



**ETD TRANSFORMÁTORŮ a.s.**  
TECHNICAL INSPECTION AND TESTING ROOM



Zborovská 54/22, Doudlevice, 301 00 Pízeň, Česká republika  
tel.: +420 373 031 402, e-mail: [jakub.langer@etd-bez.cz](mailto:jakub.langer@etd-bez.cz)

No. of pages: 1/14

## Test Certificate

TKZ 20/103 A

<b>Purchaser:</b>	<b>JSC „APSVIETIMAS“</b>
<b>Subject of tests:</b>	<b>Power three-phase regulator oil transformer type ETRZ 31 M-0, work No. 0969547</b>
<b>Date of the test:</b>	30.6. ÷ 9.7.2020
<b>Internal order No.:</b>	13.00.0048 / 3010000246
<b>Order No.:</b>	ME000110327

**Test results: listed in the text**

### Enclosures:

Enclosure to Test Certificate No. TKZ 20/103A – Lightning impulse test  
Certificate No. TKZ 20/102A – Determination of sound levels  
Certificate No. ORGREZ 709/2020-O – Insulating Oil Analysis

In Pilsen , 10.7.2020

**ETD TRANSFORMÁTORŮ a.s.**  
Technická kontrola a zkušebna

Ing. Jakub Langer  
Head of laboratory

	<b>ETD TRANSFORMÁTORÝ a.s.</b> Zborovská 54/22, Doudlevec, 301 00 Plzeň, Česká republika	Certificate No.: TKZ 20/103 A	Page No.: 2 No. of pages: 14
	<b>Test Certificate</b> <b>Transformer tests</b>		
Work No.: 0969547	Type: ETRZ 31 M-0	Manufacturer: ETD TRANSFORMÁTORÝ a.s.	



Purchaser:	JSC „APSVIETIMAS“	Internal order No.:	13.00.0048 3010000246
Order No.:	ME000110327	Register No.:	ME000110327

Technical data			
Winding:	Output [kVA]:	Voltage [V]:	Current [A]:
1	25 000	115 000 ±9x1,778%	126
2	25 000	38 500 ±2x2,5%	375
3	25 000	11 000	1312

Standard:	IEC 60076				
Vector group:	YNyn0d11	Type of cooling:	ONAN/ONAF	Sort of loading:	S1
No. of phases:	3	Rated frequency:	50 Hz	Insulation class:	A

<b>Contents:</b>	
Enclosures	1
Technical data	2
Tests evaluation	2
Measurement of voltage ratio and check of phase displacement	3
Measurement of voltage ratio and check of phase displacement	4
Applied voltage test (AV)	5
Chopped wave lightning impulse test (LI, LIN)	5
Induced voltage test with partial discharge measurement (IVPD)	5
Measurement of winding resistance	6
Measurement of d.c. insulation resistance each winding to earth, and between windings	7
Determination of capacitances windings-to-earth and between windings	7
Measurement of dissipation factor (tg δ) of the insulation system capacitances	7
Check of core and frame insulation	7
Measurement of dissipation factor (tg δ) and capacitance C of the bushings	7
Test of oil	8
Leak testing with pressure for liquid immersed transformers (tightness test)	8
Measurement of dissolved gases in dielectric liquid	9
Measurement of no-load loss and current	9
Measurement of short-circuit impedance and load loss	10
Measurement of short-circuit impedance and load loss	11
Temperature rise for liquid-immersed transformers	12
Measurement of power taken by fan motor	12
Setting of instruments	13
Insulation of auxiliary wiring (AuxW)	13
Tests on on-load tap-changers – Operation test	14
Tests on no-load tap-changers (NLTC)	14
Check of the ratio and polarity of built-in current transformers	14
List of equipment	14

**Tests evaluation**  
**The transformer complied to all tests, carried on according to IEC 60076.**



Date:	Testing engineer:	Head of laboratory:	<b>ETD TRANSFORMÁTORÝ a.s.</b> Technická kontrola a zkušebna -2-
10.7.2020	 Ing. Čiviš	 Ing. Langer	

TR0008/03/RJ

	<b>ETD TRANSFORMÁTORŮ a.s.</b> Zborovská 54/22, Doudlevice, 301 00 Plzeň, Česká republika	Certificate No.: TKZ 20/103 A	Page No.: 3 No. of pages: 14
	<b>Test Certificate</b> <b>Transformer tests</b>		
Work No.: 0969547	Type: ETRZ 31 M-0	Manufacturer: ETD TRANSFORMÁTORŮ a.s.	

Measurement of voltage ratio and check of phase displacement					
For voltage ratio:			115 ±9x1,778% kV 38,5 ±2x2,5% kV (tap.No. 3)		
Connect. symbol corresponds:			YNyn0		
No. of tap:	Winding [V]:	For voltage ratio:	Failing of ratio [%]		
			A-0/Am-0m	B-0/Bm-0m	C-0/Cm-0m
1	133 402	3,465	-0,22	-0,26	-0,26
2	131 358	3,412	-0,23	-0,24	-0,25
3	129 313	3,359	-0,21	-0,26	-0,22
4	127 268	3,306	-0,20	-0,20	-0,23
5	125 224	3,253	-0,20	-0,22	-0,22
6	123 179	3,199	-0,14	-0,21	-0,19
7	121 134	3,146	-0,17	-0,19	-0,16
8	119 089	3,093	-0,16	-0,17	-0,18
9	117 045	3,040	-0,10	-0,17	-0,16
10	115 000	2,987	-0,11	-0,13	-0,14
11	112 955	2,934	-0,12	-0,12	-0,13
12	110 911	2,881	-0,08	-0,11	-0,11
13	108 866	2,828	-0,07	-0,09	-0,08
14	106 821	2,775	-0,05	-0,07	-0,08
15	104 777	2,721	-0,01	-0,08	-0,04
16	102 732	2,668	-0,02	-0,04	-0,03
17	100 687	2,615	0,01	-0,01	-0,02
18	98 642	2,562	0,01	0,01	0,01
19	96 598	2,509	0,06	0,04	0,03

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORŮ a.s. This technical document must not be copied, duplicated nor otherwise communicated to a third party without explicit consent of the above Company to that effect.



Date: 10.7.2020	Testing engineer:  Ing. Čiviš	Head of laboratory:  Ing. Langer	<b>ETD TRANSFORMÁTORŮ a.s.</b> Technická kontrola a zkušebna -2-
--------------------	--	---	--

TR0008/03/ŘJ

	<b>ETD TRANSFORMÁTORŮ a.s.</b> Zborovská 54/22, Doudlevec, 301 00 Plzeň, Česká republika	Certificate No.: TKZ 20/103 A	Page No.: 4 No. of pages: 14
	<b>Test Certificate</b> <b>Transformer tests</b>		
Work No.: 0969547	Type: ETRZ 31 M-0	Manufacturer: ETD TRANSFORMÁTORŮ a.s.	

Measurement of voltage ratio and check of phase displacement					
For voltage ratio:		115 ±9x1,778% kV (tap No. 1 +16%) 11 kV			
Connect. symbol corresponds:		YNd11			
No. of tap:	Winding [V]:	For voltage ratio:	Failing of ratio [%]:		
			A-0/a-c	B-0/b-a	C-0/c-b
1 (+16%)	133 402	7,002	-0,17	-0,22	-0,17
For voltage ratio:		38,5 ±2x2,5% kV 11 kV			
Connect. symbol corresponds:		YNd11			
No. of tap:	Winding [V]:	For voltage ratio:	Failing of ratio [%]:		
			Am-0m/a-c	Bm-0m/b-a	Cm-0m/c-b
1 (+5%)	40 425	2,122	0,19	0,16	0,21
2 (+2,5%)	39 463	2,071	0,08	0,08	0,11
3 (0%)	38 500	2,021	-0,03	-0,04	-0,03
4 (-2,5%)	37 538	1,970	-0,17	-0,16	-0,15
5 (-5%)	36 575	1,920	-0,29	-0,30	-0,29

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORŮ a.s. This technical document must not be copied, duplicated or otherwise communicated to a third party without explicit consent of the above Company to that effect.

Date: 10.7.2020	Testing engineer:  Ing. Čiviš	Head of laboratory:  Ing. Langer	<b>ETD TRANSFORMÁTORŮ a.s.</b> Technická kontrola a zkušebna -2-
--------------------	--	---	--

TR0008/03/RJ



**ETD TRANSFORMÁTORY a.s.**  
Zborovská 54/22, Doudlevec, 301 00 Plzeň, Česká republika

Certificate No.:  
TKZ 20/103 A

Page No.: 5  
No. of pages: 14



**Test Certificate  
Transformer tests**

Work No.: 0969547

Type: ETRZ 31 M-0

Manufacturer: ETD TRANSFORMÁTORY a.s.

**Applied voltage test (AV)**

On the tested winding is applied the voltage  $U_{test}$  [kV],  $f = 50$  Hz,  $t = 60$  s against the tank and other windings.

Tested winding:	115 kV	38,5 kV	11 kV				
Testing voltage $U_{test}$ [kV]:	100	85	28				

**Chopped wave lightning impulse test (LI, LIN)**

Tested windings:	115 kV	115 kV	38,5 kV	11 kV
Terminals:	A, B, C	0	Am, Bm, Cm	a, b, c
Testing voltage $U_{test}$ [kV]:	550	250	185	75

**Induced voltage test with partial discharge measurement (IVPD)**

Rated voltage  $U_r = 115$  kV

Testing voltage „phase – phase“ $U_{test}$ [kV]	$<0,4U_r$	$1,2U_r$	$1,58U_r$	$2U_r$	$1,58 U_r$												$1,2 U_r$	$<0,4U_r$	
	46	138	182	230	182												80	27	
Testing voltage „phase - earth“ $U_{zk}/\sqrt{3}$ [kV]	$<0,4U_r/\sqrt{3}$	$1,2U_r/\sqrt{3}$	$1,58U_r/\sqrt{3}$	$2U_r/\sqrt{3}$	$1,58 U_r/\sqrt{3}$												$1,2 U_r/\sqrt{3}$	$<0,4U_r/\sqrt{3}$	
	27	80	105	133	105												13	4	
Measured	Test time t [s]	3600																60	-
		300	600	900	1200	1500	1800	2100	2400	2700	3000	3300	3600						
<b>IU</b>	Apparent charge [pC]	-	<10	<10	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	-
<b>IV</b>	Apparent charge [pC]	-	<10	<10	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	-
<b>IW</b>	Apparent charge [pC]	-	<10	<10	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	-

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORY a.s. This technical document must not be copied, duplicated not otherwise communicated to a third party without explicit consent of the above Company to that effect.

Date: 10.7.2020	Testing engineer:  Ing. Čiviš	Head of laboratory:  Ing. Langer	<b>ETD TRANSFORMÁTORY a.s.</b> Technická kontrola a zkušebna -2-
--------------------	-------------------------------------	--	--

TR0008/03/RJ



**Test Certificate**  
**Transformer tests**

Work No.: 0969547

Type: ETRZ 31 M-0



Manufacturer: ETD TRANSFORMÁTORY a.s.

**Measurement of winding resistance**

Quoted value of winding resistance  $R [\Omega]$  at temperature 20 °C

Winding: No. of tap:	A-0	B-0	C-0	Winding: No. of tap:	Am-0	Bm-0	Cm-0
115 kV / 1	1,228	1,230	1,228	38,5 kV / 1 (+5%)	0,106	0,106	0,107
2	1,202	1,204	1,202	2 (+2,5%)	0,104	0,104	0,104
3	1,176	1,178	1,176	3 (0%)	0,102	0,102	0,102
4	1,150	1,152	1,150	4 (-2,5%)	0,100	0,099	0,100
5	1,124	1,126	1,124	5 (-5%)	0,097	0,097	0,097
6	1,098	1,100	1,098				
7	1,072	1,074	1,072	11 kV / -	a-b	a-c	b-c
8	1,046	1,048	1,046		0,0125	0,0125	0,0125
9	1,020	1,022	1,020				
10	0,992	0,994	0,990				
11	1,020	1,023	1,021				
12	1,046	1,049	1,046				
13	1,071	1,075	1,072				
14	1,097	1,100	1,098				
15	1,123	1,126	1,124				
16	1,149	1,152	1,150				
17	1,175	1,178	1,176				
18	1,201	1,204	1,201				
19	1,227	1,231	1,228				

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORY a.s. This technical document must not be copied, duplicated nor otherwise communicated to a third party without explicit consent of the above Company to that effect.

Date: 10.7.2020	Testing engineer:  Ing. Čiviš	Head of laboratory:  Ing. Langer	<p><b>ETD TRANSFORMÁTORY a.s.</b> Technická kontrola a zkušebna</p> <p>-2-</p>
--------------------	--	---	--



**ETD TRANSFORMÁTORY a.s.**  
Zborovská 54/22, Doudlevec, 301 00 Plzeň, Česká republika

Certificate No.:  
TKZ 20/103 A

Page No.: 7  
No. of pages: 14



**Test Certificate**  
**Transformer tests**

Work No.: 0969547

Type: ETRZ 31 M-0

Manufacturer: ETD TRANSFORMÁTORY a.s.

**Measurement of d.c. insulation resistance each winding to earth, and between windings**

**Determination of capacitances windings-to-earth and between windings**

**Measurement of dissipation factor (tg δ) of the insulation system capacitances**

Measured at winding temperature: 25 °C

Measured at winding temperature: 25 °C

Connection at measurement:	U <sub>test.</sub> = 2500 V <sub>DC</sub>		Connection at measurement:	U <sub>test.</sub> = 10000 V/50 Hz	
	R <sub>insulating</sub> [MΩ]			C [nF]	tg δ [%]
* remaining windings connected to transf. tank	15 s	60 s	115 kV – 38,5 kV	5,3	0,17
115 kV / tank + *	13 330	15 270	38,5 kV – 11 kV	10,5	0,20
38,5 kV / tank + *	7 220	9 340	115 kV – tank	3,1	0,21
11 kV / tank + *	5 640	9 880	38,5 kV – tank	1,2	0,39
115 kV + 38,5 kV / tank + *	7 970	13 140	11 kV – tank	9,8	0,36
115 kV + 11 kV / tank + *	4 660	6 840			
38,5 kV + 11 kV / tank + *	9 180	11 500			
115 kV + 38,5 kV + 11 kV / tank + *	11 860	14 630			

**Check of core and frame insulation**

Measured at oil temperature: 25 °C

	U <sub>test.</sub> = 2500 V <sub>DC</sub>			
	R <sub>insulating</sub> [MΩ]			
	15 s	60 s		
core / tank + frame	3 087	6 780		
frame / tank + core	2 754	5 410		

**Measurement of dissipation factor (tg δ) and capacitance C of the bushings**

Measured at winding temperature: 25 °C

Terminal / Serial No.	„A“ No. 19D4366	„B“ No. 19D4367	„C“ No. 19D4368	„0“ No. 2083541					
Connection at measurement:	U <sub>test</sub>	C <sub>1</sub> [pF]	tg δ <sub>1</sub> [%]	C <sub>1</sub> [pF]	tg δ <sub>1</sub> [%]	C <sub>1</sub> [pF]	tg δ <sub>1</sub> [%]	C <sub>1</sub> [pF]	tg δ <sub>1</sub> [%]
Terminal - Power factor tap	2 kV	262,9	0,27	262,6	0,26	264,4	0,27	297,5	0,22
	4 kV	262,9	0,27	262,6	0,26	264,4	0,27	297,5	0,22
	6 kV	262,9	0,27	262,6	0,26	264,4	0,27	297,5	0,22
	8 kV	262,9	0,27	262,6	0,26	264,4	0,27	297,5	0,22
	10 kV	262,9	0,27	262,6	0,26	264,4	0,27	297,5	0,22
Connection at measurement:	U <sub>test</sub>	C <sub>2</sub> [pF]	tg δ <sub>2</sub> [%]	C <sub>2</sub> [pF]	tg δ <sub>2</sub> [%]	C <sub>2</sub> [pF]	tg δ <sub>2</sub> [%]	C <sub>2</sub> [pF]	tg δ <sub>2</sub> [%]
Power factor tap - tank	2 kV	514,1	0,27	489,7	0,24	463,5	0,27	322,1	0,48

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORY a.s. This technical document must not be copied, duplicated, not otherwise communicated to a third party without explicit consent of the above Company to that effect.

Date: 10.7.2020	Testing engineer:  Ing. Čiviš	Head of laboratory:  Ing. Langer	<b>ETD TRANSFORMÁTORY a.s.</b> Technická kontrola a zkušebna -2-
--------------------	-------------------------------------	--	--

TR0008/03/RJ



**ETD TRANSFORMÁTORY a.s.**  
Zborovská 54/22, Doudlevice, 301 00 Plzeň, Česká republika

Certificate No.:  
TKZ 20/103 A

Page No.: 8  
No. of pages: 14



**Test Certificate**  
**Transformer tests**

Work No.: 0969547

Type: ETRZ 31 M-0

Manufacturer: ETD TRANSFORMÁTORY a.s.

**Test of oil**

Oil type:	LYRA X	tg $\delta$ [%/90 °C]:	0,026	$\rho_V$ [G $\Omega$ m/90 °C]:	241,6	$\epsilon_r$ [-]:	2,12
Tr. tank:	Water content in oil[ppm]: 3	$U_p$ [kV/2,5mm]:	83,8	s [kV/2,5mm]:	6,0	V [%]:	7,2
Tap changer:	Water content in oil[ppm]: 5	$U_p$ [kV/2,5mm]:	88,0	s [kV/2,5mm]:	9,7	V [%]:	11,0

**Leak testing with pressure for liquid immersed transformers (tightness test)**

The test carried out for 48 hours + 24 hours duration from last tightness repair.

tank / external space .... with overpressure 40 kPa

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORY a.s. This technical document must not be copied, duplicated, not otherwise communicated to a third party without explicit consent of the above Company to that effect.

Date: 10.7.2020	Testing engineer:  Ing. Čiviš	Head of laboratory:  Ing. Langer	<b>ETD TRANSFORMÁTORY a.s.</b> Technická kontrola a zkušebna -2-
--------------------	-------------------------------------	--	--

TR0008/03/ŘJ





**ETD TRANSFORMÁTORY a.s.**  
Zborovská 54/22, Doudlevice, 301 00 Plzeň, Česká republika

Certificate No.:  
TKZ 20/103 A

Page No.: 9  
No. of pages: 14



**Test Certificate**  
**Transformer tests**

Work No.: 0969547

Type: ETRZ 31 M-0

Manufacturer: ETD TRANSFORMÁTORY a.s.

**Measurement of dissolved gases in dielectric liquid**

Detected gas	unit	value 1	value 2	value 3			
Oxygen (O <sub>2</sub> )	μl/l	4 486	4 873	3 685			
Nitrogen (N <sub>2</sub> )	μl/l	9 506	10 412	8 000			
Hydrogen (H <sub>2</sub> )	μl/l	0,0	0,0	0,0			
Carbon dioxide (CO <sub>2</sub> )	μl/l	79,9	99,5	93,5			
Carbon monoxide (CO)	μl/l	2	8,1	10,2			
Ethylen (C <sub>2</sub> H <sub>4</sub> )	μl/l	2	31,9	22,5			
Ethane (C <sub>2</sub> H <sub>6</sub> )	μl/l	0,0	0,0	0,0			
Methane (CH <sub>4</sub> )	μl/l	0,0	0,2	0,2			
Acetylene (C <sub>2</sub> H <sub>2</sub> )	μl/l	0,0	0,0	0,0			
Propylene (C <sub>3</sub> H <sub>6</sub> )	μl/l	0,0	0,0	0,0			
Propane (C <sub>3</sub> H <sub>8</sub> )	μl/l	0,2	4,4	3,9			
Sum of hydrocarbons	μl/l	2,2	36,5	26,6			
Sum of combustible gases	μl/l	4,2	44,6	36,9			
Total gas content (Q <sub>p</sub> )	%vol.	1,41	1,54	1,18			

Note:

value 1 – before tests

value 2 – after temperature rise test

value 3 – after tests

**Measurement of no-load loss and current**

Measured values:					Guaranteed values:	
Energized winding 11 kV					tol.+30 %	tol.+0 %
U [V]	u [%]	I <sub>0</sub> [A]	i <sub>0</sub> [%]	ΔP <sub>0</sub> [kW]	i <sub>0</sub> [%]	ΔP <sub>0</sub> [kW]
12 103	110	2,4	0,18	18,1		
11 556	105	1,3	0,10	15,1		
11 000	100	0,9	0,07	13,1	0,2	15
10 455	95	0,7	0,06	11,5		
9 908	90	0,6	0,05	10,2		

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORY a.s. This technical document must not be copied, duplicated nor otherwise communicated to a third party without explicit consent of the above Company to that effect.



Date: 10.7.2020	Testing engineer:  Ing. Čiviš	Head of laboratory:  Ing. Langer	<b>ETD TRANSFORMÁTORY a.s.</b> Technická kontrola a zkušebna -2-
--------------------	-------------------------------------	--	--

TR0008/03/RJ

	<b>ETD TRANSFORMÁTORÝ a.s.</b> Zborovská 54/22, Doudlevice, 301 00 Plzeň, Česká republika	Certificate No.: TKZ 20/103 A	Page No.: 10 No. of pages: 14
	<b>Test Certificate</b> <b>Transformer tests</b>		
Work No.: 0969547	Type: ETRZ 31 M-0	Manufacturer: ETD TRANSFORMÁTORÝ a.s.	

Measurement of short-circuit impedance and load loss										
Values for winding temperature 75 °C										
Measured values:						Guaranteed values:				
						$\Delta P_0 + \Delta P_k$	tol.±15%	tol.+0%	tol.+0%	
Powered winding:	Shorted winding:			For output:	$u_k$	$\Delta P_k$	$\Sigma \Delta P$	$u_k$	$\Delta P_k$	$\Sigma \Delta P$
Tap Nr.:	Tap Nr.:	Tap Nr.:	S [kVA]	[%]	[kW]	[kW]	[%]	[kW]	[kW]	
115 kV	1	38,5 kV	3 (0%)	25 000	10,37	112,3				
	2				10,31	112,6				
	3				10,25	112,9				
	4				10,19	113,2				
	5				10,14	113,6				
	6				10,09	114,0				
	7				10,04	114,3				
	8				9,99	114,7				
	9				9,95	115,1				
	10				9,92	115,0	128,1	10,5	130	145
	11				9,89	119,0				
	12				9,87	122,8				
	13				9,85	126,8				
	14				9,85	131,1				
	15				9,85	135,8				
	16				9,86	140,7				
	17				9,88	146,1				
	18				9,91	151,8				
	19				9,95	158,0				
115 kV	1	38,5 kV	1 (+5%)	25 000	10,46	110,6				
	10				10,02	113,6	126,7	-	-	-
	19				10,07	156,7				
115 kV	1	38,5 kV	5 (-5%)	25 000	10,27	114,9				
	10				9,82	117,8	130,9	-	-	-
	19				9,85	160,9				

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORÝ a.s. This technical document must not be copied, duplicated, not otherwise communicated to a third party without explicit consent of the above Company to that effect.

Date: 10.7.2020	Testing engineer:  Ing. Čiviš	Head of laboratory:  Ing. Langer	<b>ETD TRANSFORMÁTORÝ a.s.</b> Technická kontrola a zkušebna -2-
--------------------	--	---	--

TR0008/03/RJ


**Test Certificate**  
**Transformer tests**

Work No.: 0969547

Type: ETRZ 31 M-0

Manufacturer: ETD TRANSFORMÁTORÝ a.s.

**Measurement of short-circuit impedance and load loss**

Values for winding temperature 75 °C

Measured values:							Guaranteed values:			
							$\Delta P_0 + \Delta P_k$	tol.	tol.+0%	tol.+ 0%
Powered winding:	Shorted winding:		For output:	$u_k$	$\Delta P_k$	$\Sigma \Delta P$	$u_k$	$\Delta P_k$	$\Sigma \Delta P$	
Tap Nr.:		Tap Nr.:	S [kVA]	[%]	[kW]	[kW]	[%]	[kW]	[kW]	
115 kV	1	11 kV	-	25 000	17,44	108,0				
	2				17,38	108,3				
	3				17,32	108,6				
	4				17,27	108,9				
	5				17,22	109,2				
	6				17,16	109,5				
	7				17,12	109,8				
	8				17,07	110,2				
	9				17,03	110,5				
	10				16,99	110,5	123,6	17,5±7,5%	125	140
	11				16,97	114,4				
	12				16,95	118,1				
	13				16,93	122,1				
	14				16,93	126,4				
	15				16,93	130,9				
	16				16,94	135,8				
	17				16,96	141,1				
	18				16,99	146,8				
	19				17,04	152,9				
38,5 kV	1 (+5%)	11 kV	-	25 000	5,74	94,8				
	2 (+2,5%)				5,86	96,1				
	3 (0%)				5,98	97,4	110,5	6,5±15%	106	121
	4 (-2,5%)				6,11	98,9				
	5 (-5%)				6,26	100,0				

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORÝ a.s. This technical document must not be copied, duplicated not otherwise communicated to a third party without explicit consent of the above Company to that effect.

Date: 10.7.2020	Testing engineer:  Ing. Čiviš	Head of laboratory:  Ing. Langer	<b>ETD TRANSFORMÁTORÝ a.s.</b> Technická kontrola a zkušebna -2-
--------------------	-------------------------------------	--	--

TR0008/03/ŘJ



**Test Certificate**  
**Transformer tests**

Work No.: 0969547

Type: ETRZ 31 M-0

Manufacturer: ETD TRANSFORMÁTORŮ a.s.

**Temperature rise for liquid-immersed transformers**

Temperature rise test carried on in short-circuited connection at  $f = 50$  Hz

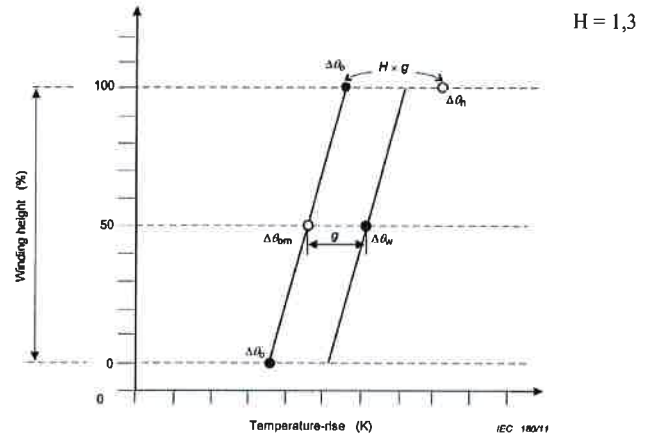
Energized winding: 115 kV tap. No.: 19 (-16%)

Short-circuited winding: 38,5 kV tap. No.: 3 (0%)

Type of cooling: ONAN/ONAF

Description of cooling:

6 pcs radiators type FR3  
2 pcs radiators type FR3L  
2 pcs radiators type FR3R  
10 pcs fans type EBM W8D500-CJ09-86



	ONAN		ONAF	
	115 kV	38,5 kV	115 kV	38,5 kV
Measured winding				
Rated power	Sn [MVA]		25	25
Rated current	In [A]		149	375
Load loss	$\Delta P_k$ [kW/75°C]		158,0	
No-load loss	$\Delta P_0$ [kW]		13,1	
Total losses	$\Sigma \Delta P$ [kW]		171,1	
External cooling medium temp.	$\Theta_a$ [°C]		24,5	
Top-liquid temp. rise (pocket)	$\Delta \Theta_o$ [K]		50,0	
Top-liquid temperature rise	$\Delta \Theta_o$ [K]		53,9	
Average liquid temperature rise	$\Delta \Theta_{om}$ [K]		39,0	
Average winding gradient	6,5	5,5	14,1	9,7
Average winding temperature rise	39,9	38,9	53,1	48,7
Hot-spot winding temperature rise	59,6	58,3	72,3	66,5
For max. external cooling medium temp.	$\Theta_a$ max. [°C]		40	
max. top-liquid temperature	$\Theta_o$ max. [°C]		93,9	

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORŮ a.s. This technical document must not be copied, duplicated nor otherwise communicated to a third party without explicit consent of the above Company to that effect.

**Measurement of power taken by fan motor**

Feeding voltage:	For 1 pc		For 10 pcs	
	Feeding current I [A]	Inp. power P [W]	Feeding current I [A]	Inp. power P [W]
3x 400 V, 50 Hz				
Fans	0,137	72,7	1,355	710,1

Date:	Testing engineer:	Head of laboratory:	<p><b>ETD TRANSFORMÁTORŮ a.s.</b> Technická kontrola a zkušebna -2-</p>
10.7.2020	Ing. Čiviš	Ing. Langer	



**ETD TRANSFORMÁTORY a.s.**  
Zborovská 54/22, Doudlevice, 301 00 Plzeň, Česká republika

Certificate No.:  
TKZ 20/103 A

Page No.: 13  
No. of pages: 14



**Test Certificate  
Transformer tests**

Work No.: 0969547

Type: ETRZ 31 M-0

Manufacturer: ETD TRANSFORMÁTORY a.s.

**Check the wiring and operation of the auxiliary circuits**

Main, auxiliary, control, measuring, signalisation and guard circuits on the transformer according to EH 0003197 and EH 0003198 drawings.

**Setting of instruments**

Circuits:	Description:	Instrument (terminals):	Value:
Cooling control:	Automatic of cooling – switch on fans (oil)	BT1 (11-14)	60 °C
	Automatic of cooling – switch off fans (oil)	BT1 (11-14)	cca 48 °C
	Automatic of cooling – switch on fans (winding)	BT2 (11-14)	75 °C
	Automatic of cooling – switch off fans (winding)	BT2 (11-14)	cca 63 °C
Signalisation of fallures:	High temperature oil	BT1 (31-34)	90 °C
	High temperature winding	BT2 (31-34)	105 °C
Guard protection:	Dangerous temperature oil	BT1 (41-44)	100 °C
	Dangerous temperature winding	BT2 (41-44)	115 °C
Measuring:	Temperature increase, oil - winding for $I_n$	BT2 (5 - 5)	1,21 $\Omega$ (15 K)
Fans of motors:	Protection of fans	F01 – F10	0,16 A
Box equipment:	Heating	B51 (1-2)	10 °C

**Insulation of auxiliary wiring (AuxW)**

Repeated tests after final circuits connection.

Current transformer	2 500 V / 60 s / 50 Hz
Other circuits*	2 000 V / 60 s / 50 Hz

\*Equipments with insulation level less than 2kV were disconnected from testing circuit.

**Measurement of separate circuits insulation resistance**

Measurement of individual circuits against earth	$U_{test} = 1\ 000V_{DC}$
Individual circuits tested	$R_{insulating} > 500\ M\Omega$

**Check of effective earth continuity between mounted devices and the protective circuit**

Connection with protection circuits according to standard ČSN EN 61439-1 ed.2.

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORY a.s. This technical document must not be copied, duplicated not otherwise communicated to a third party without explicit consent of the above Company to that effect.

Date: 10.7.2020	Testing engineer:  Ing. Čiviš	Head of laboratory:  Ing. Langer	<b>ETD TRANSFORMÁTORY a.s.</b> Technická kontrola a zkušebna -2-
--------------------	-------------------------------------	--	--

TR0008/03/ŘJ

	<b>ETD TRANSFORMÁTORÝ a.s.</b> Zborovská 54/22, Doudlevec, 301 00 Plzeň, Česká republika	Certificate No.: TKZ 20/103 A	Page No.: 14 No. of pages: 14
	<b>Test Certificate</b> <b>Transformer tests</b>		
Work No.: 0969547	Type: ETRZ 31 M-0	Manufacturer: ETD TRANSFORMÁTORÝ a.s.	



<b>Tests on on-load tap-changers – Operation test</b>
a) 8 complete operating cycles with transformer not energized; b) 1 complete operating cycle with transformer not energized, with 85 % of the rated auxiliary supply voltage; c) 1 complete operating cycle with the transformer energized at rated voltage and frequency at no-load; d) 10 tap-change operations with $\pm 2$ steps on either side of the principal tapping with as far as possible the rated current of the transformer, with one winding short – circuited.

<b>Tests on no-load tap-changers (NLTC)</b>
Operation test of NLTC was carried out during of the voltage ratio measurement, short-circuit impedance and load loss measurement and no-load loss and current measurement.

<b>Check of the ratio and polarity of built-in current transformers</b>
Check of the ratio and polarity of built-in current transformers – during measurement of short-circuit impedance and load loss.

<b>List of equipment</b>				
Meters:	Fab. No.:	Date of calibration:	Date next calibration:	Pasport No.:
Current measurement transformer TETTEX 4874 sp.	32370 A+C	12.01.2018	12.01.2023	8017-KL-T0003÷5-18
Voltage measurement transformer EPRO NVOS 50	2/12/3738+3740	12.01.2018	12.01.2023	8017-KL-T0006÷8-18
Power analyzer NORMA 5000-PP64	WO15590BA	30.11.2019	30.11.2020	5249/19/A
Multimeter AGILENT 34970A	MY57007180	14.03.2020	14.03.2021	1252/20/A
Ratio and vector groupe MEGGER TTR 300	71273 1114	30.01.2019	30.01.2021	TKZ 19/014
Megaohmmeter C.A 6547	106803TAH	22.02.2020	22.02.2022	899/20/A
Kilovoltmeter MU17+A2	884764	20.02.2020	20.02.2022	893/20/A
Divider HIGHVOLT 250 kV - AC	884766	20.09.2019	20.09.2021	3880/19/A
Calibrator PD OMICRON CAL542B	GB324B	16.03.2020	16.03.2022	72/20/S
Kilovoltmeter HAEFELY 2000 kV	12100015.60.1÷2 12100015.65.1	26.07.2017	26.07.2022	2873/17/A
Measuring device HAEFELY HiAS 743	176632	21.02.2020	21.02.2022	896/20/A
Bridge MEGGER DELTA 4110	1777 1014	01.12.2018	01.12.2020	412/18/S
Dieltest of oil BAUR DTA 100	952922008	17.10.2019	17.10.2021	TKZ 19/210
Aquameter BAUR KFM 1000 S	959713011	28.04.2020	28.04.2022	TKZ 20/068
Schering bridge TETTEX 2801	121510	24.07.2017	24.07.2020	2755/17/A
Teraohmmeter SEFELEC M1500 UFA	676	24.07.2017	24.07.2020	2812/17/A
Gas chromatograph AGILENT 7890B	CN 18073060	22.08.2018	22.08.2021	TKZ 18/205
Acoustic calibrator CAL200	10693	27.11.2018	27.11.2021	6035-KL-K0056-18
Noise meter NTI Audio XL2 with microphone NTI Audio MC230	A2A-08124-E0 9106	14.02.2020	14.02.2023	6035-KL-Z0013-20

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORÝ a.s. This technical document must not be copied, duplicated or otherwise communicated to a third party without explicit consent of the above Company to that effect.

Date: 10.7.2020	Testing engineer:  Ing. Čiviš	Head of laboratory:  Ing. Langer	<b>ETD TRANSFORMÁTORÝ a.s.</b> Technická kontrola a zkušebna -2-
--------------------	--	---	--

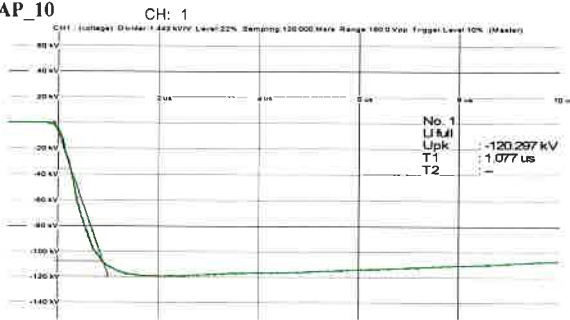
TR0008/03/RJ

Work No.: 0969547

Temperature: 23 °C

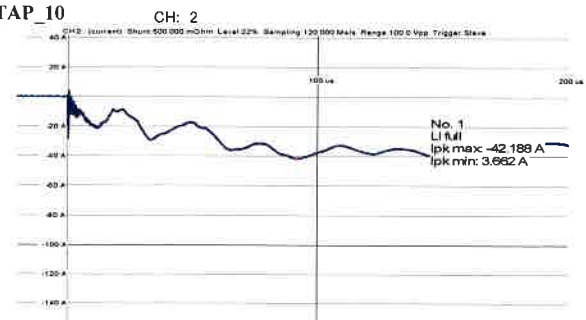
Pressure: 730,5 mmHg

A\_TAP\_10



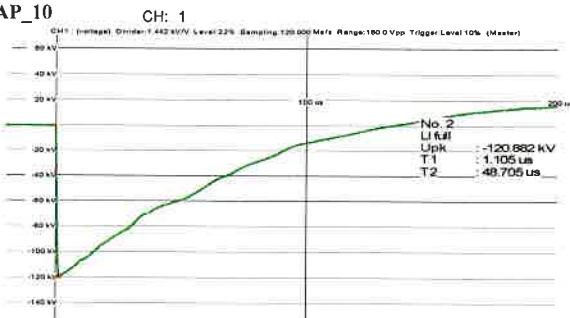
No. 1 LI full Upk: -120.297 kV T1: 1.077 us T2: --

A\_TAP\_10



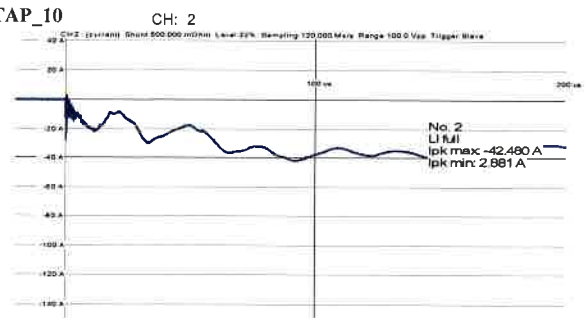
No. 1 LI full Ipk max: -42.188 A Ipk min: 3.662 A

A\_TAP\_10



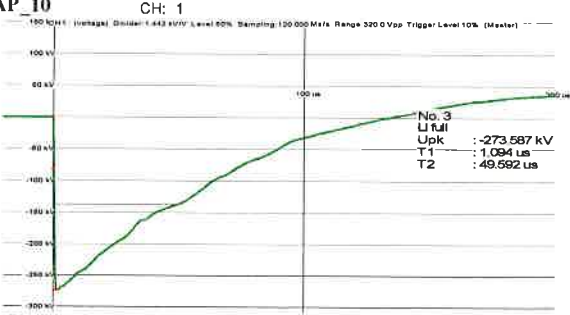
No. 2 LI full Upk: -120.882 kV T1: 1.105 us T2: 49.705 us

A\_TAP\_10



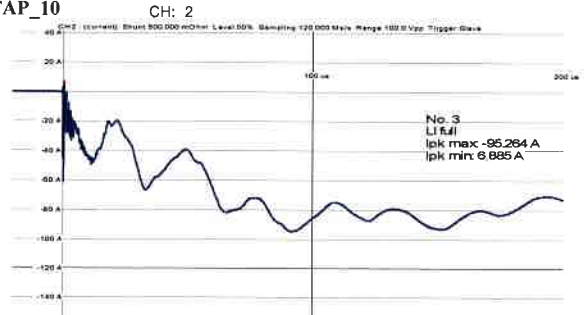
No. 2 LI full Ipk max: -42.480 A Ipk min: 2.881 A

A\_TAP\_10



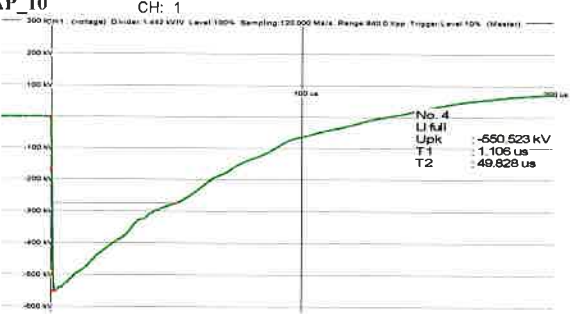
No. 3 LI full Upk: -273.587 kV T1: 1.094 us T2: 49.592 us

A\_TAP\_10



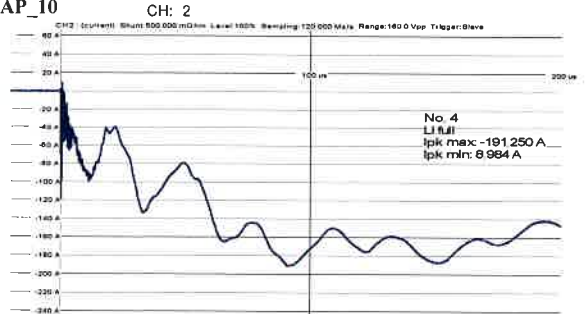
No. 3 LI full Ipk max: -95.264 A Ipk min: 6.885 A

A\_TAP\_10



No. 4 LI full Upk: -550.523 kV T1: 1.106 us T2: 49.828 us

A\_TAP\_10



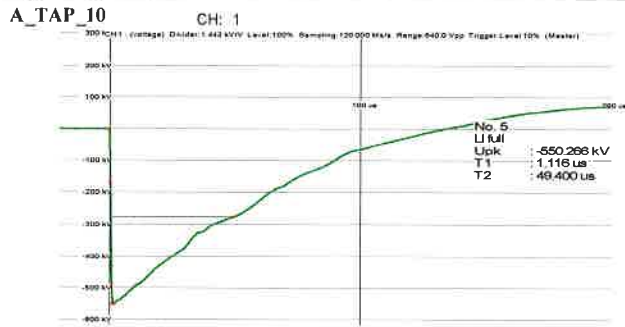
No. 4 LI full Ipk max: -191.250 A Ipk min: 8.984 A

Date:  
02/07/20

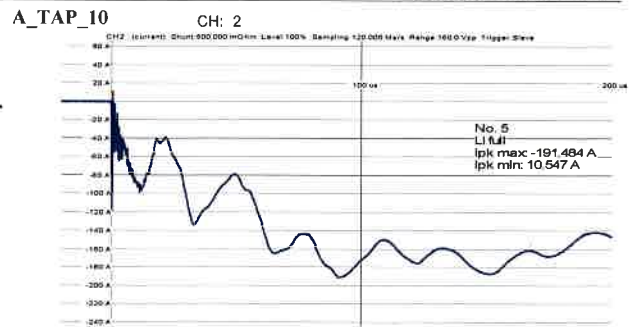
Testing engineer:

ETD TRANSFORMÁTORÝ a.s. Ing. Čiviš  
Technická kontrola a zkušebna

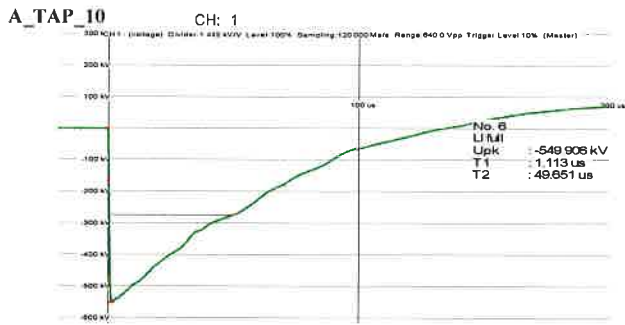
-2-



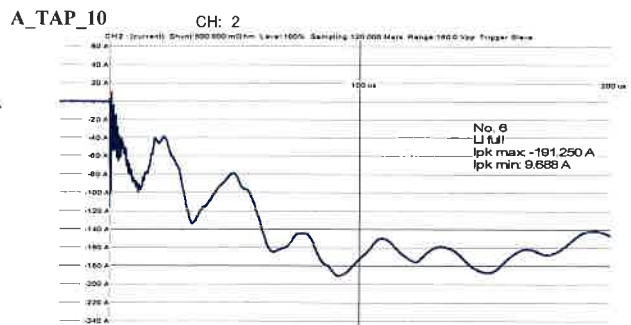
No. 5 LI full Upk: -550.266 kV T1: 1.116 us T2: 49.400 us



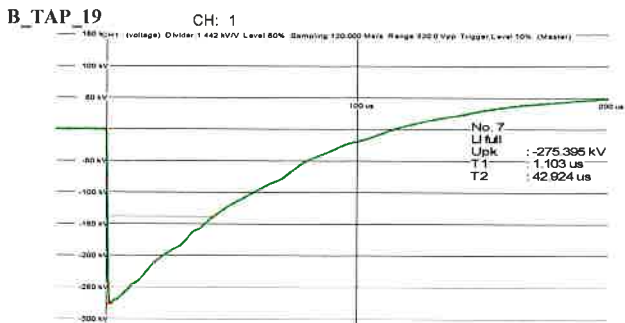
No. 5 LI full Ipk max: -191.484 A Ipk min: 10.547 A



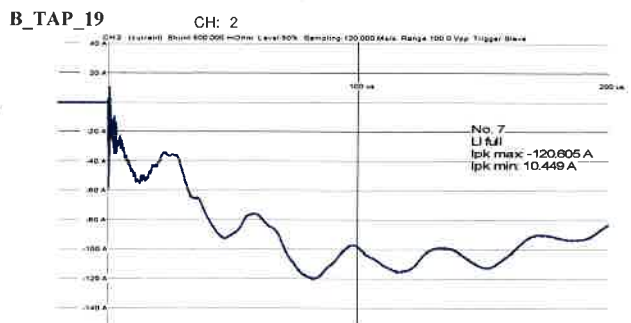
No. 6 LI full Upk: -549.906 kV T1: 1.113 us T2: 49.651 us



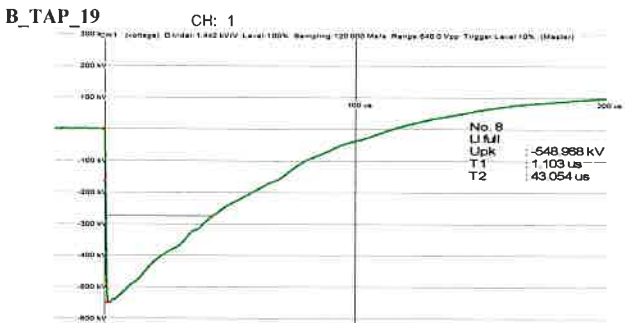
No. 6 LI full Ipk max: -191.250 A Ipk min: 9.688 A



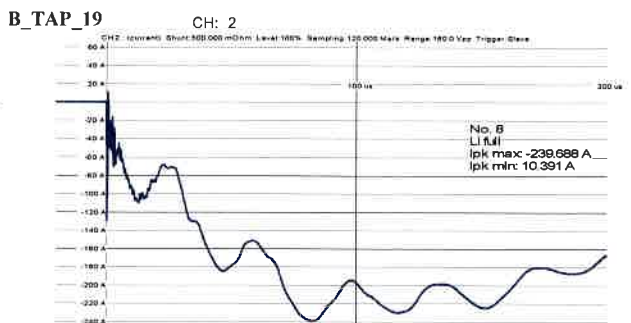
No. 7 LI full Upk: -275.395 kV T1: 1.103 us T2: 42.924 us



No. 7 LI full Ipk max: -120.605 A Ipk min: 10.449 A



No. 8 LI full Upk: -548.968 kV T1: 1.103 us T2: 43.054 us



No. 8 LI full Ipk max: -239.688 A Ipk min: 10.391 A

Date:  
02/07/20

Testing engineer:  
Ing. Čiviš

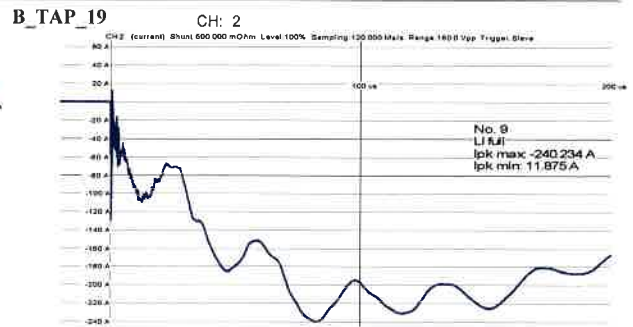
ETD TRANSFORMÁTORY a.s.  
Technická kontrola a zkušebna

-2-

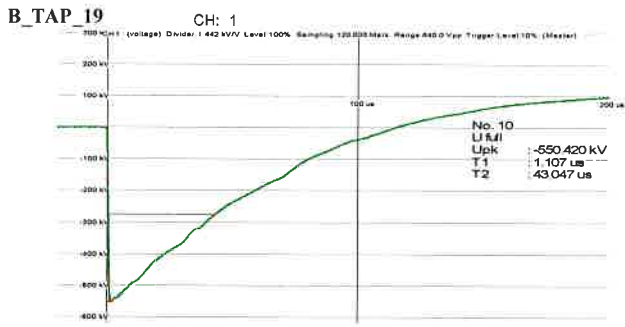




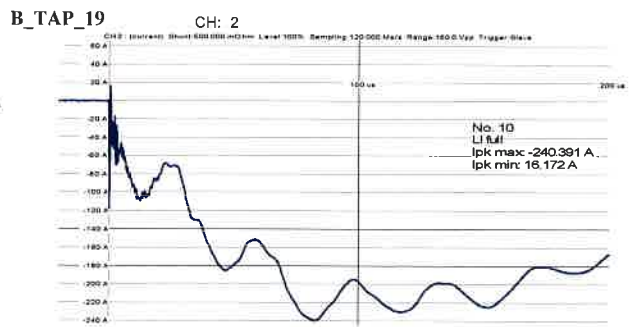
No. 9 LI full Upk: -550.438 kV T1: 1.105 us T2: 43.086 us



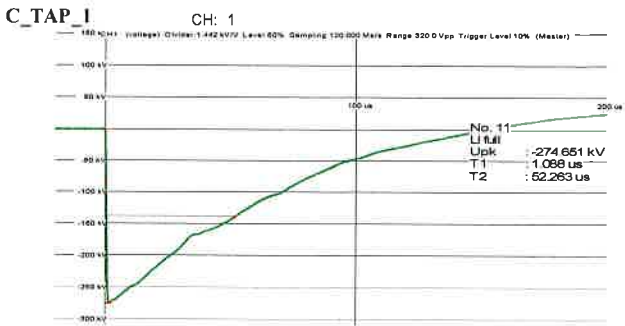
No. 9 LI full Ipk max: -240.234 A Ipk min: 11.875 A



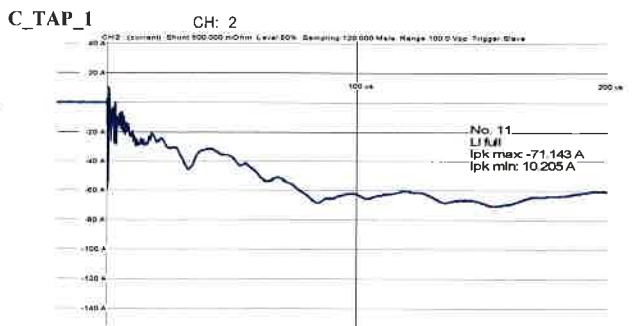
No. 10 LI full Upk: -550.420 kV T1: 1.107 us T2: 43.047 us



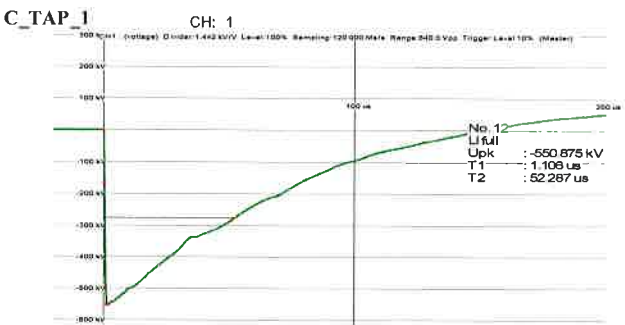
No. 10 LI full Ipk max: -240.391 A Ipk min: 16.172 A



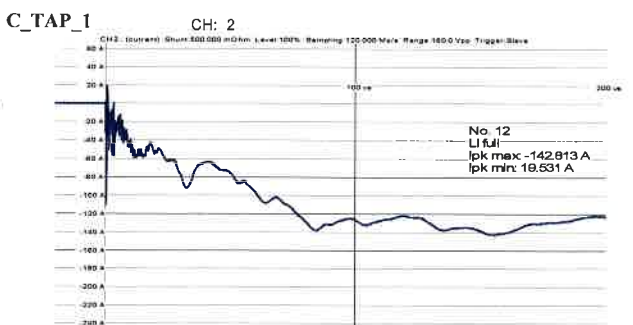
No. 11 LI full Upk: -274.651 kV T1: 1.088 us T2: 52.263 us



No. 11 LI full Ipk max: -71.143 A Ipk min: 10.205 A



No. 12 LI full Upk: -560.875 kV T1: 1.106 us T2: 52.287 us

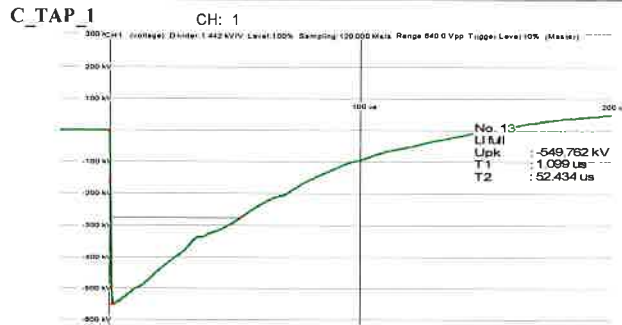


No. 12 LI full Ipk max: -142.813 A Ipk min: 19.531 A

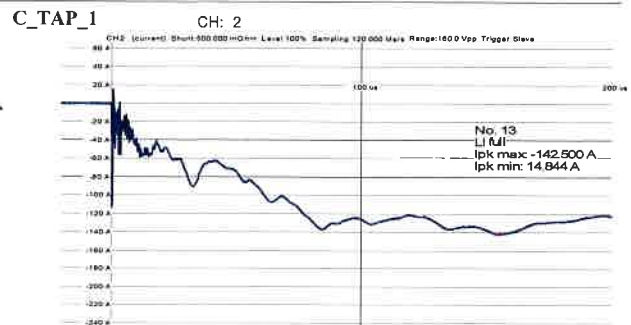
Date:  
02/07/20

**ETD TRANSFORMÁTORY a.s.**  
Technická kontrola a zkušebna

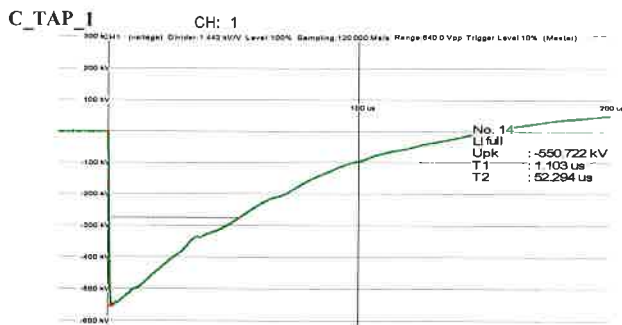
Testing engineer:  
Ing. Čiviš



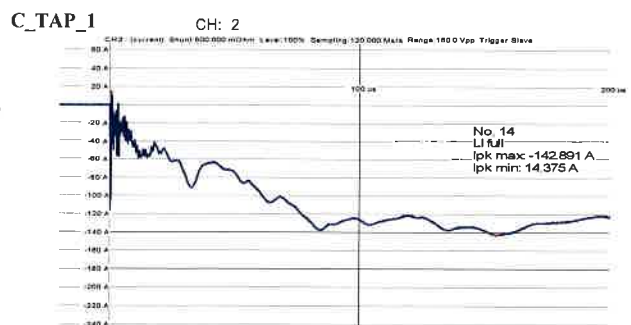
No. 13 LI full Upk: -549.762 kV T1: 1.099 us T2: 52.434 us



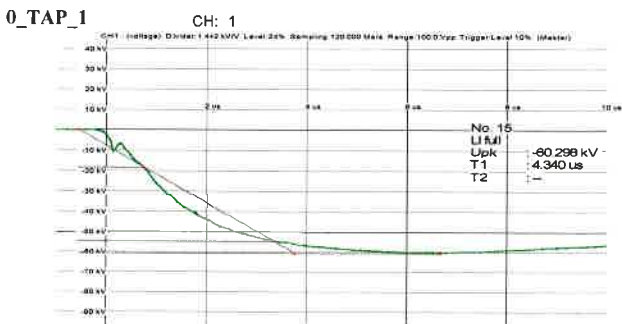
No. 13 LI full Ipk max: -142.500 A Ipk min: 14.844 A



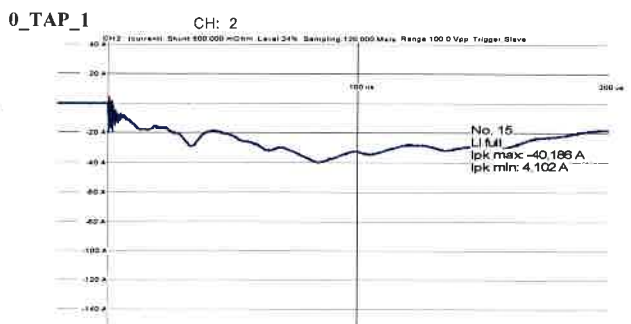
No. 14 LI full Upk: -550.722 kV T1: 1.103 us T2: 52.294 us



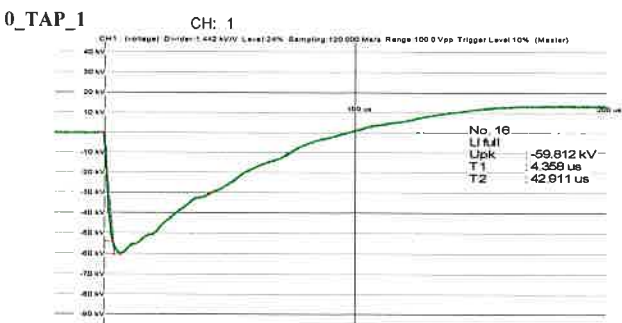
No. 14 LI full Ipk max: -142.891 A Ipk min: 14.375 A



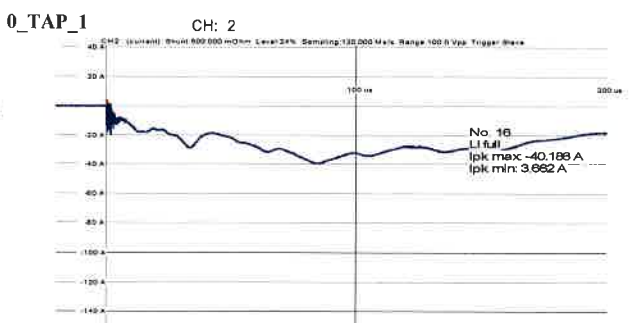
No. 15 LI full Upk: -60.298 kV T1: 4.340 us T2: --



No. 15 LI full Ipk max: -40.186 A Ipk min: 4.102 A



No. 16 LI full Upk: -59.812 kV T1: 4.358 us T2: 42.911 us



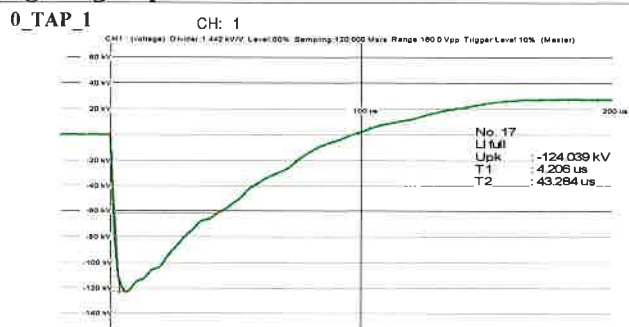
No. 16 LI full Ipk max: -40.186 A Ipk min: 3.662 A

Date:  
02/07/20

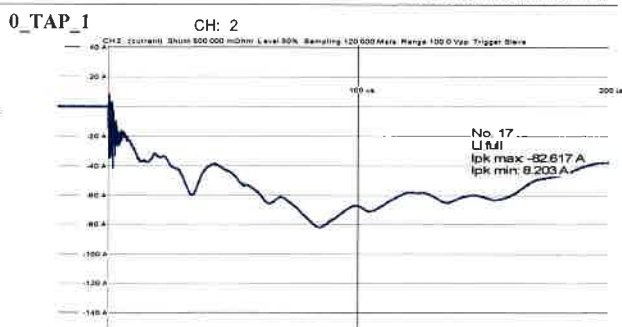
Testing engineer:  
Ing. Čiviš

ETD TRANSFORMÁTORÝ a.s.  
Technická kontrola a zkušebna

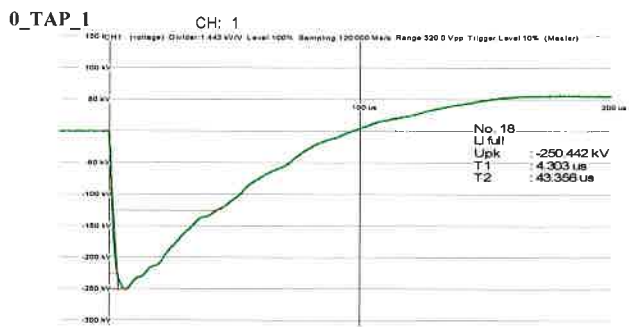
-2-



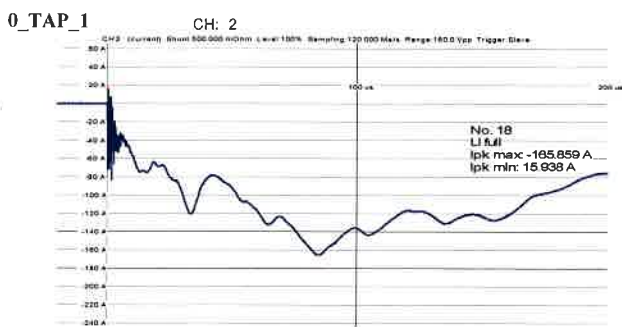
No. 17 LI full Upk: -124.039 kV T1: 4.206 us T2: 43.284 us



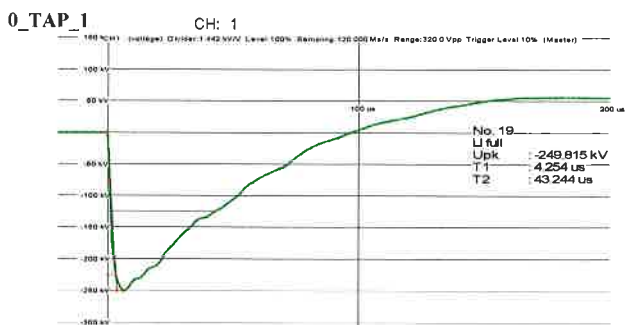
No. 17 LI full Ipk max: -82.617 A Ipk min: 8.203 A



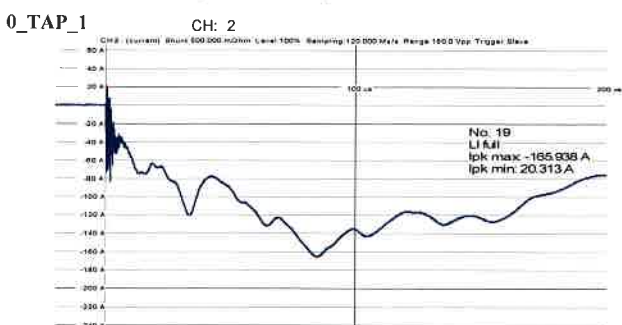
No. 18 LI full Upk: -250.442 kV T1: 4.303 us T2: 43.356 us



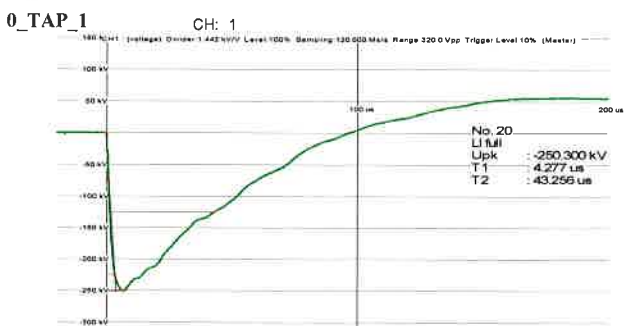
No. 18 LI full Ipk max: -165.859 A Ipk min: 15.938 A



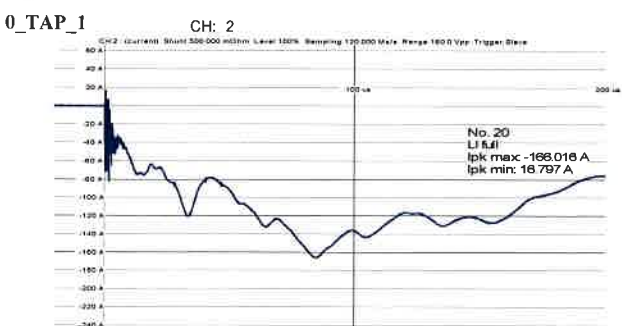
No. 19 LI full Upk: -249.815 kV T1: 4.254 us T2: 43.244 us



No. 19 LI full Ipk max: -165.938 A Ipk min: 20.313 A



No. 20 LI full Upk: -250.300 kV T1: 4.277 us T2: 43.256 us



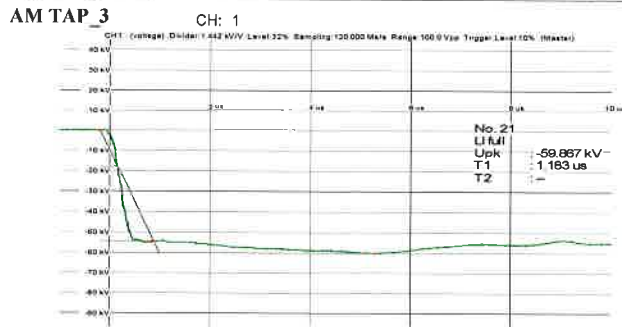
No. 20 LI full Ipk max: -166.016 A Ipk min: 16.797 A

Date:  
02/07/20

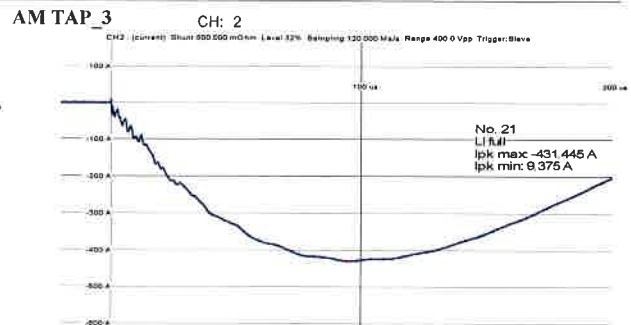
Testing engineer:  
Ing. Čiviš

ETD TRANSFORMÁTORY a.s.  
Technická kontrola a zkušebna

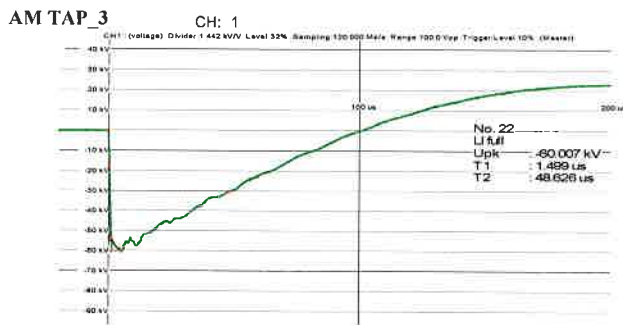
-2-



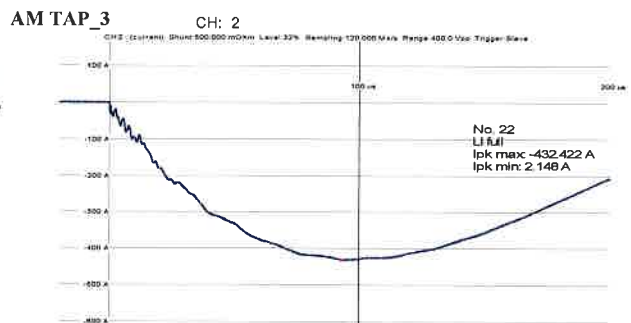
No. 21 LI full Upk: -59.867 kV T1: 1.183 us T2: --



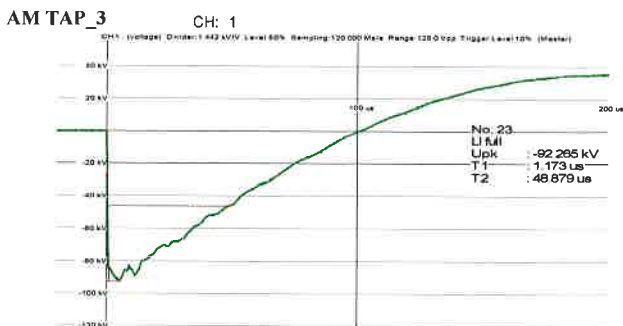
No. 21 LI full Ipk max: -431.445 A Ipk min: 9.375 A



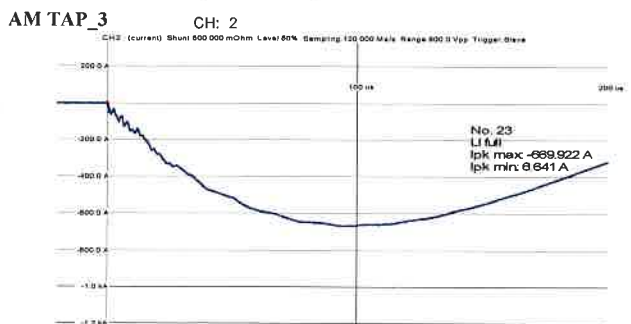
No. 22 LI full Upk: -60.007 kV T1: 1.489 us T2: 48.626 us



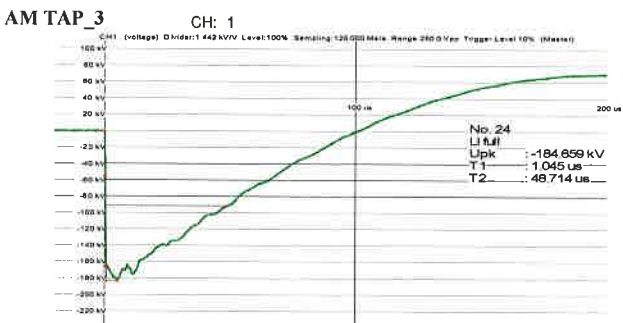
No. 22 LI full Ipk max: -432.422 A Ipk min: 2.148 A



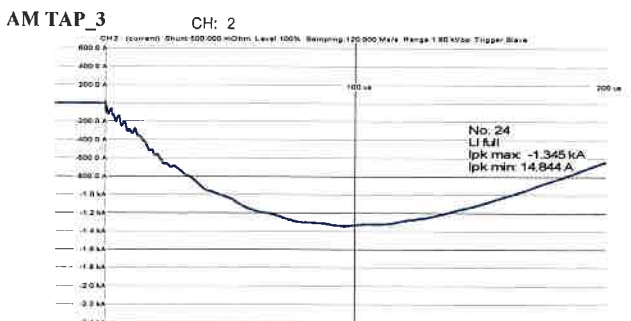
No. 23 LI full Upk: -92.265 kV T1: 1.173 us T2: 48.879 us



No. 23 LI full Ipk max: -669.922 A Ipk min: 6.641 A



No. 24 LI full Upk: -184.659 kV T1: 1.045 us T2: 48.714 us



No. 24 LI full Ipk max: -1.345 kA Ipk min: 14.844 A

Date:  
02/07/20

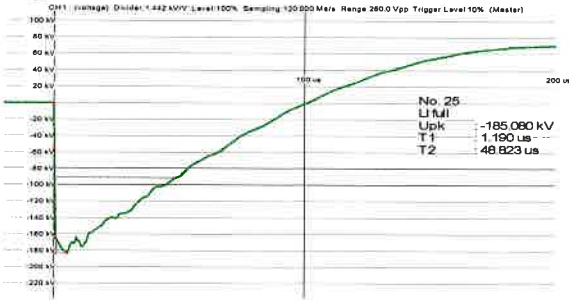
Testing engineer:  
Ing. Čiviš

ETD TRANSFORMÁTORY a.s.  
Technická kontrola a zkušebna

-2-

AM TAP\_3

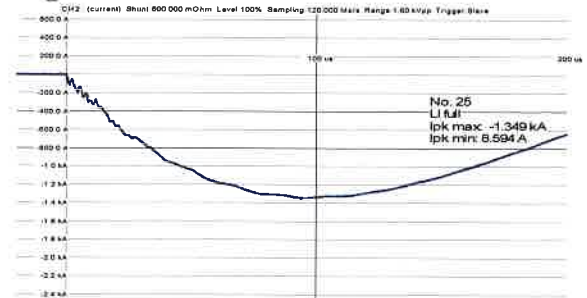
CH: 1



No. 25 LI full Upk: -185.080 kV T1: 1.190 us T2: 48.823 us

AM TAP\_3

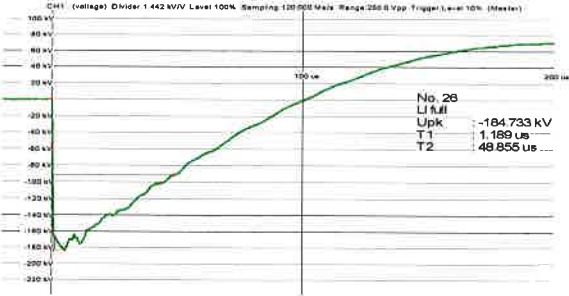
CH: 2



No. 25 LI full Ipk max: -1.349 kA Ipk min: 8.594 A

AM TAP\_3

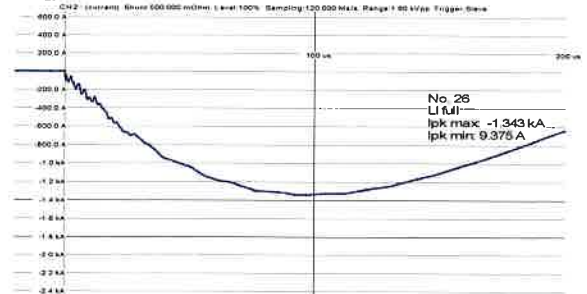
CH: 1



No. 26 LI full Upk: -184.733 kV T1: 1.189 us T2: 48.855 us

AM TAP\_3

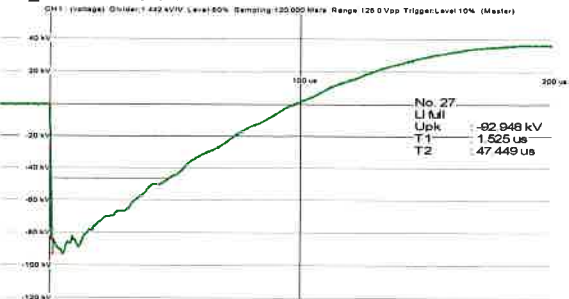
CH: 2



No. 26 LI full Ipk max: -1.343 kA Ipk min: 9.375 A

BM TAP\_5

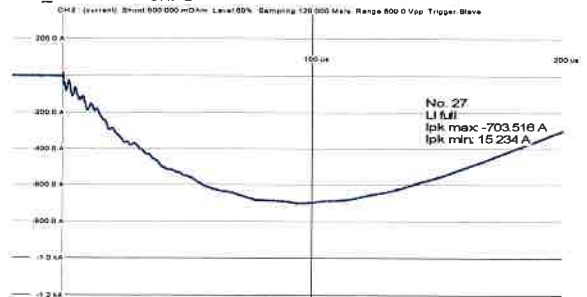
CH: 1



No. 27 LI full Upk: -92.948 kV T1: 1.525 us T2: 47.449 us

BM TAP\_5

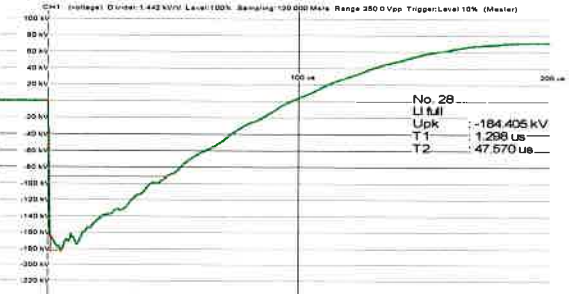
CH: 2



No. 27 LI full Ipk max: -703.516 A Ipk min: 15.234 A

BM TAP\_5

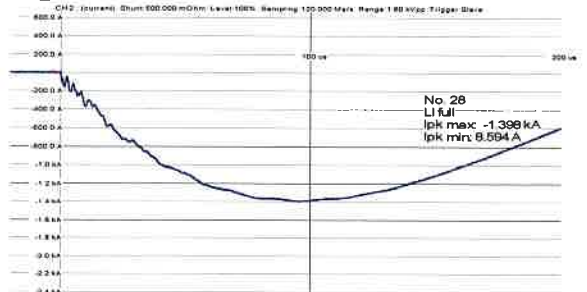
CH: 1



No. 28 LI full Upk: -184.405 kV T1: 1.298 us T2: 47.570 us

BM TAP\_5

CH: 2



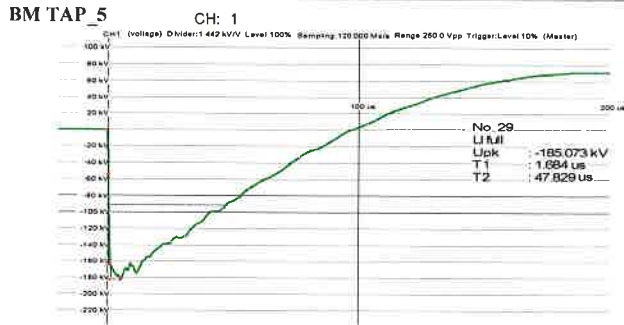
No. 28 LI full Ipk max: -1.398 kA Ipk min: 8.594 A

Date:  
02/07/20

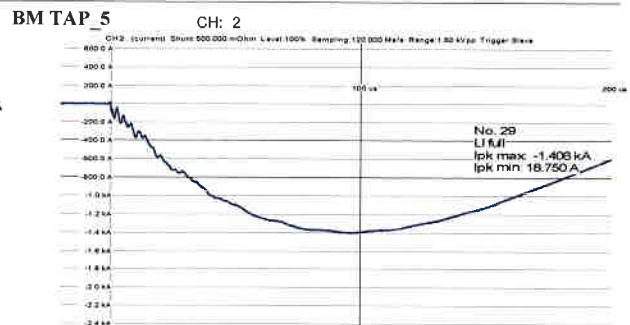
Testing engineer:  
Ing. Čiviš

ETD TRANSFORMÁTORÝ a.s.  
Technická kontrola a zkušebna  
-2-

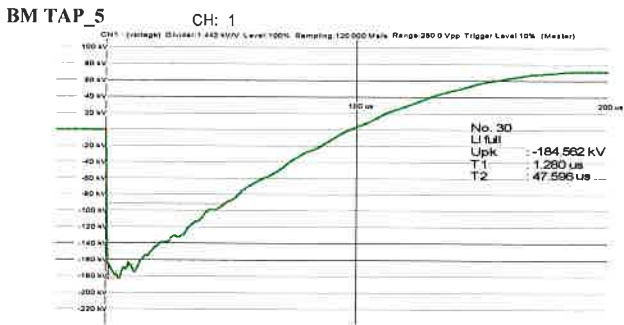




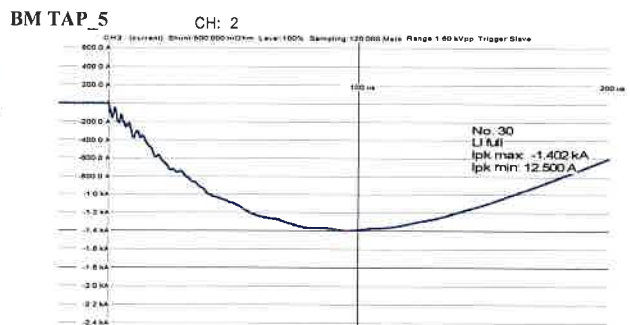
No. 29 LI full Upk: -185.073 kV T1: 1.684 us T2: 47.829 us



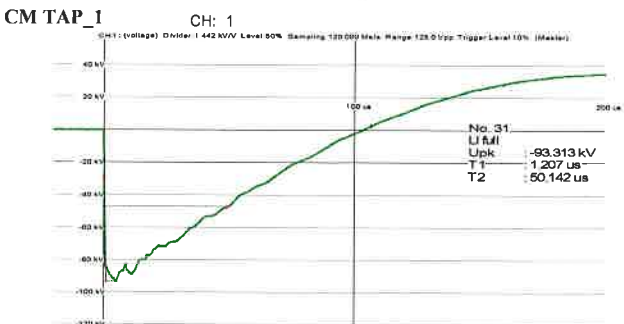
No. 29 LI full Ipk max: -1.406 kA Ipk min: 18.750 A



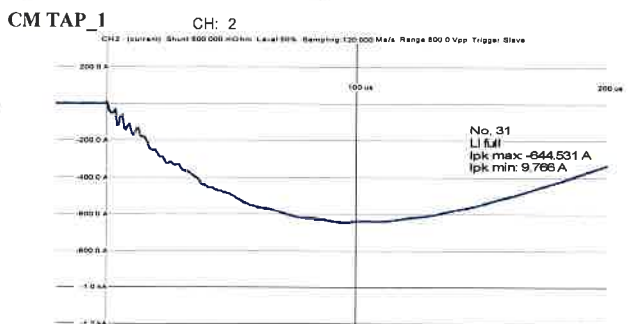
No. 30 LI full Upk: -184.562 kV T1: 1.280 us T2: 47.596 us



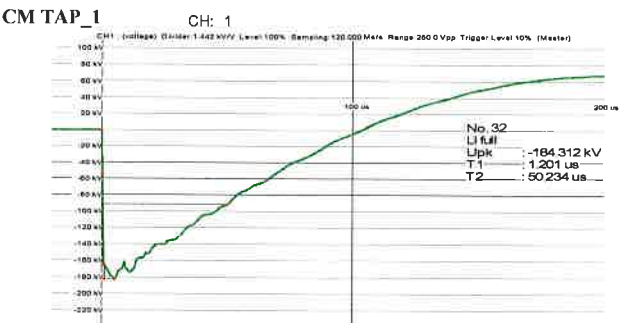
No. 30 LI full Ipk max: -1.402 kA Ipk min: 12.500 A



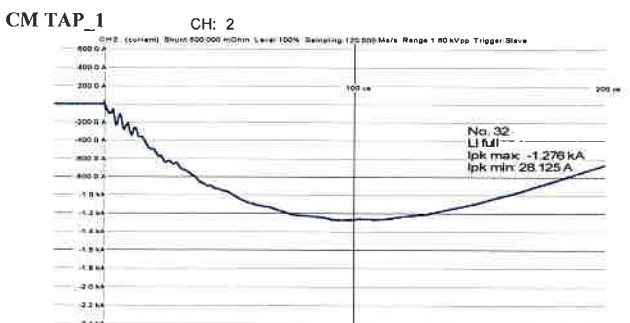
No. 31 LI full Upk: -93.313 kV T1: 1.207 us T2: 50.142 us



No. 31 LI full Ipk max: -644.531 A Ipk min: 9.766 A



No. 32 LI full Upk: -184.312 kV T1: 1.201 us T2: 50.234 us

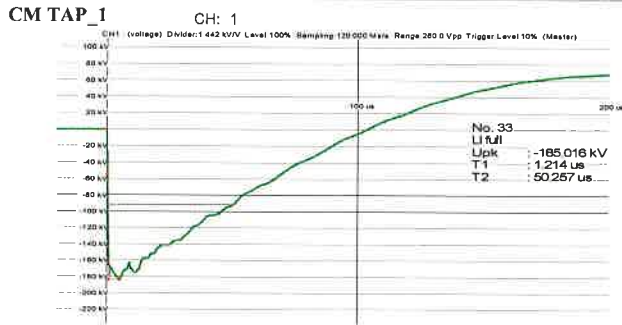


No. 32 LI full Ipk max: -1.276 kA Ipk min: 28.125 A

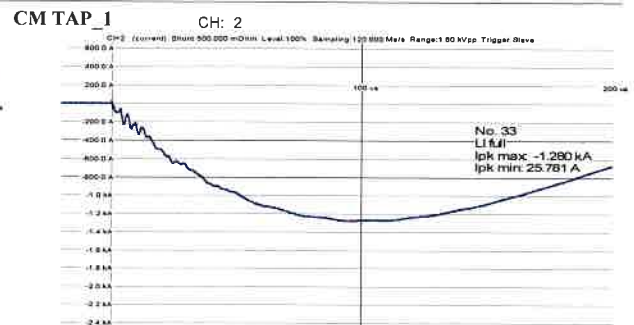
Date:  
02/07/20

Testing engineer:  
Ing. Čiviš

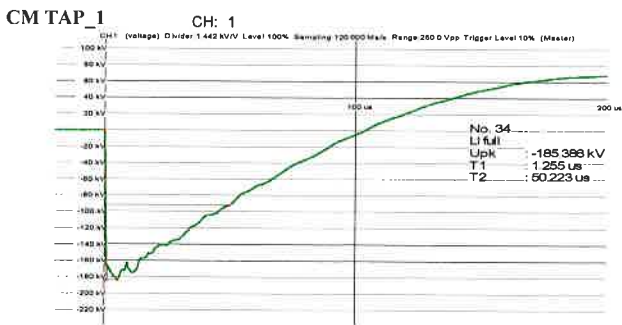
ETD TRANSFORMÁTORÝ a.s.  
Technická kontrola a zkušebna



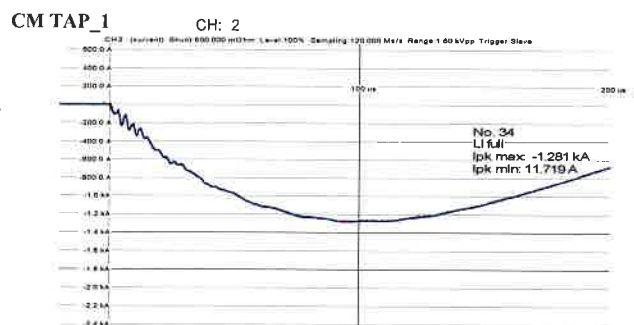
No. 33 LI full Upk: -185.016 kV T1: 1.214 us T2: 50.257 us



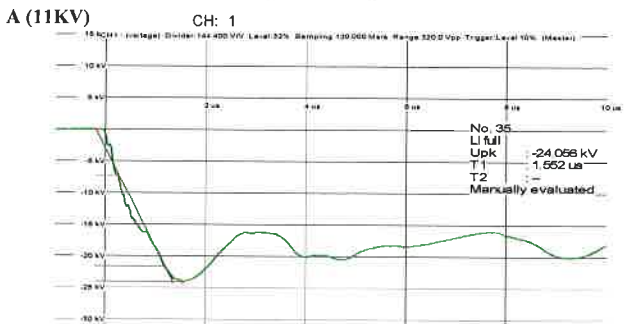
No. 33 LI full Ipk max: -1.280 kA Ipk min: 25.781 A



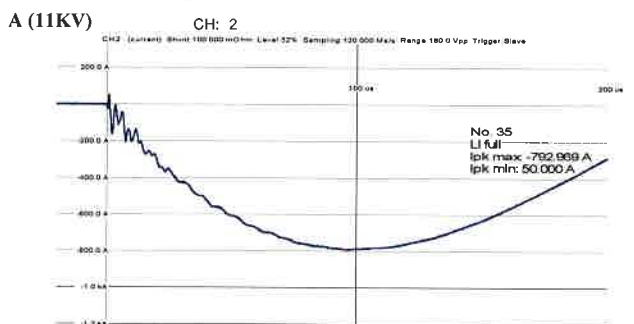
No. 34 LI full Upk: -185.386 kV T1: 1.255 us T2: 50.223 us



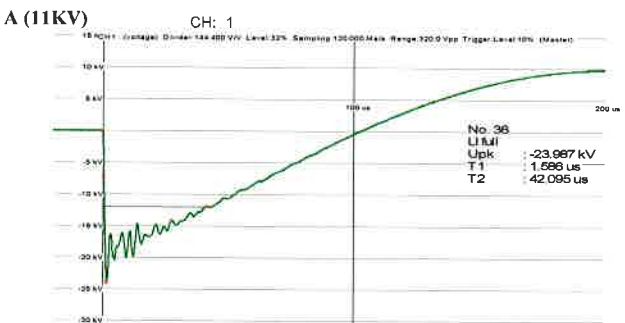
No. 34 LI full Ipk max: -1.281 kA Ipk min: 11.719 A



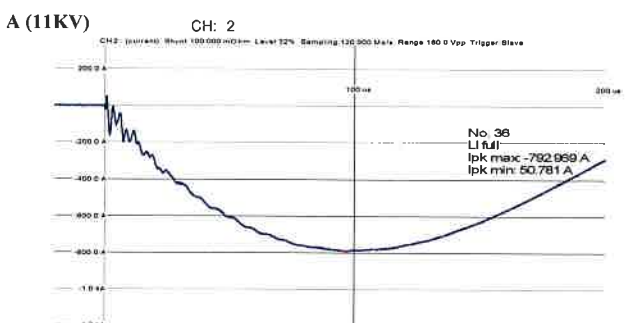
No. 35 LI full Upk: -24.056 kV T1: 1.552 us T2: -- Manually evaluated



No. 35 LI full Ipk max: -792.969 A Ipk min: 50.000 A



No. 36 LI full Upk: -23.987 kV T1: 1.586 us T2: 42.095 us



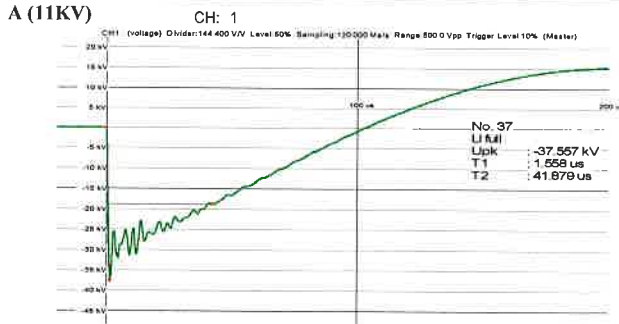
No. 36 LI full Ipk max: -792.969 A Ipk min: 50.781 A

Date:  
02/07/20

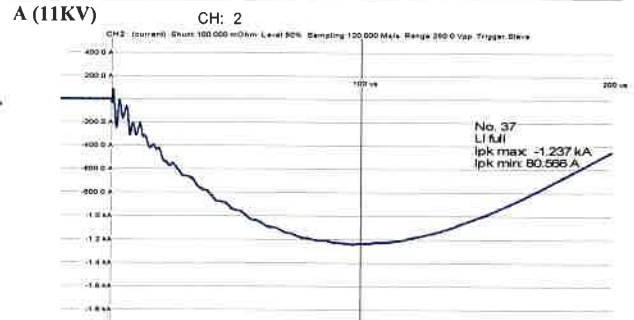
Testing engineer:  
Ing. Čiviš

ETD TRANSFORMÁTORÝ a.s.  
Technická kontrola a zkušebna

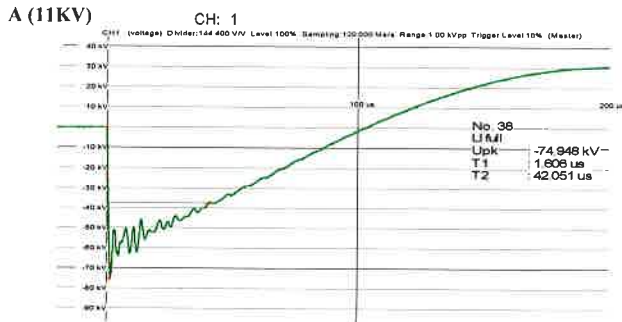
-2-



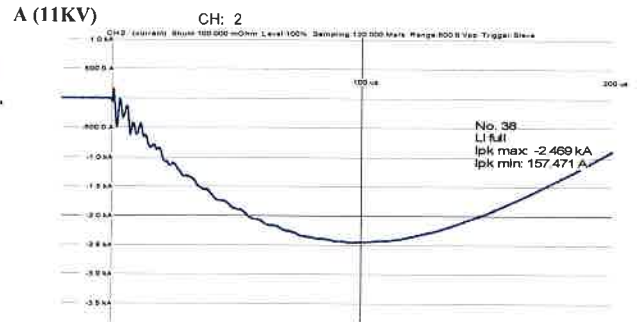
No. 37 LI full Upk: -37.567 kV T1: 1.558 us T2: 41.879 us



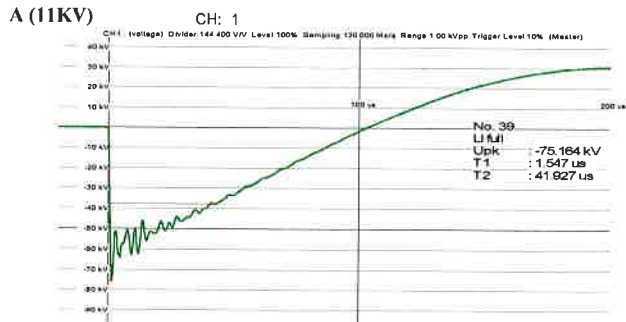
No. 37 LI full Ipk max: -1.237 kA Ipk min: 80.566 A



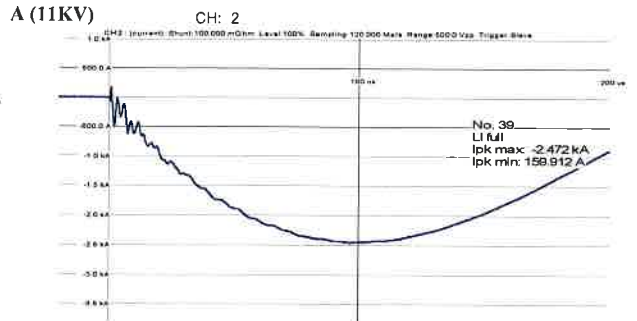
No. 38 LI full Upk: -74.948 kV T1: 1.606 us T2: 42.051 us



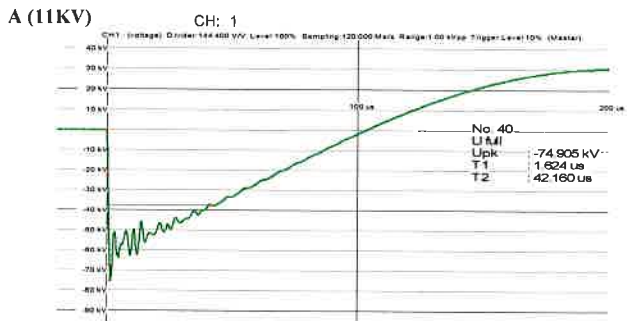
No. 38 LI full Ipk max: -2.469 kA Ipk min: 157.471 A



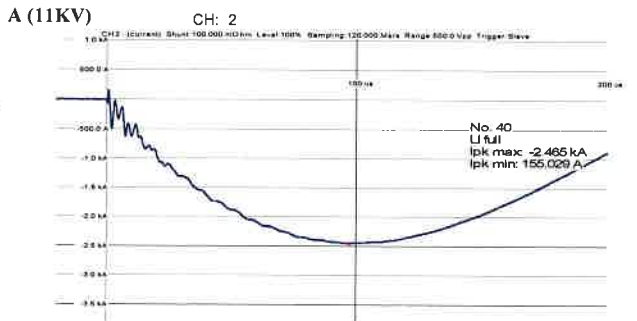
No. 39 LI full Upk: -75.164 kV T1: 1.547 us T2: 41.927 us



No. 39 LI full Ipk max: -2.472 kA Ipk min: 159.912 A



No. 40 LI full Upk: -74.905 kV T1: 1.624 us T2: 42.160 us



No. 40 LI full Ipk max: -2.465 kA Ipk min: 155.029 A

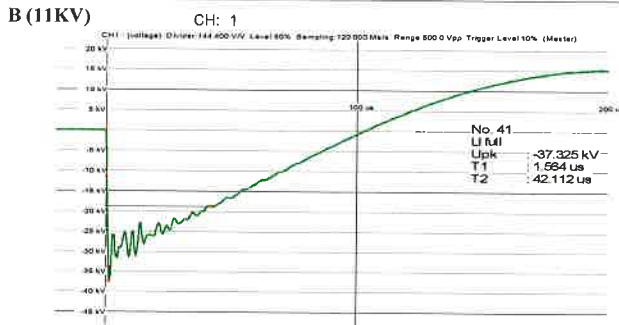
Date:  
02/07/20

Testing engineer:  
Ing. Čiviš

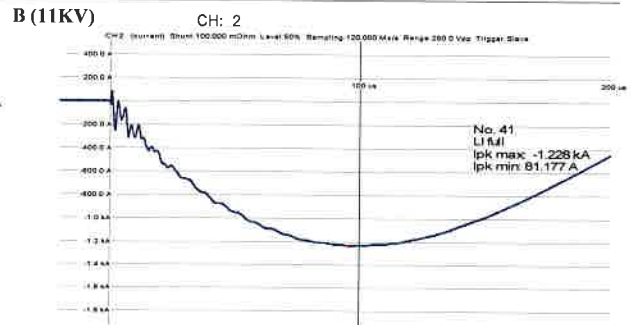
ETD TRANSFORMÁTORÝ a.s.  
Technická kontrola a zkušebna  
-2-



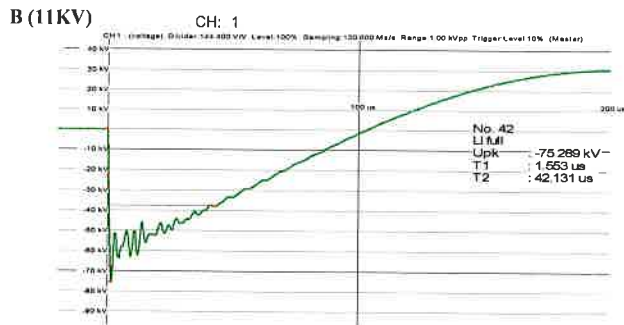
**Enclosure to protocol No. TKZ 20/103A**  
**Lighting impulse test**



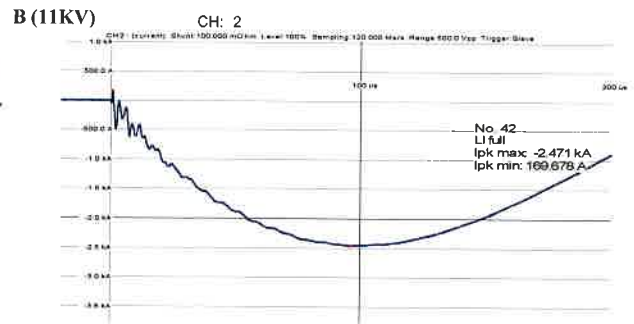
No. 41 LI full Upk: -37.325 kV T1: 1.584 us T2: 42.112 us



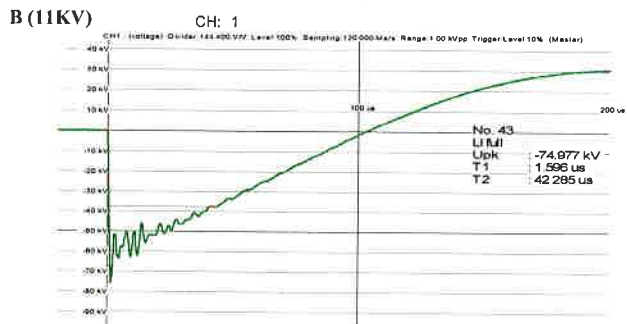
No. 41 LI full Ipk max: -1.228 kA Ipk min: 81.177 A



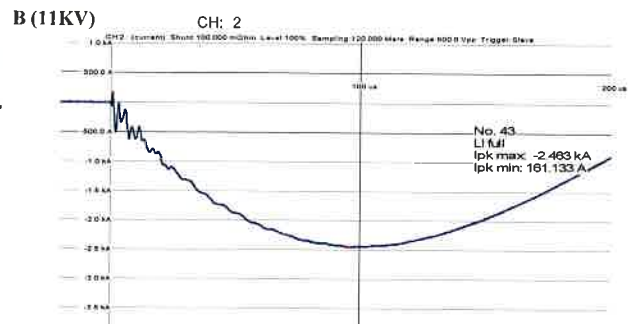
No. 42 LI full Upk: -75.289 kV T1: 1.553 us T2: 42.131 us



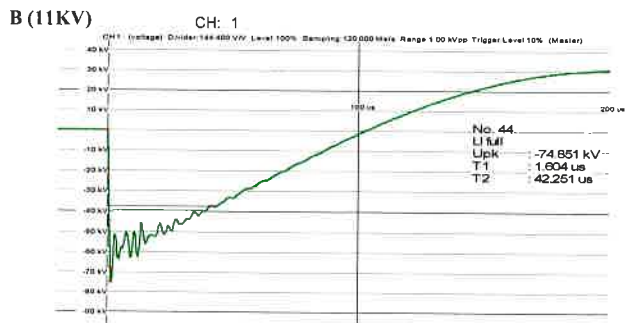
No. 42 LI full Ipk max: -2.471 kA Ipk min: 169.678 A



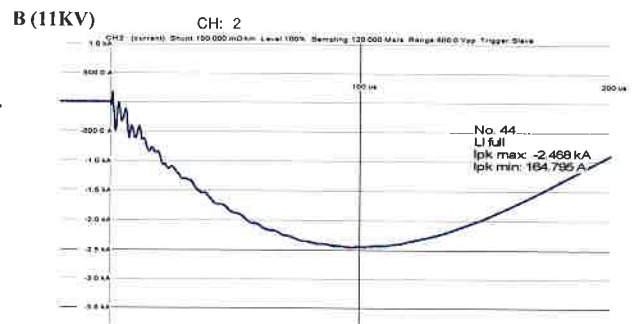
No. 43 LI full Upk: -74.977 kV T1: 1.596 us T2: 42.285 us



No. 43 LI full Ipk max: -2.463 kA Ipk min: 161.133 A



No. 44 LI full Upk: -74.851 kV T1: 1.604 us T2: 42.251 us



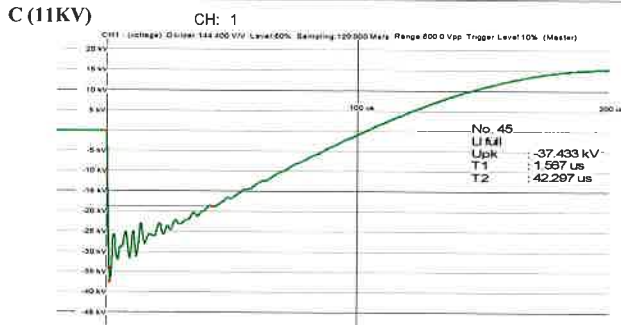
No. 44 LI full Ipk max: -2.468 kA Ipk min: 164.795 A

Date:  
 02/07/20

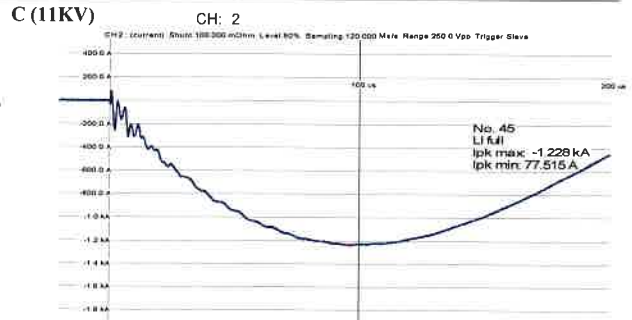
Testing engineer:  
 Ing. Čiviš

**ETD TRANSFORMÁTORY a.s.**  
 Technická kontrola a zkušebna  
 -2-

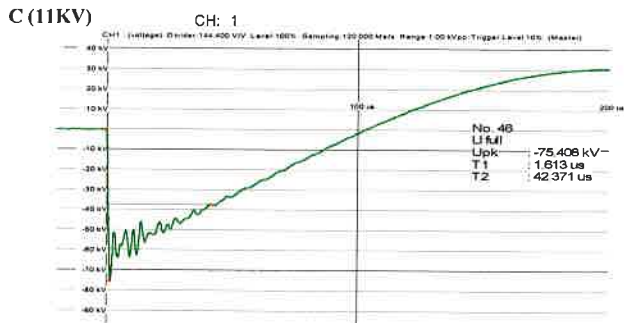
**Enclosure to protocol No. TKZ 20/103A**  
**Lighting impulse test**



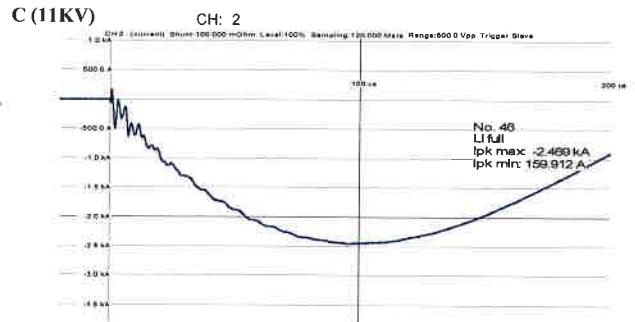
No. 45 LI full Upk: -37.433 kV T1: 1.567 us T2: 42.297 us



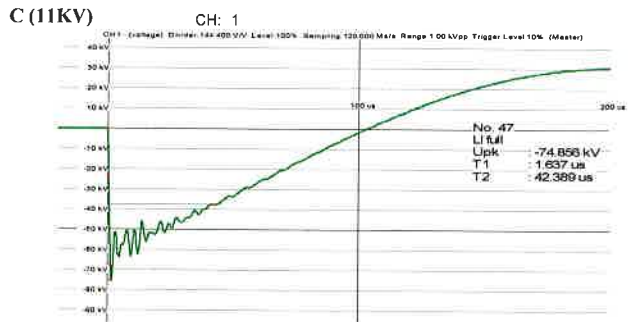
No. 45 LI full Ipk max: -1.228 kA Ipk min: 77.515 A



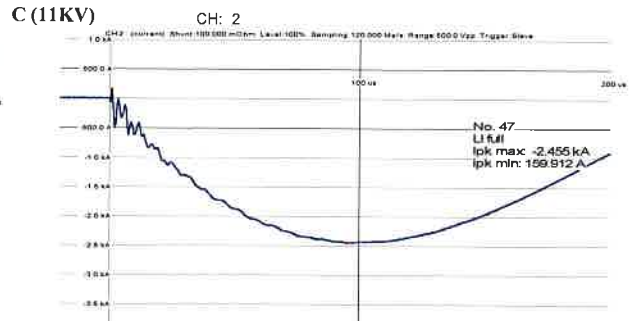
No. 46 LI full Upk: -75.408 kV T1: 1.613 us T2: 42.371 us



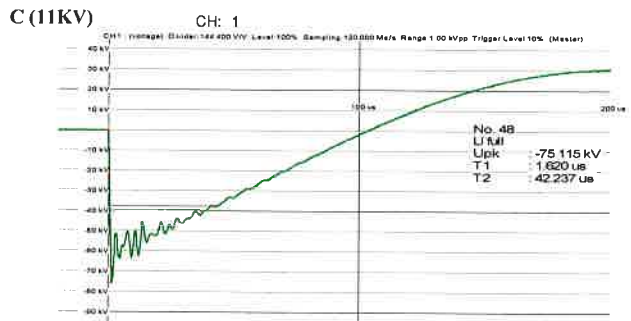
No. 46 LI full Ipk max: -2.469 kA Ipk min: 159.912 A



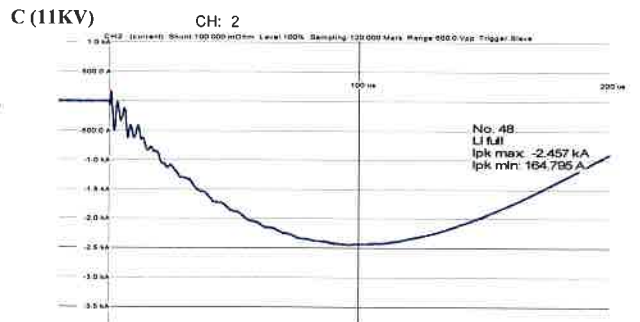
No. 47 LI full Upk: -74.856 kV T1: 1.637 us T2: 42.389 us



No. 47 LI full Ipk max: -2.455 kA Ipk min: 159.912 A



No. 48 LI full Upk: -75.115 kV T1: 1.620 us T2: 42.237 us



No. 48 LI full Ipk max: -2.457 kA Ipk min: 164.795 A

Date:  
 02/07/20

Testing engineer:  
 Ing. Čiviš

**ETD TRANSFORMÁTORY a.s.**  
 Technická kontrola a zkušebna  
 -2-



**ETD TRANSFORMÁTORŮ a.s.**  
**TECHNICKÁ KONTROLA A ZKUŠEBNA**

Zborovská 54/22, Doudlevice, 301 00 Pízeň, Česká republika  
tel.: +420 373 031 402, e-mail: [jakub.langer@etd-bez.cz](mailto:jakub.langer@etd-bez.cz)



Number of pages: 1/10

## Test Certificate

TKZ 20/102A

<b>Purchaser:</b>	<b>JSC „APSVIETIMAS“</b>
<b>Subject of tests:</b>	<b>Power three-phase regulator oil transformer type ETRZ 31 M-0, work No. 0969547</b>
<b>Date of the test:</b>	1st – 2nd July 2020
<b>Internal order No.:</b>	13.00.0048 / 3010000246
<b>Order No.:</b>	ME000110327

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORŮ a.s. This technical document must not be copied, duplicated or otherwise communicated to a third party.

### Test methods:

ČSN EN 60076-10 ed. 2

Power transformers – Part 10: Determination of sound levels

**Test results: listed in the text**

In Pilsen, 2nd July 2020

**ETD TRANSFORMÁTORŮ a.s.**  
Technická kontrola a zkušebna  
-2-

Ing. Jakub Langer  
Head of laboratory

**ETD TRANSFORMÁTORÝ a.s.**Certificate No.:  
TKZ 20/102APage No.: 2  
No. of pages: 10**Test Certificate  
Power Transformer - Determination of Sound Levels**

Work No.: 0969547

Type ETRZ 31 M-0

Manufacturer: ETD TRANSFORMÁTORÝ a.s.

Purchaser:	JSC „APSVIETIMAS“	Internal order No.:	13.00.0048 3010000246
Order No.:	ME000110327	Register No.:	ME000110327

**Technical data**

Winding:	Output [kVA]:	Voltage [V]:	Current [A]:
1	25 000	115 000 ±9x1.778%	126
2	25 000	38 500 ±2x2.5%	375
3	25 000	11 000	1312

Vector group:	YNyn0d11	Type of cooling:	ONAN/ONAF	Sort of loading:	S1
No. of phases:	3	Rated frequency:	50 Hz	Insulation class:	A

**Contents:**

Technical data .....	2
Method of measurements .....	2
Measuring instruments .....	2
Calibration.....	2
Test evaluation .....	3
Environmental correction.....	3
Layout of measuring points.....	4
Results of measurements.....	5
Charts of measurement.....	9

**Method of measurements**

Standard:	IEC 60076-10		
Method:	Sound pressure level (Ch. 11)	Weighting filter:	A - filter
	Point by point method	Zone:	1/3 octave

**Measuring instruments**

Instrument	Model	Serial number:	Calibration certificate:
Sound Level Meter	NTi Audio XL2	A2A-08124-EO	6035-KL-Z0013-20
Microphone	M2230	9106	
Acoustic calibrator	CAL200	10693	6035-KL-K0056-18

**Calibration**

Sound Level Meter is checked before and after each measurement using acoustic calibrator  
Acoustic calibrator, sound level meter and microphone are calibrated once every three years approved external organizations

Date:	Tested by:	Approved:	<b>ETD TRANSFORMÁTORÝ a.s.</b> Technická kontrola a zkušebna -2-
2nd July 2020	 Ing. Windrich Ing. Lexa	 Ing. Langer	

TR0007/02/RJ

**Test Certificate**  
**Power Transformer - Determination of Sound Levels**

Work No.: 0969547

Type ETRZ 31 M-0

Manufacturer: ETD TRANSFORMÁTORÝ a.s.

**Test evaluation**

1) Load operation  $I_k = 100\% I_n$  – without fans (ONAN) - measurement at 0.3 m from the principal radiation surface:

- Corrected average sound pressure level –  $L_{pA} = 47 \text{ dB(A)}$
- Sound power level –  $L_{WA} = 65 \text{ dB(A)}$

2) No-load operation  $U = 100\% U_n$  – without fans (ONAN) - measurement at 0.3 m from the principal radiation surface:

- Corrected average sound pressure level –  $L_{pA} = 57 \text{ dB(A)}$
- Sound power level –  $L_{WA} = 74 \text{ dB(A)}$

3) No-load operation  $U = 100\% U_n$  – fans on (ONAF) - measurement at 2.0 m from the principal radiation surface:

- Corrected average sound pressure level –  $L_{pA} = 55 \text{ dB(A)}$
- Sound power level –  $L_{WA} = 77 \text{ dB(A)}$

4) Calculated final acoustic level ONAN - sum of acoustic components 1) and 2):

- Sound power level -  $L_{WA} = 75 \text{ dB(A)}$
- Sound pressure level at the measuring distance of 0.3 m -  $L_{pA} = 57 \text{ dB(A)}$

5) Calculated final acoustic level ONAF - sum of acoustic components 1) and 3):

- Sound power level -  $L_{WA} = 77 \text{ dB(A)}$
- Sound pressure level at the measuring distance of 2.0 m -  $L_{pA} = 56 \text{ dB(A)}$

Guaranteed sound pressure level  $L_{pA}$  ONAN(0.3 m)  $\leq 60 \text{ dB(A)}$  tolerance + 3 dB(A)

Guaranteed sound pressure level  $L_{pA}$  ONAF(2.0 m)  $\leq 65 \text{ dB(A)}$  tolerance + 3 dB(A)

**The test results are positive.**

**Environmental correction**

Length of the test room - $l_r$	152.2 [m]
Width of the test room - $w_r$	24.1 [m]
Height of the test room - $h_r$	22.0 [m]
Total area of the surface of the test room - $S_v$	15086.3 [m <sup>2</sup> ]
Acoustic absorption coefficient - $\alpha$	0.2
Sound absorption area - $A$	3017.3 [m <sup>2</sup> ]
Height of the transformer tank - $h$	2.95 [m]
Measuring distance – $d_1, d_2$	0.3[m] 2.0 [m]
Length of the measuring contour - $l_{m1}, l_{m2}$	16.8[m] 26.8 [m]
Area of the measuring surface – $S_1, S_2$	54.6[m <sup>2</sup> ] 132.7 [m <sup>2</sup> ]

The height of the transformer tank is higher than 2.5 m → two measuring level in 1/3 and 2/3 height of transformer tank.

Date:  2nd July 2020	Tested by:  Ing. Windrich Ing. Lexa	Approved:  Ing. Langer	<b>ETD TRANSFORMÁTORÝ a.s.</b> Technická kontrola a zkušebna -2-
----------------------------	---	---	--

## Test Certificate

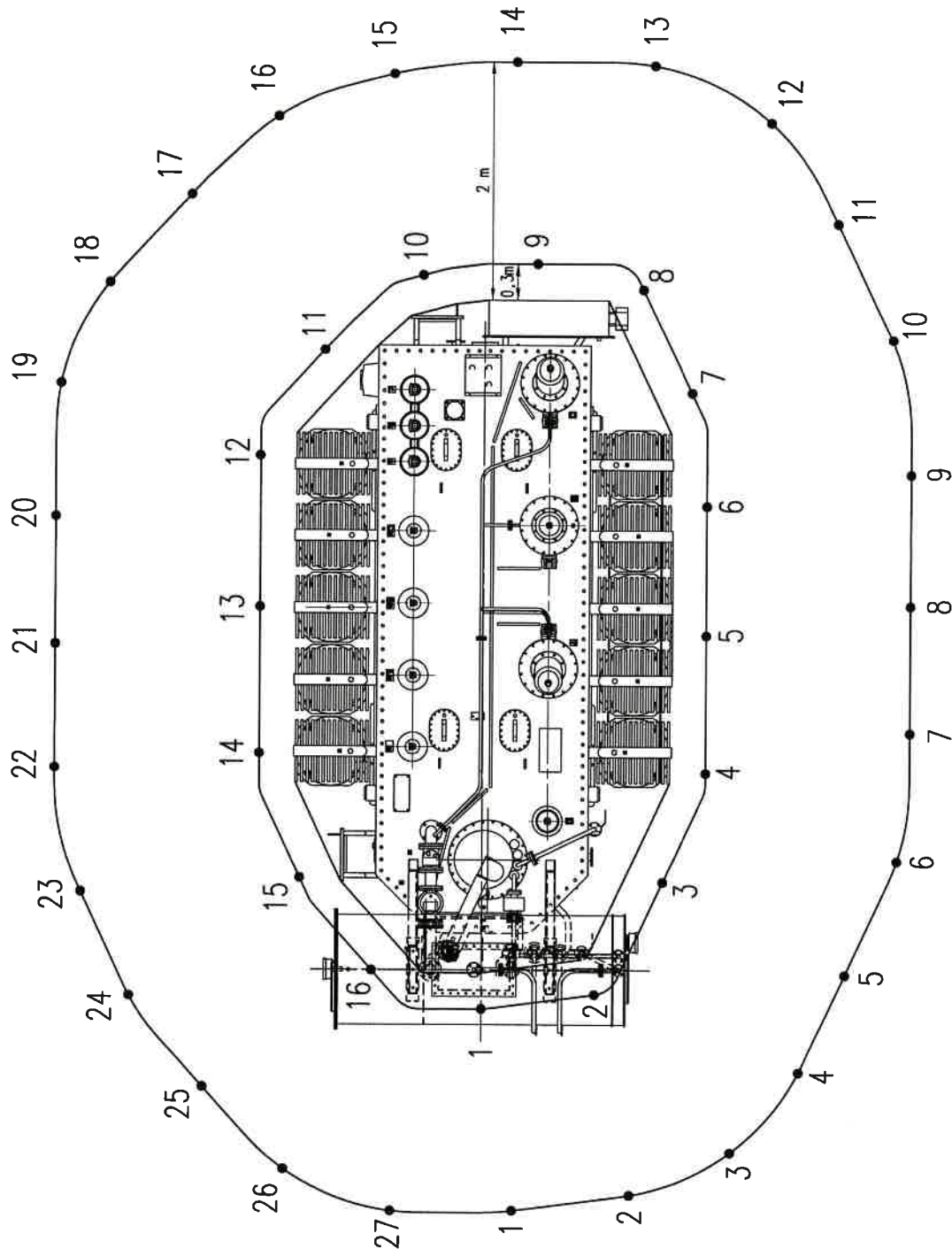
### Power Transformer - Determination of Sound Levels

Work No.: 0969547

Type ETRZ 31 M-0


Manufacturer: ETD TRANSFORMÁTORÝ a.s.

#### Layout of measuring points



All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORÝ a.s. This technical document must not be copied, duplicated nor otherwise communicated to a third party

Date:  2nd July 2020	Tested by:  Ing. Windrich Ing. Lexa	Approved:  Ing. Langer	<b style="color: red;">ETD TRANSFORMÁTORÝ a.s.</b> Technická kontrola a zkušebna -2-
----------------------------	--	------------------------------	--

	<b>ETD TRANSFORMÁTORÝ a.s.</b>	Certificate No.: TKZ 20/102A	Page No.: 5 No. of pages: 10
<b>Test Certificate</b>			
<b>Power Transformer - Determination of Sound Levels</b>			
Work No.: 0969547	Type ETRZ 31 M-0	Manufacturer: ETD TRANSFORMÁTORÝ a.s.	

### Results of measurements

1) Noise of the background - measurement at 0.3 m from the principal radiation surface:


Sound pressure level of the background noise $L_{pAi}$ dB(A)				
meas. point No.	beginning of the test		end of the test	
	height No.1	height No.2	height No.1	height No.2
1	42.6	42.7	42.3	42.0
4	42.7	41.7	42.0	41.6
7	43.1	41.5	42.0	42.0
10	41.4	41.0	42.2	42.2
13	43.6	41.6	43.5	41.9
$\overline{L}_{bgA}$	42.6 dB(A)		41.8 dB(A)	

2) Noise of the background - measurement at 2.0 m from the principal radiation surface:

Sound pressure level of the background noise $L_{pAi}$ dB(A)				
meas. point No.	beginning of the test		end of the test	
	height No.1	height No.2	height No.1	height No.2
1	42.2	41.5	42.4	41.6
6	41.3	41.8	42.5	41.6
11	42.4	42.8	42.9	41.6
16	41.9	41.0	41.8	41.3
21	41.5	41.4	41.8	40.9
$\overline{L}_{bgA}$	42.1 dB(A)		41.6 dB(A)	

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORÝ a.s. This technical document must not be copied, duplicated nor otherwise communicated to a third party

Date:  2nd July 2020	Tested by:  Ing. Windrich Ing. Lexa	Approved:  Ing. Langer	<b>ETD TRANSFORMÁTORÝ a.s.</b> Technická kontrola a zkušebna -2-
----------------------------	---	---	--



	<b>ETD TRANSFORMÁTORÝ a.s.</b>	Certificate No.: TKZ 20/102A	Page No.: No. of pages: 6 10
<b>Test Certificate</b>			
<b>Power Transformer - Determination of Sound Levels</b>			
Work No.: 0969547	Type ETRZ 31 M-0	Manufacturer: ETD TRANSFORMÁTORÝ a.s.	

3) Load operation  $I_k = 100\% I_n$  - without fans (ONAN) - measurement at 0.3 m from the principal radiation surface:

Sound pressure level $L_{pAi}$ dB(A)					
meas. point No.	height No.1	height No.2	meas. point No.	height No.1	height No.2
1	47.2	45.9	9	46.8	46.9
2	43.4	47.3	10	48.8	47.0
3	45.0	46.3	11	45.3	49.9
4	57.7	49.3	12	47.2	48.7
5	49.7	49.1	13	48.5	44.7
6	51.4	47.1	14	48.7	45.4
7	48.2	48.6	15	47.1	47.1
8	44.1	46.3	16	45.3	46.0
$\overline{L_{pA0}}$ - uncorrected average sound pressure level				<b>48.7 dB(A)</b>	

$\overline{L_{pA0}} - \max \overline{L_{bgA}}$	6.1 dB(A)
Initial $\overline{L_{bgA}}$ - final $\overline{L_{bgA}}$	0.7 dB(A)
Environmental correction K	0.3 dB(A)
<b>Corrected average A-weighted sound pressure level <math>\overline{L_{pA}}</math></b>	<b>47.3 dB(A)</b>
<b>A - weighted sound power level <math>L_{WA}</math></b>	<b>64.7 dB(A)</b>
$\overline{L_{pA0}} - \max \overline{L_{bgA}}$ - value is lower than 8 dB(A) but higher than 3 dB(A) while value initial $\overline{L_{bgA}}$ - final $\overline{L_{bgA}}$ is lower than 3dB(A) - <b>test can be accepted</b>	

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORÝ a.s. This technical document must not be copied, duplicated nor otherwise communicated to a third party

Date:  2nd July 2020	Tested by:  Ing. Windrich Ing. Lexa	Approved:  Ing. Langer	<b>ETD TRANSFORMÁTORÝ a.s.</b> Technická kontrola a zkušebna -2-
----------------------------	---	---	--



**Test Certificate**  
**Power Transformer - Determination of Sound Levels**

Work No.: 0969547

Type ETRZ 31 M-0



Manufacturer: ETD TRANSFORMÁTORÝ a.s.

4) No-load operation  $U = 100\% U_n$  – without fans (ONAN) – measurement at 0.3 m from the principal radiation surface:

Sound pressure level $L_{pAi}$ dB(A)					
meas. point No.	height No.1	height No.2	meas. point No.	height No.1	height No.2
1	55.0	58.6	9	52.0	55.3
2	55.7	54.4	10	57.5	58.6
3	58.4	56.8	11	58.9	61.8
4	62.2	54.5	12	55.6	51.0
5	53.1	50.4	13	53.5	49.9
6	57.7	50.7	14	57.3	55.5
7	51.8	54.2	15	62.3	60.8
8	61.0	59.7	16	53.9	50.5
$\overline{L}_{pA0}$ – uncorrected average sound pressure level				<b>57.4 dB(A)</b>	

$\overline{L}_{pA0} - \max \overline{L}_{bgA}$	14.8 dB(A)
Initial $\overline{L}_{bgA}$ - final $\overline{L}_{bgA}$	0.7 dB(A)
Environmental correction K	0.3 dB(A)
<b>Corrected average sound pressure level <math>\overline{L}_{pA}</math></b>	<b>56.9 dB(A)</b>
<b>Sound power level <math>L_{WA}</math></b>	<b>74.3 dB(A)</b>
$\overline{L}_{pA0} - \max \overline{L}_{bgA}$ - measured value is above 8 dB – test can be accepted	

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORÝ a.s. This technical document must not be copied, duplicated nor otherwise communicated to a third party

Date:  2nd July 2020	Tested by:  Ing. Windrich Ing. Lexa	Approved:  Ing. Langer	<b>ETD TRANSFORMÁTORÝ a.s.</b> Technická kontrola a zkušebna -2-
----------------------------	---	---	--

**Test Certificate**  
**Power Transformer - Determination of Sound Levels**

Work No.: 0969547

Type ETRZ 31 M-0

Manufacturer: ETD TRANSFORMÁTORÝ a.s.

5) No-load operation  $U = 100\% U_n$  – fans on (ONAF) - measurement at 2.0 m from the principal radiation surface:

Sound pressure level $L_{pAi}$ dB(A)					
meas. point No.	height No.1	height No.2	meas. point No.	height No.1	height No.2
1	52.5	54.7	15	59.8	55.9
2	52.9	51.9	16	54.3	53.6
3	53.1	52.4	17	58.7	57.9
4	55.0	57.0	18	56.9	58.6
5	54.2	55.3	19	56.4	54.3
6	56.7	56.7	20	54.2	55.3
7	56.1	58.6	21	54.2	54.8
8	55.9	57.8	22	54.6	55.3
9	54.4	54.1	23	59.5	59.8
10	55.2	54.6	24	55.6	56.2
11	53.7	56.8	25	54.7	53.6
12	58.8	58.3	26	53.2	55.1
13	57.3	54.9	27	53.5	53.8
14	60.0	55.2			
$\overline{L}_{pA0}$ – uncorrected average sound pressure level				<b>56.1 dB(A)</b>	

$\overline{L}_{pA0} - \max \overline{L}_{bgA}$	14.0 dB(A)
Initial $\overline{L}_{bgA}$ - final $\overline{L}_{bgA}$	0.5 dB(A)
Environmental correction K	0.7 dB(A)
<b>Corrected average sound pressure level <math>\overline{L}_{pA}</math></b>	<b>55.3 dB(A)</b>
<b>Sound power level <math>L_{WA}</math></b>	<b>76.5 dB(A)</b>
$\overline{L}_{pA0} - \max \overline{L}_{bgA}$ - measured value is above 8 dB – test can be accepted	

All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORÝ a.s. This technical document must not be copied, duplicated nor otherwise communicated to a third party

Date:  2nd July 2020	Tested by:  Ing. Windrich Ing. Lexa	Approved:  Ing. Langer	<b>ETD TRANSFORMÁTORÝ a.s.</b> Technická kontrola a zkušebna -2-
----------------------------	---	---	--

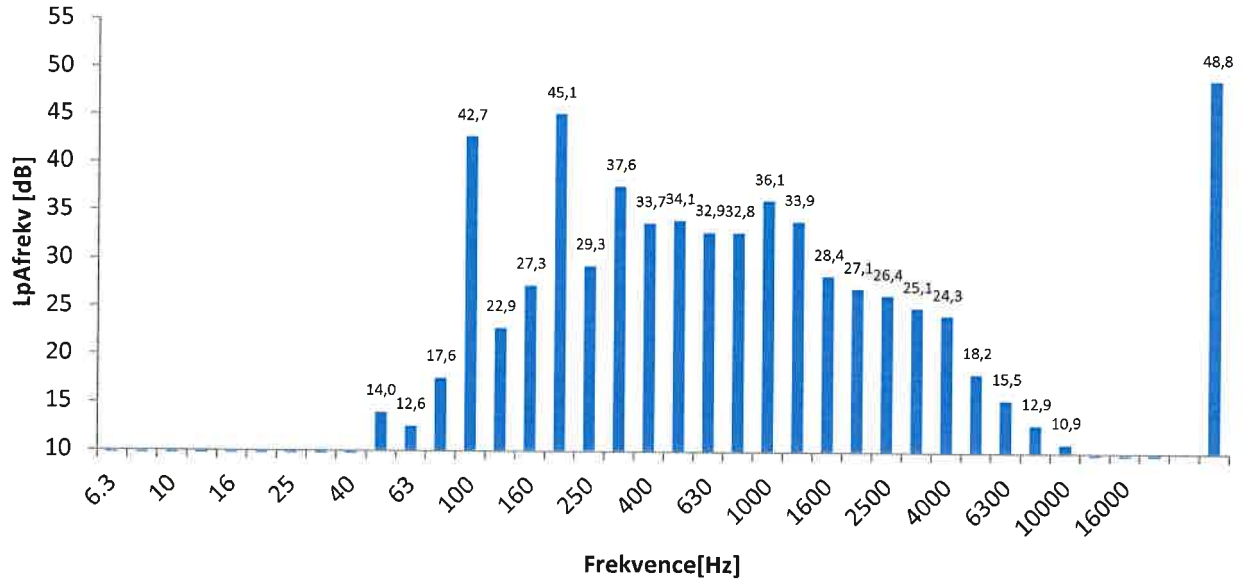
### Test Certificate

#### Power Transformer - Determination of Sound Levels

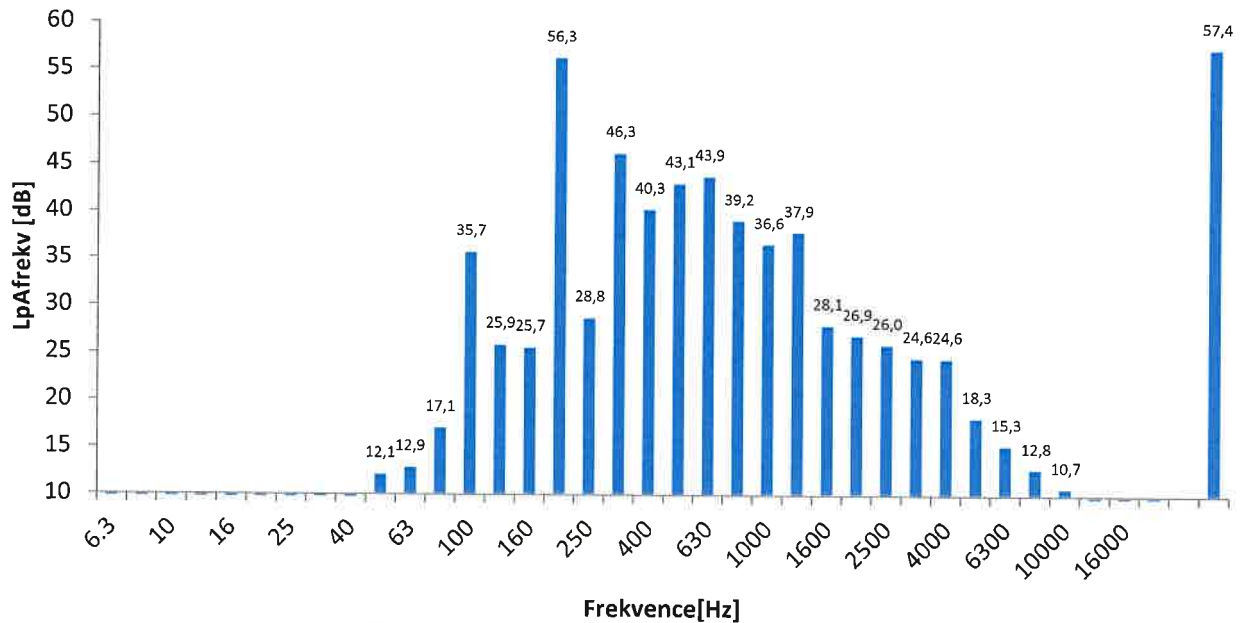
Work No.: 0969547	Type ETRZ 31 M-0	Manufacturer: ETD TRANSFORMÁTORÝ a.s.
-------------------	------------------	---------------------------------------

### Charts of measurement

Mean pressure spectrum  $L_{pA0}$   $I_k = 100\% I_n$  - without fans (ONAN)



Mean pressure spectrum  $L_{pA0}$   $U = 100\% U_n$  - without fans (ONAN)



All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORÝ a.s. This technical document must not be copied, duplicated nor otherwise communicated to a third party

Date:  2nd July 2020	Tested by:  Ing. Windrich Ing. Lexa	Approved:  Ing. Langer	<b>ETD TRANSFORMÁTORÝ a.s</b> Technická kontrola a zkušebna -2-
----------------------------	--	------------------------------	---

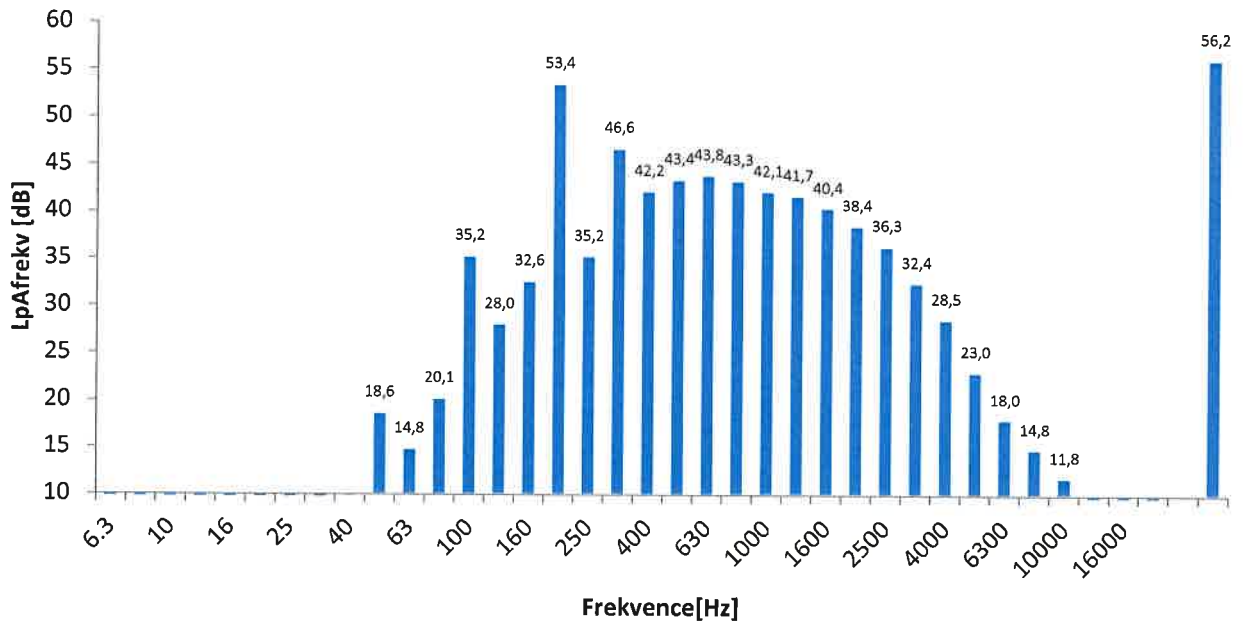
**Test Certificate**  
**Power Transformer - Determination of Sound Levels**

Work No.: 0969547

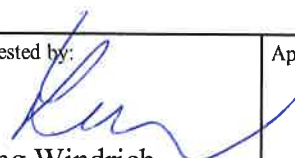

Type ETRZ 31 M-0

Manufacturer: ETD TRANSFORMÁTORÝ a.s.

**Mean pressure spectrum  $L_{pA0}$   $U = 100\% U_n$  – fans on (ONAF)**



All rights to this technical document belong exclusively to the Company ETD TRANSFORMÁTORÝ a.s. This technical document must not be copied, duplicated nor otherwise communicated to a third party

Date:  2nd July 2020	Tested by:  Ing. Windrich Ing. Lexa	Approved:  Ing. Langer	ETD TRANSFORMÁTORÝ a.s. Technická kontrola a zkušebna -2-
----------------------------	---	---	---



**ORGREZ, a.s. Electrical Engineering Laboratory Division**  
**Testing laboratory E01**

Vítkova 17, Prague 8 - Karlín, 18600, Czech republic  
Phone: +420 222314320 E-mail: [laborg@orgrez.cz](mailto:laborg@orgrez.cz)



**Testing laboratory No. 1179.2 – accredited by CAI according to ČSN EN ISO/IEC 17025:2018**

# TEST REPORT

**709/2020-O**

Customer: ETD TRANSFORMÁTORŮ a.s.  
Zborovská 22/54  
301 00 Plzeň

Tested object: JSC "APSVIETIMAS", Litva  
Serial number: 0969547  
Equipment: power transformer  
Operating condition: new equipment

Type: RTRZ31M-O  
Manufacturer: ETD Transformátory a.s.  
Year of manufacture: 2020  
Voltage: 115/38.5 kV  
Rating: 25 MVA  
Insulating liquid: Nytro Lyra X  
Weight of filling: 12 200 kg

Made by: Ing. Lenka Košanová




Date of issue: 03/07/2020

Issued: Ing. Lenka Košanová  
Vice-head for chemistry

Annotation: †N - non-accredited test.

Page No.: 1 / 3

This test report must not be reproduced in other way than as a whole without a prior written consent of the testing laboratory. The measurement results relate only to the tested object and do not replace other documentation.

	<b>ORGREZ, a.s.</b> <b>High Voltage laboratory E01</b> Vítkova 17 Prague 8 - Karlín, 18600, Czech republic	Number of pages: 3 Page No.: 2
---	---	-----------------------------------

## Used instruments and equipment, uncertainty

### INSULATING OIL ANALYSIS

Test Report Number: 709/2020-O

*Measured by*

**Laboratory Conditions:**

*Šimon Kotek*

- 1) Digital thermometer, hygrometer and barometer, Serial. No: 34901952, type GFTB200, manufacturer GREISINGER electronic GmbH, y.m. 2009.

**Acidity:**

*Šimon Kotek, Petra Jermářová*

- 1) Analytic Balances, Serial. No: K9300294, type Helago, HM 202, manufacturer A&D Instruments Ltd..
- 2) Balances, Serial. No: 8790, type MC1, LC 202S, manufacturer Sartorius.
- 3) Dosino 800, Serial. No: 1800002004270, type Dosino 800, manufacturer Metrohm, y.m. 2012.
- 4) Stirrer 801, Serial. No: 1801001050462, type Stirrer 801, manufacturer Metrohm, y.m. 2012.
- 5) 916 Ti - Touch, Serial. No: 1916001005258, type 916 Ti - Touch, manufacturer Metrohm, y.m. 2012.

*Expanded uncertainty:  $\pm 15\%$  of rdg..*

**Antioxidant Content:**

*Šimon Kotek, Petra Jermářová*

- 1) Infrared Spectrometer, Serial. No: 469, type M 500, manufacturer Buck Scientific Inc..

*The reported expanded uncertainty is stated as the standard uncertainty multiplied by  $k=2$ , and has been determined according to EA4/16. The coverage factor  $k=2$  for a normal distribution corresponds to a coverage probability of approximately 95%.  
rdg. ... reading value.*



**ORGREZ, a.s.**  
**High Voltage laboratory E01**  
Vitkova 17  
Prague 8 - Karlín, 18600, Czech republic

Number of pages: 3  
Page No.: 3

## Insulating Oil Analysis

Test Report Number: 709/2020-O (Serial No.: 0969547)  
Place of sampling: transformer tank, bottom  
Oil temperature: 30°C / 25°C (dry) - top / bottom layer of oil  
Insulating liquid: Nytro Lyra X  
Oil colour: transparent  
Date of sampling: 02/07/2020 (sampling carried by a third party)  
Date of delivery: 03/07/2020  
Date of testing: 03/07/2020

Temperature in lab:	26°C	Relative air humidity in lab:	46%
---------------------	------	-------------------------------	-----

Test	Unit	Standard	Result
Acidity	mg KOH/g	SOP 2-14/72 (ČSN EN 62021-1; ZM-12)	0.001
Antioxidant content	%w.	SOP 2-16/72 (ČSN EN 60666, ZM-15) †N	0.39

– END OF TEST REPORT –