standards by Morgan-Schaffer.

Test results

Date of analysis: 04.10.2021

Performed by: Michał Lewandowski

No.	Component	Measured value [ppm]
		after factory tests
1.	H ₂ - Hydrogen	none
2.	CH ₄ - Methane	none
3.	C ₂ H ₆ - Ethane	none
4.	C ₂ H ₄ - Ethylene	none
5.	C ₂ H ₂ - Acetylene	none
6.	C ₃ H ₈ - Propane	none
7.	C ₃ H ₆ - Propylene	none
8.	CO - Carbon monoxide	1,3
9.	CO ₂ - Carbon dioxide	41,8
10.	O ₂ - Oxygen	1169,4
11.	N ₂ - Nitrogen	2275,8
12.	The sum of flammable gases (from 1 to 8)	1,3
13.	Total amount of gases	3488,3

Test result: positive.

Notes: none.

Drawn up: Specialista ds. Analiz Chemicznych  Michał Lewandowski	Confirmed: Dział Kontroli Jakości Kierownik  Kamil Lewandowski
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CHEMICAL LABORATORY

FAX: 061/892-88-73

PHONE: 061/892-88-17

Czerwonak: 30.09.2021

Protocol no. 88/09/21 Analysis of transformer oil before factory tests

GENERAL INFORMATION

Transformer made by: PET Sp. z o.o.	Type: PTRP 25000-123/A
Serial No.: 116253214508	Power: 25/25/25 MVA
Voltage: 115000/22000/6600 V	Year of production: 2021
Amount of oil: 13500 kg	
Place of sampling: transformer tank	Order: 3214508
Oil temperature during sampling: 21,5°C	
Sampling by M. Lewandowski in day: 30.09.2021	
Oil status: new, inhibited mineral oil Nynas Nytro 11 GX	
More information about oil source: from Belgium	
Range of analysis: full	

Test results are provided on the other side

Test results

Date of analysis: 30.09.2021

Performed by: Michał Lewandowski

No	TYPE OF TEST	RESULT sample from top	RESULT sample from bellow	REQUIREMENTS by IEC 60422:2013 Table 3
1.	Appearance IEC 60296	Clear, free from sediment and suspended matter	Clear, free from sediment and suspended matter	Clear, free from sediment and suspended matter
2.	Acidity mg KOH/g (titration method for indicators) ISO 6618	0,01	0,01	≤ 0,03
3.	Flash-point °C (Pensky Martens method) ISO 2719	148	148	-----
4.	Dielectric dissipation factor (measurement device: Megger OTD) in temp. 90°C & freq. 50 Hz IEC 60247	0,001250	0,001008	≤ 0,015
5.	Spec. resistant Gohmm (measurement device Megger OTD) in temp. 90°C IEC 60247	636	653	≥ 60
6.	Water content mg/kg (ppm) (K. Fischer – Coulometer KF 831) IEC 60814	2	2	< 10
7.	Breakdown voltage kV/2,5 mm (measurement device Megger OTS80AF with magnetic stirrer) IEC 60156	76	77	> 60

Interpretation of results:

Transformer oil meets the requirements of IEC 60422:2013 Table 3.

Notes: according to the quality certificate from Nynas of 18.08.2021 the oil does not contain PCBs.

Drawn up: Specialista ds. Analiz Chemicznych  Michał Lewandowski	Confirmed: Dział Kontroli Jakości Kierownik  Kamil Lewandowski
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CHEMICAL LABORATORY

FAX: 061/892-88-73

PHONE: 061/892-88-17

Czerwonak: 30.09.2021

Protocol no. 89/09/21/CH Chromatographic analysis of gases dissolved in oil before factory tests

GENERAL INFORMATION

Transformer made by: PET Sp. z o.o.	Type: PTRP 25000-123/A
Serial No.: 116253214508	Power: 25/25/25 MVA
Voltage: 115000/22000/6600 V	Year of production: 2021
Amount of oil: 13500 kg	
Place of sampling: transformer tank	Order: 3214508
Sampling by M. Lewandowski in day: 30.09.2021	
Oil status: new, inhibited mineral oil Nynas Nytro 11 GX	
More information about oil source: from Belgium	
Range of analysis: full	

1. Chromatographic analysis includes:
 - Determination of the total amount of gases dissolved in the transformer oil,
 - Testing the composition of the gas separated from transformer oil
2. Research basis and evaluation criteria:
 - IEC 61181 "Mineral oil-filled electrical equipment – Application of dissolved gas analysis (DGA) to factory test on electrical equipment"
 - IEC 60567 "Oil-filled electrical equipment – Sampling of gases and analysis of free and dissolved gasses – Guidance"
 - IEC 60599 "Mineral oil-filled electrical equipment in service - Guidance on the interpretation of dissolved and free gases analysis"
3. Analyzes were performed on a Agilent 7890B chromatograph with FID & TCD detector and Agilent 7697A Headspace Sampler. Device is calibrated with Air Products certified gas and a set of liquid standards by Morgan-Schaffer.

Test results

Date of analysis: 30.09.2021

Performed by: Michał Lewandowski

No.	Component	Measured value [ppm]
		before factory tests
1.	H ₂ - Hydrogen	none
2.	CH ₄ - Methane	none
3.	C ₂ H ₆ - Ethane	none
4.	C ₂ H ₄ - Ethylene	none
5.	C ₂ H ₂ - Acetylene	none
6.	C ₃ H ₈ - Propane	none
7.	C ₃ H ₆ - Propylene	none
8.	CO - Carbon monoxide	0,9
9.	CO ₂ - Carbon dioxide	36,6
10.	O ₂ - Oxygen	1042,7
11.	N ₂ - Nitrogen	2173,5
12.	The sum of flammable gases (from 1 to 8)	0,9
13.	Total amount of gases	3253,7

Test result: positive.

Notes: none.

Drawn up: Specjalista ds. Analiz Chemicznych  Michał Lewandowski	Confirmed: Dział Kontroli Jakości Kierownik  Kamil Lewandowski
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Quality Department

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TRANSFORMER TEST REPORT NO. 160/QD/T/21

ORDER:3214508

Type: PTRP 25000-123/A Rated power: 25000 / 25000 / 25000 kVA Serial no.: 116253214508 Producer: PET

Rated voltage: 115000 $\pm 16\%$ ± 9 taps / 22000 $\pm 5\%$ ± 2 taps / 6600 V Rated current: 125,5 / 656,1 / 2186,9 A

Short circuit impedance refer to power 25 MVA: HV-LV: + 19,33% 0 18,32% - 17,61%

Short circuit impedance refer to power 25 MVA: HV-MV: + 10,85% 0 9,88% - 9,18%

Short circuit impedance refer to power 25 MVA: MV-LV: 0 6,49% - 6,85%

Load losses refer to power 25 MVA: HV-LV: 157424 W HV-MV: 127563 W MV-LV: 108404 W

Type of work: C Vector group: YNyd11 No-load losses: 18168 W No-load current: 0,11 %

Type of cooling: ONAF Year of production: 2021 Frequency: 50 Hz

Tested in acc.: PN-EN 60076-1:2011 Total mass: 53500 kg Oil mass: 13500 kg Transport mass: 36500 kg

1. Measurement of winding resistance. Oil temperature 21,5°C.

Measuring equipment: TESTRANO 600. Serial number CE123V.

Tested in acc.: IEC 60076-1: 2011.

Winding	Tap	Resistance [Ω]	Deviation [%]	Resistance [Ω]	Deviation [%]	Resistance [Ω]	Deviation [%]
HV		1U1N		1V1N		1W1N	
	1	0,981540	-0,11	0,982328	-0,03	0,983867	+0,13
	2	1,007506	-0,09	1,008024	-0,04	1,009825	+0,14
	3	1,033381	-0,09	1,033865	-0,04	1,035713	+0,13
	4	1,059072	-0,08	1,059400	-0,05	1,061252	+0,13
	5	1,084962	-0,08	1,085149	-0,06	1,087262	+0,14
	6	1,110852	-0,07	1,110972	-0,05	1,112906	+0,12
	7	1,136284	-0,09	1,136614	-0,06	1,139008	+0,15
	8	1,162448	-0,08	1,162607	-0,07	1,165050	+0,14
	9	1,188247	-0,06	1,188157	-0,06	1,190343	+0,12
	10	1,183743	-0,01	1,183764	-0,01	1,184226	+0,03
	11	1,210536	-0,11	1,211724	-0,01	1,213391	+0,12
	12	1,236288	-0,11	1,237335	-0,02	1,239310	+0,13
	13	1,262514	-0,09	1,263355	-0,03	1,265244	+0,12
	14	1,288083	-0,09	1,288905	-0,03	1,290797	+0,12
	15	1,313805	-0,09	1,314622	-0,03	1,316547	+0,12
	16	1,339741	-0,08	1,340472	-0,02	1,342125	+0,10
	17	1,365351	-0,09	1,366083	-0,03	1,368242	+0,12
	18	1,391515	-0,07	1,392059	-0,03	1,393840	+0,10
	19	1,417182	-0,07	1,417654	-0,03	1,419545	+0,10
MV		2U2N		2V2N		2W2N	
	1	0,026926	+0,18	0,026747	-0,49	0,026961	+0,31
	2	0,027532	+0,00	0,027476	-0,20	0,027587	+0,20
	3	0,028309	+0,00	0,028249	-0,21	0,028369	+0,21
	4	0,029074	+0,01	0,029028	-0,15	0,029113	+0,14
	5	0,029823	-0,01	0,029784	-0,14	0,029874	+0,16
LV		3U3V		3U3W		3V3W	
		0,0058097	-0,15	0,0058405	-0,77	0,0057913	+0,92

Resistance values for each phase must not differ by more than $\pm 3\%$ on a given tap compared to the average value.

Result: positive

2. Measurement of no load current at 230V

HV winding was supplied with AC 230V.
Measuring equipment: TESTRANO 600. Serial number CE123V.

Winding	Tap	Phase	Current [mA]	Phase	Current [mA]	Phase	Current [mA]
HV	1	U	2,18	V	1,26	W	2,18
	10		1,64		0,94		1,64
	19		1,31		0,74		1,31

The measured values are the reference basis for future measurements.

Result: positive

3. Measurement of voltage ratio

Measuring equipment: TESTRANO 600. Serial number CE123V.
Tested in acc.: IEC 60076-1: 2011.

3.1 Measurement of voltage ratio for configuration HV-LV for vector group YNd11

Tap	Voltage $U_{H,V}$ [V]	Voltage $U_{L,V}$ [V]	Calculated ratio		Deviation [%]		Deviation [%]		Deviation [%]
1	96600	6600	8,450	1U-1N 3U-3W	-0,01	1V-1N 3V-3U	-0,02	1W-1N 3W-3V	-0,03
2	98644		8,629		+0,01		+0,00		-0,01
3	100689		8,808		+0,03		+0,02		+0,01
4	102733		8,987		+0,05		+0,04		+0,03
5	104778		9,166		+0,06		+0,05		+0,05
6	106822		9,345		+0,08		+0,07		+0,07
7	108867		9,523		+0,10		+0,10		+0,10
8	110911		9,702		+0,12		+0,12		+0,12
9	112956		9,881		+0,14		+0,13		+0,13
10	115000		10,060		+0,16		+0,15		+0,15
11	117044		10,239		+0,18		+0,17		+0,16
12	119089		10,418		+0,19		+0,18		+0,18
13	121133		10,596		+0,21		+0,20		+0,20
14	123178		10,775		+0,22		+0,22		+0,21
15	125222		10,954		+0,23		+0,23		+0,23
16	127267		11,133		+0,25		+0,24		+0,24
17	129311		11,312		+0,26		+0,25		+0,25
18	131356		11,491		+0,27		+0,26		+0,26
19	133400		11,669		+0,29		+0,28		+0,28

The deviation on the rated tap must not exceed $\pm 0.5\%$ of the declared value.

Result: positive

3.2 Measurement of voltage ratio for configuration HV-MV for vector group YNyn0

Tap	Voltage $U_{H,V}$ [V]	Voltage $U_{L,V}$ [V]	Calculated ratio		Deviation [%]		Deviation [%]		Deviation [%]
1	96600	22000	4,391	1U-1N 2U-2N	-0,20	1V-1N 2V-2N	-0,20	1W-1N 2W-2N	-0,20
2	98644		4,484		-0,17		-0,18		-0,17
3	100689		4,577		-0,15		-0,15		-0,15
4	102733		4,670		-0,13		-0,13		-0,13
5	104778		4,763		-0,11		-0,11		-0,11
6	106822		4,856		-0,09		-0,09		-0,09
7	108867		4,948		-0,07		-0,07		-0,07
8	110911		5,041		-0,05		-0,05		-0,05
9	112956		5,134		-0,04		-0,04		-0,04
10	115000		5,227		-0,02		-0,02		-0,02
11	117044		5,320		+0,00		+0,00		+0,00
12	119089		5,413		+0,01		+0,01		+0,01
13	121133		5,506		+0,03		+0,03		+0,03
14	123178		5,599		+0,04		+0,04		+0,04
15	125222		5,692		+0,06		+0,06		+0,06
16	127267		5,785		+0,07		+0,07		+0,07
17	129311		5,878		+0,09		+0,09		+0,09
18	131356		5,971		+0,10		+0,10		+0,10
19	133400		6,064		+0,11		+0,11		+0,11

The deviation on the rated tap must not exceed $\pm 0.5\%$ of the declared value.

Result: positive

3.3 Measurement of voltage ratio for configuration MV-LV for vector group ynd11

Tap	Voltage $U_{H.V.}$ [V]	Voltage $U_{L.V.}$ [V]	Calculated ratio		Deviation [%]		Deviation [%]		Deviation [%]
1	20900	6600	1,828	2U-2N 3U-3W	+0,17	2V-2N 3V-3U	+0,19	2W-2N 3W-3V	+0,18
2	21450		1,876		+0,17		+0,18		+0,18
3	22000		1,925		+0,18		+0,18		+0,18
4	22550		1,973		+0,17		+0,18		+0,18
5	23100		2,021		+0,17		+0,18		+0,18

The deviation on the rated tap must not exceed $\pm 0.5\%$ of the declared value.

Result: positive

4. Measurement of insulation resistance. Oil temperature 21,5°C.

Measuring equipment: Megger type S1-552/2. Serial number 12/TE/13.

Measured with 2500V.

The measured insulation resistance values were calculated to 30°C.

Winding	R_{15} [M Ω]	R_{60} [M Ω]	R_{300} [M Ω]	R_{60}/R_{15}
HV – MV, LV, G	11416	13408	20841	1,17
MV – HV, LV, G	4654	7919	15303	1,70
LV – HV, MV, G	6413	11756	26573	1,83
HV, MV – LV, G	8307	11708	16226	1,41
HV, LV – MV, G	6218	8356	14088	1,34
HV – MV LV, E, G	45762	56353	71898	1,23
MV – LV HV, G, E	45762	80643	109791	1,76

HV – High voltage winding,

LV - Low voltage winding,

G – grounded tank,

E - shield.

The insulation resistance at 30°C should be higher than 70M Ω in the earth system and not less than 150M Ω between the windings.

Result: positive

5. Check of vector group

Measuring equipment: Keller compensator. Type: MPT-3. Serial number: 11/TE/13.

Windings HV-LV. Connection group YNd11.

Windings HV – MV. Connection group YNyn0.

Windings MV – LV. Connection group YNd11.

Result: positive

6. Tests on on-load tap changer

Tap changer: Company: Hyundai. Type: RS9.3 III 200 72,5/L 10.19.1G. Serial number 18011.

Motor drive unit. Company: Hyundai. Type: MZ-4.4. Serial number 18011.

The following sequence of operations was performed without failure:

- with the transformer de-energized, eight complete cycles of operation (a cycle of operation goes from one end of the tapping range to the other, and back again).
- with the transformer de-energized, and with the auxiliary voltage reduced to 85 % of its rated value, one complete cycle of operation.
- with the transformer energized at rated voltage and frequency at no load, one complete cycle of operation.
- with one winding short-circuited and rated current in the tapped winding, 10 cycles of tap-change operations across the range of two steps on each side from where a coarse or reversing changeover selector operates, or otherwise from the middle tapping (the tap changer will pass 20 times through the changeover position).

Result: positive

7. Load losses and impedance voltage measurement

Oil temperature 21,0°C.

Measuring equipment: power analyzer FLUKE type NORMA 4000. Serial number Y115789.
Tested in acc.: IEC 60076-1: 2011.

7.1. Windings HV - LV

f [Hz]	powered	shorted	VOLTAGE				CURRENT				POWER
			UV [V]	VW [V]	UW [V]	Average [V]	U [A]	V [A]	W [A]	Average [A]	
49,79	HV tap 19	LV	14346	14275	14194	14272	60,,20	60,20	60,12	60,17	46485
49,78	HV tap 10	LV	11901	11861	11805	11856	70,98	71,03	70,90	70,97	46314
49,72	HV tap 1	LV	9080,0	9058,4	9023,2	9053,8	80,02	80,08	79,97	80,02	42460

Load losses at 25MVA in oil temperature 75°C			
Windings	$\Delta P_{\text{basic}75}$ [W]	$\Delta P_{\text{additional}75}$ [W]	$\Delta P_{\text{Cu}75}$ [W]
HV10/LV	118030	39394	157424

Windings	$\Delta P_{\text{Cu}75}$ [W]	$\Delta P_{\text{Cu}75}$ [W] guaranteed	Deviation [%]	Tolerance
HV10/LV	157424	145000 W	+8,6	+10%

Windings	$U_{\text{zw}\%}$			$U_{\text{zw}\%}$ guaranteed	Deviation [%]	Tolerance
	+	0	-			
HV/LV	19,33	18,32	17,61	17,5	+4,7	±10%

Result: positive

7.2. Windings HV - MV

f [Hz]	powered	shorted	VOLTAGE				CURRENT				POWER
			UV [V]	VW [V]	UW [V]	Average [V]	U [A]	V [A]	W [A]	Average [A]	
49,82	HV tap 19	MV 3	7858,4	7834,5	7802,1	7831,7	59,03	58,69	58,71	58,81	33832
49,82	HV tap 10	MV 3	5821,3	5825,2	5805,4	5817,3	64,76	64,42	64,53	64,57	29459
49,82	HV tap 1	MV 3	4481,8	4491,0	4474,6	4482,4	76,11	75,78	75,86	75,92	30228
49,79	HV tap 1	MV 1	4446,8	4455,4	4438,9	4447,0	76,90	76,56	76,65	76,70	31286

Load losses at 25MVA in oil temperature 75°C			
Windings	$\Delta P_{\text{basic}75}$ [W]	$\Delta P_{\text{additional}75}$ [W]	$\Delta P_{\text{Cu}75}$ [W]
HV10/MV	111801	15762	127563

Windings	$\Delta P_{\text{Cu}75}$ [W]	$\Delta P_{\text{Cu}75}$ [W] guaranteed	Deviation [%]	Tolerance
HV10/MV	127563	150000 W	-15,0	+10%

Windings	$U_{\text{zw}\%}$			$U_{\text{zw}\%}$ guaranteed	Deviation [%]	Tolerance
	+	0	-			
HV/MV	10,85	9,88	9,18	10,5	-5,9	±10%

Result: positive

7.3. Windings MV - LV

f [Hz]	powered	shorted	VOLTAGE				CURRENT				POWER
			UV [V]	VW [V]	UW [V]	Average [V]	U [A]	V [A]	W [A]	Average [A]	P [W]
49,84	MV tap 3	LV	805,0	801,4	803,8	803,4	370,03	371,06	372,36	371,15	30325
49,81	MV tap 1	LV	773,0	769,7	772,3	771,7	373,24	374,47	375,56	374,42	28525

Load losses at 25MVA in oil temperature 75°C			
Windings	$\Delta P_{\text{basic}75}$ [W]	$\Delta P_{\text{additional}75}$ [W]	$\Delta P_{\text{Cu}75}$ [W]
MV3/LV	94590	13814	108404

Windings	$\Delta P_{\text{Cu}75}$ [W]	$\Delta P_{\text{Cu}75}$ [W] guaranteed	Deviation [%]	Tolerance
MV3/LV	108404	105000 W	+3,2	+10%

Windings	$U_{\text{ZW}}\%$			$U_{\text{ZW}}\%$ guaranteed	Deviation [%]	Tolerance
	+	0	-			
MV/LV	---	6,49	6,85	6,5	-0,2	±10%

Result: positive

8. No-load losses and no-load current measurement

Measuring equipment: power analyzer FLUKE type NORMA 4000. Serial number Y115789.

LV winding powered.

Tested in acc.: IEC 60076-1: 2011.

f [Hz]	VOLTAGE				CURRENT				POWER
	UV [V]	VW [V]	UW [V]	Average [V]	U [A]	V [A]	W [A]	Average [A]	P [W]
50,0	380,49	381,33	380,70	380,84	0,12	0,13	0,18	0,14	71,70
50,0	5943,9	5930,8	5889,2	5921,3	1,22	1,39	1,86	1,49	13665
50,0	6633,9	6603,7	6564,4	6600,6	2,20	2,22	2,91	2,44	18173
50,0	7309,1	7252,7	7215,1	7259,0	8,03	7,74	8,67	8,15	25305

No-load losses guaranteed [W]	No-load losses at U_n [W]	Deviation [%]	Tolerance
22000	18168	---	+10%

No-load current guaranteed I_0 [%]	No-load current I_0 at U_n [%]	Tolerance
0,30	0,11	---

Result: positive

9. Applied voltage test AV

The test station testing system was used for the measurement.

Tested in acc.: IEC 60076-1: 2011.

Windings	U [kV]	Time of test [sek]
HV	95	60
MV	50	60
LV	25	60

Result: positive

10. Induced voltage test

Tested in acc.: IEC 60076-1: 2011.

10.1. Line terminal AC withstand test LTAC

Three single-phase test voltage applications with different winding points connected to earth each time.

Energizing winding: LV.
U=200 kV f = 100. Hz ; time- sek.:60.
Result: positive

10.2. Induced voltage withstand test (IVW) combined with Induced voltage test with partial discharge measurement (IVPD)

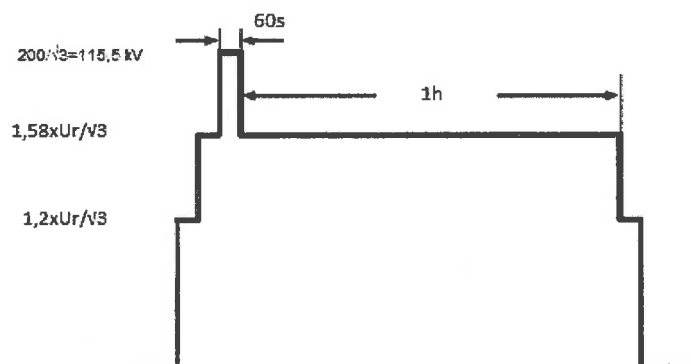
Energizing winding: LV
U=200 kV f = 100. Hz ; time- sek.:60.
Result: positive

The partial discharge test was carried out using the electric method. The source of voltage at 100 Hz was a generator. The measurement terminals of the HV side bushing were used for measurements. The measurements were made with the Doble Lemke PD Smart device. The tests included measurements of apparent charge of partial discharges by the electric method, in accordance with the requirements of IEC 60270. Measurements were carried out simultaneously for all transformer phases. Before the measurement, the test system was calibrated for each phase with a standard charge of 100 pC. The transformer was subjected to IVPD test with induced voltage in accordance with IEC 60076-3: 2013 with tests voltage acc. to IEC and customer requirements:

a) $1,20 \times U_r / \sqrt{3} = 79,7 \text{ kV} - U_3$

b) $1,58 \times U_r / \sqrt{3} = 104,9 \text{ kV} - U_2$

c) $200 / \sqrt{3} = 115,5 \text{ kV} - U_1$



According to IEC 60076-3: 2013, the test result is positive when the following criteria are fulfilled:

- a) no collapse of the test voltage occurs;
- b) none of the PD levels recorded during the one hour period exceed 250 pC;
- c) the PD levels measured during the one hour period do not exhibit any rising trend and no sudden sustained increase in the levels occur during the last 20 min of the test;
- d) the measured PD levels during the one hour period do not increase by more than 50 pC;
- e) the PD level measured at a voltage level of $(1,2 \times U_r) / \sqrt{3}$ after the one hour period does not exceed 100 pC.

Occasional high peaks of partial discharge may be disregarded.

The table below show the value of test voltage and the corresponding value of the apparent charge of partial discharges, determined during the testing of phase windings U, V and W throughout the entire test.

Voltage level	Duration [min]	Measured PD [pC]		
		1U	1V	1W
U3	1,0	35	17	20
U2	5,0	35	18	30
U1	1,0	38	18	32
U2	5,0	35	18	30
U2	5,0	35	18	30
U2	5,0	35	18	30
U2	5,0	35	18	30
U2	5,0	35	18	30
U2	5,0	35	18	30
U2	5,0	35	18	30
U2	5,0	35	18	30
U2	5,0	35	18	30
U2	5,0	25	18	30
U2	5,0	25	18	30
U2	5,0	25	18	30
U3	1,0	25	18	20

Result:

The stabilized apparent charge level did not exceed 250pC for any phase.

Result: positive

11. Auxiliary wiring insulation test (AuxW)

Tested in acc.: IEC 60076-3: 2013.

The measurement was made with the Megger type S1-552 / 2 and serial number 12/TE/13.

U_{pr} [kV]	time [sek]
2,5	60

Result: positive

12. Leakage test

Tested in acc.: IEC 60076-1: 2011.

For testing, a pressure gauge type 111.20 with serial number 08/TE/13 was used.

The test was performed at overpressure of 300hPa. Duration of test 24h.

Result: positive

13. Check of core and frame insulation

The insulation check between the core and beams was made with 1000V DC.

Result: positive

14. Measurement of capacitances and dissipation factor of windings. Oil temperature 21,5°C

Measuring equipment: Omicron type TESTRANO 600. Serial number CE123V. Omicron type CP TD 1. Serial number QK944W.

The measured $tg\delta$ values were calculated to 30 °C.

Test Mode	Capacitances	U [kV]	$tg\delta_{30}$ [%]	C [pF]
GSTg	C_H	10	0,38	3800
GSTg	C_L	10	0,24	1681
GSTg	C_T	10	0,40	11570
UST	C_{HL}	10	0,30	7062
UST	C_{HT}	10	0,77	26
UST	C_{LT}	6	0,48	9030

UST – Ungrounded Specimen Test,

GSTg – Guarded Specimen Test,

U – test voltage,

C_{HL} – capacitance between windings: HV and MV,

C_{HT} – capacitance between windings: HV and LV,

C_{LT} – capacitance between windings: MV and LV,

C_{HL} – capacitance between W.N. and N.N.,

C_H – capacitance between HV. and Gnd,

C_L – capacitance between MV and Gnd,

C_T – capacitance between LV and Gnd,

$tg\delta_{30}$ – dissipation factor converted to temperature 30°C,

C – measured capacity.

Result: positive

15. Measurement of capacitances and dissipation factor of bushings. Measurement temperature 21,5°C

Measuring equipment: Omicron type TESTRANO 600. Serial number CE123V. Omicron type CP TD 1. Serial number QK944W.

The measured $tg\delta$ values were calculated to 20 °C.

Measurement of $tg\delta_1$ and C_1 was performed with 10 kV in configuration UST.

Bushing	Results calculated to 20°C		Factory data	
	$tg\delta_1$ [%]	C_1 [pF]	$tg\delta_1$ [%]	C_1 [pF]
Phase: 1U	0,39	363	0,35	367
Phase: 1V	0,39	358	0,35	361
Phase: 1W	0,38	352	0,35	356
Phase: 1N	0,39	448	0,36	452

Result: positive

Notes

Tested in acc.:

- IEC 60076-1: 2011. Power transformers – Part 1: General ,
- IEC 60076-3: 2013. Power transformer – Part 3: Insulation levels, dielectric tests and external clearances in air.

16. Interpretation of results

**Transformer measurement results meet the requirements
standards and contract no. 21/008-A.**

Tested by:

- Robert Szybiak electrical license No.: 6/D/2675/2018 and 6/E/2676/2018,
- Andrii Voskoboinyk electrical license No.: 6/D/406/2021 and 6/E/407/2021,
- Kamil Lewandowski electrical license No.: 6/D/2677/2018 and 6/E/2678/2018.

First test day: 30.09.2021

Last test day: 04.10.2021

Prepared by: Dział Kontroli Jakości Kierownik  Kamil Lewandowski	Approved by: Dział Kontroli Jakości Kierownik  Kamil Lewandowski
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SHORT-CIRCUIT TEST REFERENCE LIST

B48750

Page 1 / 4

Reference list of all transformers with rated power above 5 MVA which were submitted to the short circuit special test according to IEC 60076-5:

- 1 SWEDEN - E.ON - TRP 80000-145/E**
- 2 UAE - FEWA - TRP 25000-36/C**
- 3 GERMANY - E.ON - TRP 40000-123/DQ**
- 4 HUNGARY - OVIT - MRP 16000-145/E**
- 5 UAE - MEW - TRN 20000-36/B**
- 6 CROATIA - HEP - TRP 40000-123/G**
- 7 CROATIA - HEP - TRN 10000-123/E**
- 8 HUNGARY - TRANSELEKTRO - MRP 12000-145/A**
- 9 CROATIA - ELEKTRA - TRN 20000-123/J**

Technical data for each unit:

1 SWEDEN - E.ON - TRP 80000-145/E

Type: TRP 80000-145/E
 Rated power: 80000 kVA
 Type of cooling: ONAN / ONAF
 Rated frequency: 50 Hz
 Rated voltages:
 HV winding 140 ± 9×1,67 % kV
 LV winding 57,5 kV
 Connection symbol: YNd5
 Impedance voltage at rated power and rated voltage: 12 %
 Year: 2019.
 Customer: E.ON, Sweden

2 UAE - FEWA - TRP 25000-36/C

Type: TRP 25000-36/C
 Rated power: 25000 kVA
 Type of cooling: ONAN / ONAF
 Rated frequency: 50 Hz
 Rated voltages:
 HV winding 33 +8 -12×1,25 % kV
 LV winding 11 kV
 Connection symbol: Dyn11
 Impedance voltage at rated power and rated voltage: 15,625 %
 Year: 2014.
 Customer: FEWA Dubai, UAE

Promjena Revision	Rev. A
Odobrio Approved	<i>ing. Vatešić</i>
Izradio Designed	<i>ing. Gardić</i>
Datum Date	02.03.2020.



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3 Germany - E.ON - TRP 40000-123/DQ

Type: TRP 40000-123/DQ
 Rated power: 40000 kVA
 Type of cooling: ONAN / ONAF
 Rated frequency: 50 Hz
 Rated voltages:
 HV winding 115 ± 9×1,778 % kV
 LV winding 21 kV
 Connection symbol: YNd5
 Impedance voltage at rated power and rated voltage: 16,5 %
 Year: 2013.
 Customer: E.ON, Germany

4 Hungary - OVIT - MRP 16000-145/E

Type: MRP 16000-145/B
 Rated power: 16000 kVA
 Type of cooling: ONAN / ONAF
 Rated frequency: 50 Hz
 Rated voltages:
 HV winding 126 ± 9×1,78 % kV
 LV winding 55 (27,5) kV
 Connection symbol: li0i6
 Impedance voltage at rated power and rated voltage: 11,5 %
 Year: 2009.
 Customer: OVIT, Hungary

5 UAE - MEW - TRN 20000-36/B

Type: TRN 20000-36/B
 Rated power: 20000 kVA
 Type of cooling: ONAN
 Rated frequency: 50 Hz
 Rated voltages:
 HV winding 33 +8-12×1,25 % kV
 LV winding 11 kV
 Connection symbol: Dyn11
 Impedance voltage at rated power and rated voltage: 12,5 %
 Year: 2001.
 Customer: MEW, UAE

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Promjena Revision	Rev. A
Odobrio Approved	ing. Vatešić
Izradio Designed	ing. Gardić
Datum Date	02.03.2020.



6 Croatia - HEP - TRP 40000-123/G

Type: TRP 40000-123/G
 Rated power:
 HV winding 40000 kVA
 MV winding 40000 kVA
 STAB winding 13333 kVA
 Type of cooling: ONAN / ONAF
 Rated frequency: 50 Hz
 Rated voltages:
 HV winding $110 \pm 10 \times 1,5\%$ kV
 MV winding 21 (10,5) kV
 STAB winding 10,5 kV
 Connection symbol: YNyn0(yn0) + d5
 Impedance voltage at rated power and rated voltage: 18,5 %
 Year: 1997.
 Customer: HEP, Croatia

7 Croatia - HEP - TRN 10000-123/E

Type: TRN 10000-123/E
 Rated power:
 HV winding 10000 kVA
 LV winding 10000 kVA
 STAB winding 3333 kVA
 Type of cooling: ONAN
 Rated frequency: 50 Hz
 Rated voltages:
 HV winding $110 \pm 10 \times 1,5\%$ kV
 LV winding 21 (10,5) kV
 STAB winding 10,5 kV
 Connection symbol: YNyn0(yn0) + d5
 Impedance voltage at rated power and rated voltage: 11 %
 Year: 1997.
 Customer: HEP, Croatia

8 Hungary - Transelektro - MRP 12000-145/A

Type: MRP 12000-145/A
 Rated power: 12000 kVA
 Type of cooling: ONAN / ONAF
 Rated frequency: 50 Hz
 Rated voltages:
 HV winding 126 kV
 LV winding $26,3 \pm 10 \times 1,5\%$ kV
 Connection symbol: li0
 Impedance voltage at rated power and rated voltage: 10 %
 Year: 1990.
 Customer: Transelektro, Hungary

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9 Croatia - Elektra - TRN 20000-123/J

Type: TRN 20000-123/J
 Rated power:
 HV winding 20000 kVA
 MV winding 20000 kVA
 LV winding 13400 kVA
 Type of cooling: ONAN
 Rated frequency: 50 Hz
 Rated voltages:
 HV winding $110 \pm 10 \times 1,5\%$ kV
 LV winding 21 (10,5) kV
 LV winding 10,5 kV
 Connection symbol: YNyn0(yn0)d5
 Impedance voltage and rated voltage
 windings HV-MV at 20 MVA 11 %
 windings HV-LV at 13.4 MVA 14 %
 windings MV-LV at 13.4 MVA 6 %
 Year: 1988.
 Customer: Elektra, Croatia

All of the submitted transformers passed the short circuit special test according to the IEC 60076-5. For calculation of short-circuit forces and stresses in the transformer windings, the software "SILEKS" was used. "SILEKS" calculates the short-circuit forces according to the Rabin's method. The result is the solution of the Laplace's-Poisson's equations in the polar coordinate system.



Signed by /
Podpisano przez:

Radosław
Łopatkiewicz

Date / Data:
2023-06-28 13:26

Promjena Revision	Rev. A
Odobrio Approved	ing. Vatešić
Izradio Designed	ing. Gardić
Datum Date	02.03.2020.



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