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INSPECTION REPORT

CONFIDENTIAL APPROVED B4020696

Client	SHENDA ELECTRIC GROUP CO.,LTD No.17, Huatong Road, Jiangshan Economical Development Zone, Zhejiang Province, China
Subject	Witness to type, special and routine tests on Power Transformer Type SFZ-100000/220, Serial Number 120514-1
Place and date of inspection	STRI-CTQC Laboratory, No. 18 Building, Hushitai South Avenue Shenbei New District Shenyang Liaoning Province, P.R. of China From October 10th to October xx, 2012
Order	Agreement (CESI Quotation B4020084)
Notes	-
N. of pages	4 N. of pages annexed 79
Issue date	September 3rd 2014

Prepared	TCE/CER/PRO	Giorgio CRIPPA
Approved	TCE/CER	Fiorenzo BREGANI

CESI S.p.A.
Testing & Certification Division
Business Area Certification
Il Responsabile
Fiorenzo Bregani

Mod. RISP v. 5

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Capitale sociale € 8.550.000 interamente versato
C.F. e numero iscrizione Reg. Imprese di Milano 00793580150
P.I. IT00793580150
N. R.E.A. 429222

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Vs. rif.

Protocollo B4020960 TCE-CER/PRO GC/kz
AE14ISP001, B4020442

Data 5/09/2014

Shenda Electric Group Co., Ltd.
No.17, Huatong Road, Jiangshan Economical Development Zone,
Zhejiang Province, China
Attn Mr. Zheng Jun
Tel: +86 570 4222602

Object: **dispatch documentation**

Dear Sirs

Here enclosed we are sending you the following documents

- 1 original "Inspection Report" number **B4020696** with annex Test report No. CTQC/B-12.218 number **B2033383** dated 23/10/2012.

Best regards

CESI S.p.A.
Testing & Certification Division
Business Area Certification

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Table of contents

1 GENERAL

CESI was entrusted by SHENDA ELECTRIC CO., LTD. to issue Inspection Report related to type tests, special tests and routine tests performed on following Oil immersed Power Transformer:

Manufacturer:	SHENDA ELECTRIC GROUP CO.,LTD.
Type:	SFZ-100000/220
Serial number:	120514-1
Year of manufacturing:	2012

Above tests, carried out at STRI-CTQC Laboratories, were performed according to IEC standard and (for the ones not specified in IEC), according to GB standards.
Detailed applicable Standard edition are listed in paragraph 2.1.

Tests have been witnessed by CESI inspector, Mr Umberto Di Marco, who stamped and signed every page of CTQC Test report of witnessed tests.
Pages of above report which have not been signed, refer to test not witnessed
(See paragraph 2.2. for details).

2 REFERENCE DOCUMENTS

2.1 Normative documents

[1] IEC 60076-1 (2011);
[2] IEC 60076-2 (2011);
[3] IEC 60076-3 (2000);
[4] IEC 60076-5 (2006);
[5] GB 1094-1 (1996);
[6] GB 1094-2 (1996);
[7] GB 1094-3 (2003);
[8] GB 1095-5 (2008);
[9] GB /T6451 (2008).

2.2 Test reports issued by Test laboratory

[1] Test Report Nr CTQC/B-12.218, dated 23.10.2012, (See Annex 1), identified with CESI reference B2033383

Note: CESI Inspector was not present to following tests and therefore relevant pages do not have CESI inspector signature:
- Routine tests before Short Circuit;
- FRA, winding frequency response (pag,. 38, 39)
- RIV Radio Interference voltage (Pag. 43)
- Transient voltage transfer (Page 49 and Annexe 2-j)

3 CONCLUSIONS

On the basis of the test results , it can be concluded that the Oil-immersed Power Transformer type SFZ11-100000/220, Serial number 120514-1, manufactured by SHENDA ELECTRIC GROUP CO., LTD., passed successfully all performed tests listed in Test report specified in par 2.2, in compliance with the reference specifications listed in par 2.1.

ANNEX 1: TEST REPORT CTQC/B-12.218 WITH CESI STAMP AND SIGNATURE (79 PAGES)

CX-F-01	Test Report	№: CTQC/B-12.218 Total 60 Page 1

CONTENTS

Page

CESI

Protocol Date

B2033383 23 October 2012

Signature:

CESI
Inspection service
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Address: Hushitai Sounth Avenue No. 18, Shenbei New District, Shenyang Postal code: 110122 Tel: (024)89874449
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CTQC

China National Transformer Quality Supervision And Testing Center

Shenyang Transformer Institute Co.,Ltd. Transformer Laboratory

Test Report

№: CTQC/B-12.218

Test object name	Power transformer	Test object type	SFZ -100000/220
		Brand	/
Entrusted by	Shenda Electric Group Co., Ltd.	Kind of testing	Trust testing
Manufactu-rer	Shenda Electric Group Co., Ltd.	Sampling date	Sept.19, 2012
Address	No.17, Huatong RD.,Jiangshan Economic Development Zone, Zhejiang Province, P.R.China	Serial №	120514-1
Standards	IEC60076-1:2011, GB1094.1-1996 IEC60076-2:2011, GB1094.2-1996 IEC60076-3:2000, GB1094.3-2003 IEC60076-5:2006, GB1094.5-2008 GB/T6451-2008 Technical contract	Test items	See page 3~6
Results	The test results of routine tests, short-duration AC withstand voltage test, temperature-rise test, measurement of sound levels, measurement of zero sequence impedance on three phase transformers, measurement of the harmonics of the no-load current, short-circuit withstand test, lightning impulse test, long-duration no-load test, radio interference voltage measurement, measurement of analysis of winding frequency response spectrum, determination of transient voltage transfer characteristics of SFZ-100000/220 are in accordance with standards and technical contract. The sample passed the above tests. Signing and issuing date: 2012.10.23 Period of validity 5 years		
Note			

CESI Inspection service verified by

Test witnessed by: Umberto Di Marco(CESI Inspector).

Approved by: Lishicheng Checked by: Sunqingyun Compiled by: Xiucai

Statement : 1. Testing report is invalid without test special seal.
2. Testing report is invalid without compiler, checker and approver's signature.
3. Please inform CTQC in time after received the testing report if you have some disagreement to the testing report.
4. Testing or witnessing only apply to sample.
5. Copying testing certificate or testing report is forbidden without written permission from CTQC(expect for copying all the testing report).

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Test Report

Test results

№	Test items	Specified values	Measured values		Conclusions
		Standards (Technical contract)	Before S.C.T.	After S.C.T.	
1	Measurement of dissipation factor (tan δ) of the insulation system capacitances (Routine test)	Providing system capacitances Providing dissipation factor (tan δ)	See 4.1	See 4.15.5.3	/
2	Determination of capacitances windings-to-earth and between windings (Routine test, special test)	Providing capacitances	See 4.1	See 4.15.5.3	/
3	Measurement of d.c. insulation resistance between each winding to earth and between windings (Routine test)	Providing d.c. insulation resistance Providing absorption ratio (R_{60}/R_{15})	See 4.3	See 4.15.5.5	/
4	Check of the ratio and polarity of built-in current transformers (Routine test)	Providing ratio measured value Check of relative polarities	N.A. Not applicable No built-in current transformers	N.A. Not applicable No built-in current transformers	/
5	Measurement of voltage ratio and check of connection group (Routine test)	The tolerances of voltage ratio : ±0.5% Connection group: Dyn1	0.04%~0.07% Dyn1	0.04%~0.07% Dyn1	Passed
6	Measurement of winding resistance (Routine test)	Maximum unbalancedness Phase: ≤2% Line: ≤1%	H.V(phase): 0.61% L.V(line): 0.04%	H.V(phase): 0.70% L.V(line): 0.13%	Passed
7	Measurement of no-load loss and current (Routine test)	I_0%: 0.3 +30% P_0 (kW): 69.2 +15%	0.11 61.10	0.11 62.09	Passed
8	Measurement of no-load loss and current at 90% and 110% of rated volage (Routine test)	I_0%: Providing measured value P_0(kW): Providing measured value	90% 110% 0.06 0.53 45.78 96.58	90% 110% 0.06 0.50 46.64 97.70	/
9	Test on on-load tap-changers (Routine test)	According to Clause 10.8 of IEC60076-1:2011,GB1094.1-1996	Comply with standard	Comply with standard	Passed

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Test Report

№: CTQC/B-12.218
Total 60 Page 4

№	Test items	Specified values Standards (Technical contract)	Measured values Before S.C.T.	 After S.C.T.	Conclusions
10	Switching impulse test (Routine test)	Switching impulse wave (kV): 750 ±3%	754～757	747～754	Passed
11	Separate-source AC withstand voltage test (Routine test)	H.V. neutral: 200kV; 60s L.V. : 85kV; 60s	200kV; 60s 85kV; 60s	200kV; 60s 85kV; 60s	Passed
12	Long-duration AC withstand voltage test (Routine test)	Phase to earth test			Passed
		$U_1=1.7Um/\sqrt{3}$ (kV) Duration (s): 120 (f_n/f)	247 30	247.34 30	
		$U_2=1.5Um/\sqrt{3}$ (kV) Duration(min): 30 PD≤500pC	218 30 <40	218.24 30 <20	
		$1.1Um/\sqrt{3}$ (kV) Duration(min): 5 PD≤100pC	160 5 <20	160.05 5 <10	
		Frequency (Hz): >50	200		
13	Measurement of short-circuit impedance and load loss (Routine test)	t: 75℃ Z%: 13.0 ±7.5% P_k (kW): 296.0 +15% P_{total} (kW): 365.2 +10%	 13.10 274.74 335.84	 13.10 272.57 334.66	Passed
14	Test on transformer oil (Routine test)	Breakdown voltage (kV): ≥40 tan δ (90℃): ≤0.01 Water dissolved in oil (mg/L): ≤15 Providing gas chromatography	62.7 0.00049 8.68 Providing gas chromatography	62.4 0.00053 8.70 Providing gas chromatography	Passed
15	Short-circuit withstand test (Special test)	Three times each phase Duration (s): 0.25±10% Test waveshapes have no distortion Deviation of reactance before and after S.C.T.≤2% The untanking inspection shows no apparent defects Successfully check items after S.C.T.	3 0.25 No distortion 0.14% No apparent defects Passed		Passed
16	Lightning impulse test (Routine test, type test)	Full wave Chopped wave H.V.(kV): 950 1050 ±3% O (kV): 400 / ±3% L.V. (kV): 200 220 ±3%	 948.6～958.0 1055～1060 396.0～401.2 199.0～201.4 218.8～221.7		Passed

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Test Report

№	Test items	Specified values Standards (Technical contract)	Measured values	Conclusions
17	Measurement of analysis of winding frequency response spectrum (Special test)	Providing measured oscillograms	See 4.13	/
18	Short-duration AC withstand voltage test (Special test)	A phase-to-earth test with single-phase supply		Passed
		U_1 (kV): 395 Duration (s): 120 (f_n/f)	395 30	
		$U_2=1.5Um/\sqrt{3}$ (kV) Duration(min): 5 PD≤500pC	218 5 <10	
		$1.1Um/\sqrt{3}$ (kV) Duration(min): 5 PD≤100pC	160 5 <10	
		Frequency (Hz): >50	200	
		A phase-to-phase test with three-phase supply		
		U_1 (kV): 395 Duration (s): 120 (f_n/f)	395 30	
		$U_2=1.3Um$ (kV) Duration(min): 5 PD≤300pC	327.6 5 <10	
		1.1Um (kV) Duration(min): 5 PD≤100pC	277.2 5 <10	
		Frequency (Hz): >50	200	
19	Measuremen of sound levels (Special test)	Sound level L_{PA} dB(A): / Sound power level $L_{WA,SN}$ dB(A): ≤94	65 86	Passed
20	Measurement of the harmonics of the no-load current (Special test)	Providing no-load current harmonic values of each phase	I_1-I_{26} no load current harmonics	/
21	Radio interference voltage test (Special test)	Applied voltage (kV): 277.2 Radio interference level(μV): ≤2500	277.2 A: 467 B: 355 C: 473	Passed

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Test Report

№	Test items	Specified values Standards (Technical contract)	Measured values	Conclu-sions
22	Long-duration no-load test (Special test)	Applied voltage(kV): 1.1Ur Duration(h): 12 No C_2H_2 in oil	40.7 12 No C_2H_2 in oil	Passed
23	Measurement of zero sequence impedance on three phase transformers (Special test)	Providing zero sequence impedance value (Ω)	57.37	/
24	Leakage test (Routine test)	Applied pressure (kPa): 30 Duration (h): 24 No leakage oil and damage	30 24 No leakage oil and damage	Passed
25	Temperature-rise test(Type test)	Temperature–rise limit (K): Top oil: 60 Winding: 65	55.7 H.V. : 60.1 L.V. : 61.9	Passed
26	Determination of transient voltage transfer characteristics (Special test)	Providing measured value	See 4.26	/

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Test Report

1. Test object parameters

Rated power (kVA): 100000
Um (kV): 252
Rated voltage (kV): 220/37
Rated current (A): 262.43/1560.4
Rated frequency (Hz): 50
Number of phases: 3
Tap range (kV): (220±8×1.25%) /37
Connection symbol: Dyn1
Cooling method: ONAF
Temperature class of insulation: A
Insulation level: h.v. line terminal SI/LI/AC 750/950/395kV
h.v. neutral LI/AC 400/200kV
l.v. line terminal LI/AC 200/85kV

2. Sample condition description

Sample exterior construction and major dimensions(length, width, height) are in compliance with drawing.
Measured values: length is 7340mm, width is 6040mm, height is 8280mm.

Outline dimensions	Rating plate	Body assembly	Core assembly
1SD.001.1619	8SD.011.1619	5SD.401.1619	5SD.301.1619
H.V. lead	L.V. lead	H.V. winding	L.V. winding
6SD.801.1619	5SD.901.1619	6SD.601.1619	6SD.701.1619

Rating plate and outline drawings are in testing report annex, other drawings should be conserved by enterprise after affirming by testing center.
The form, performance data , specifications of sample rating plate are in compliance with drawings.
The marking of the phase sequence on high voltage and low voltage side of the sample is clear and right.
The surface of the sample has no collision and damage.

3. Standards

GB1094.1-1996, IEC60076—1:2011《Power transformers Part 1: General》
GB1094.2-1996, IEC60076—2:2011《Power transformers Part 2: Temperature rise》
GB1094.3-2003, IEC60076—3:2000《Power transformers Part 3: Insulation levels, dielectric tests and external clearances in air》
GB1094.5-2008, IEC60076—5:2006《Power transformers Part 5: Ability to withstand short circuit》
GB/T6451-2008《Specification and technical requirements for oil-immersed power transformers》
Technical contract

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Test Report

4. Test items and conclusions

4.1 Measurement of dissipation factor (tan δ) of the insulation system capacitances

(Routine test) Test date: Sept.26,2012

Humidity: 40%; Oil temperature: 23.7℃

Measurement position	Cx (pF)	tan δ
H.V.—L.V. &E	10270	0.0030
L.V.—H.V. &E	16270	0.0034
H.V., L.V.—E	15510	0.0034
H.V.—L.V.	5514	0.0025

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

(Routine test, Special test) Test date: Sept.26,2012

See 4.1

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

Test date: Sept.26,2012

Humidity: 40%; Oil temperature: 23.7℃

Measurement position	Insulation resistance (MΩ)			R_{60}/R_{15}	R_{600}/R_{60}
	R_{600}	R_{60}	R_{15}		
H.V.—L.V. &E	35900	18300	15600	1.17	1.96
L.V.—H.V. &E	65100	24000	16600	1.45	2.71
H.V., L.V.—E	32500	15900	11700	1.36	2.04
H.V. —L.V.	/	25900	16800	1.54	/
Core—E	/	10000	/		
Clamp—E	/	8000	/		

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4.4 Check of the ratio and polarity of built-in current transformers (Routine test)
Because the sample doesn't fix current transformer, it doesn't put up this test item.

4.5 Measurement of voltage ratio and check of connection group (Routine test)
Test date: Sept.26,2012

H.V.		L.V.		Ratio	Measured deviation (%)			Connection group
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AB/ab	BC/bc	CA/ca	
1	242.000			6.541	0.02	0.03	0.04	
2	239.250			6.466	0.02	0.03	0.04	
3	236.500			6.392	0.02	0.03	0.04	
4	233.750			6.318	0.02	0.03	0.04	
5	231.000			6.243	0.02	0.03	0.05	
6	228.250			6.169	0.02	0.03	0.05	
7	225.500			6.095	0.04	0.05	0.06	
8	222.750			6.020	0.04	0.05	0.07	
9,10,11	220.000	/	37	5.946	0.04	0.05	0.07	Dyn1
12	217.250			5.872	0.04	0.05	0.07	
13	214.500			5.797	0.04	0.06	0.07	
14	211.750			5.723	0.04	0.06	0.07	
15	209.000			5.649	0.05	0.06	0.08	
16	206.250			5.574	0.05	0.06	0.08	
17	203.500			5.500	0.05	0.06	0.08	
18	200.750			5.426	0.05	0.06	0.09	
19	198.000			5.351	0.05	0.06	0.09	

Result: Passed.

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Test Report

4.6 Measurement of winding resistance(Routine test) Test date: Sept.26,2012

Oil temperature:23.7℃

Winding	Tap position	Measured values (Ω)			Unbalancedness (%)
		A~O a~b	B~O b~c	C~O c~a	
H.V.	1	0.6142	0.6175	0.6167	0.54
	2	0.6040	0.6072	0.6067	0.53
	3	0.5940	0.5970	0.5966	0.50
	4	0.5838	0.5868	0.5864	0.51
	5	0.5737	0.5767	0.5764	0.52
	6	0.5634	0.5666	0.5663	0.57
	7	0.5534	0.5566	0.5564	0.58
	8	0.5430	0.5463	0.5461	0.61
	9,10,11	0.5322	0.5347	0.5340	0.47
	12	0.5433	0.5465	0.5461	0.59
	13	0.5535	0.5564	0.5562	0.52
	14	0.5637	0.5667	0.5663	0.53
	15	0.5738	0.5768	0.5764	0.52
	16	0.5840	0.5871	0.5866	0.53
	17	0.5940	0.5970	0.5966	0.50
	18	0.6043	0.6075	0.6070	0.53
	19	0.6142	0.6176	0.6169	0.55
L.V.	/	0.02330	0.02329	0.02330	0.04

Result: Passed.

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4.7 Measurement of no-load loss and current(Routine test) Test date: Sept.26,2012

Test circuit is given in Annex2-a

Voltage multiple	Applied voltage (kV)		No-load current		No-load loss (kW)	
	Reading of mean value voltmeter	Reading of r.m.s. voltmeter	(A)	(%)	Measured value	Corrected value
90% U_r	33.300	33.280	1.01	0.06	45.76	45.78
100% U_r	37.000	37.043	1.75	0.11	61.17	61.10
110% U_r	40.700	41.432	8.32	0.53	98.35	96.58

Result: Passed.

4.8 Measurement of no-load loss and current at 90% and 110% of rated voltage (Routine test)

See 4.7

4.9 Test on on-load tap-changers (Routine test) Test date: Sept.26, 2012

Operation test:

a. 8 complete operating cycles with the transformer not energized(a cycle of operation goes from one end of the tapping range to the other and back again).

b. 1 complete operate cycle with the transformer is not energized, with 85% of the rated operation voltage.

c. 1 complete operating cycle with the transformer is energized at rated voltage and rated frequency at no-load.

d. With one winding short-circuited and made 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 tapchangger will pass 20 times through the changeover position).

Result: Passed.

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Test Report

4.10 Switching impulse test (Routine test) Test date: Sept.26,2012

Humidity: 43.3%; Ambient temperature: 20.6℃; Atmospheric press: 99.9kPa.

Test items and voltage

Tested terminals	Rated withstand voltage (kV)	Tap position
A, B, C	750	1

Test sequence:

One reduced negative polarity switching impulse;

Three rated negative polarity switching impulse.

Test records:

T1:Front time; T0:A total duration from the virtual origin to the first zero passage;

Td:Time above 90%Up; Up:Peak voltage.

Result: Passed.

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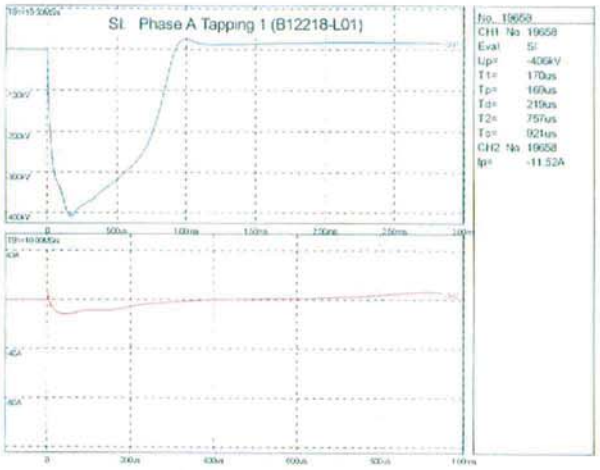
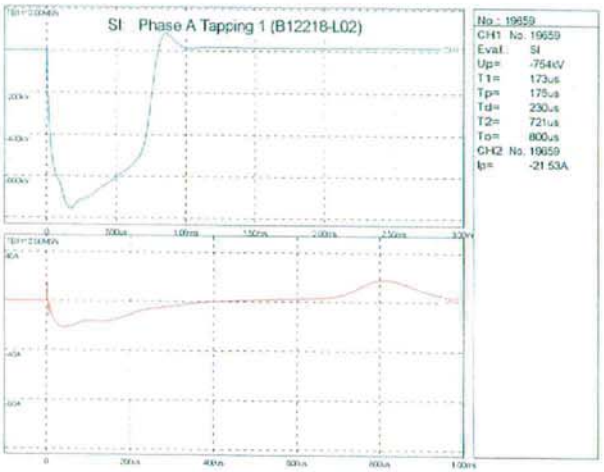
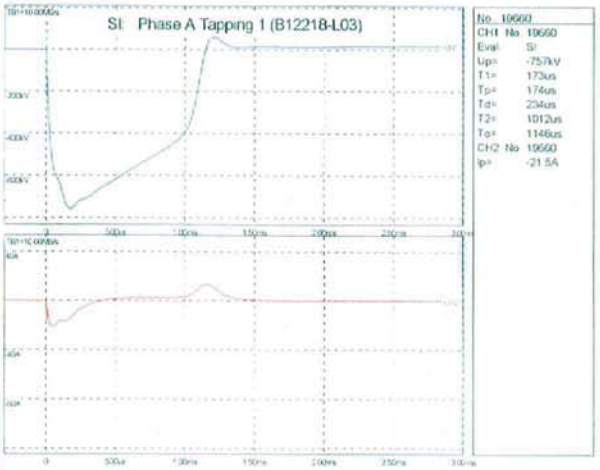
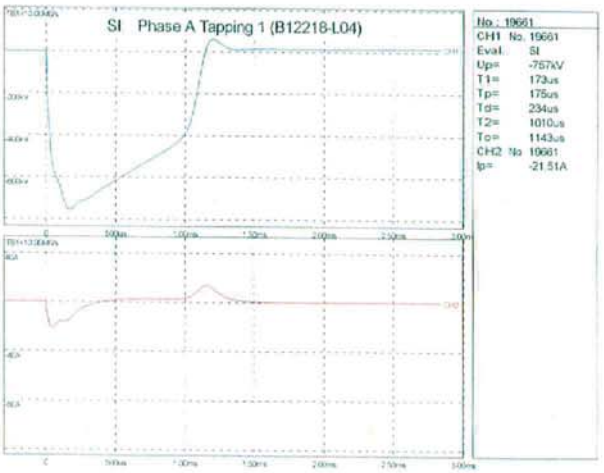
Tested terminal: A Test polarity: Negative CH1.Voltage records CH2. Neutral current records









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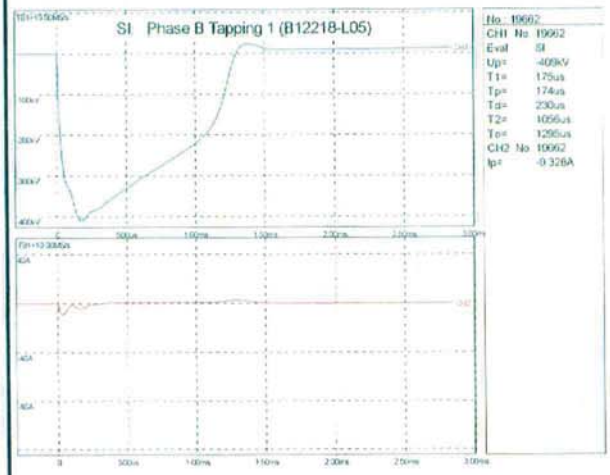
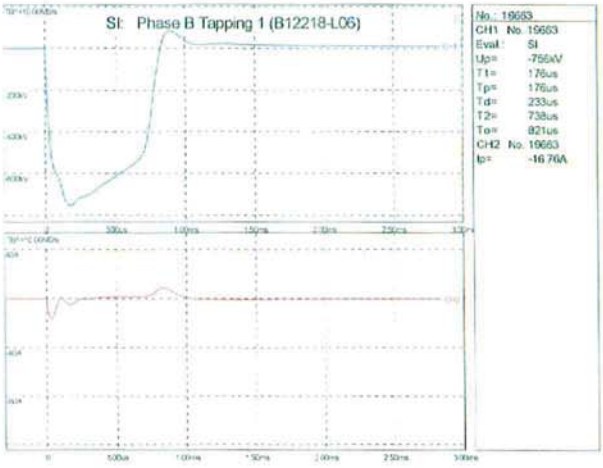
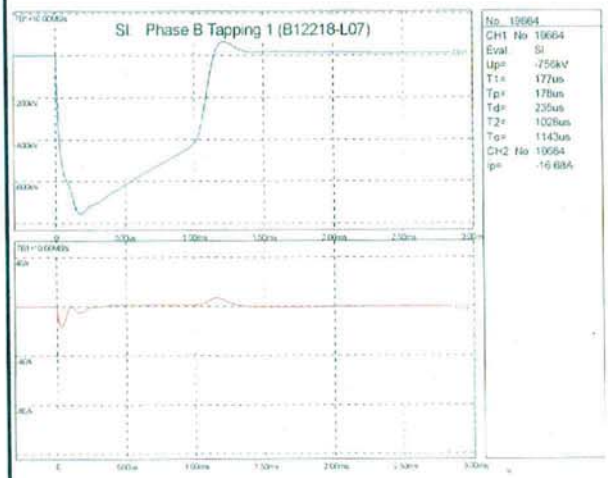
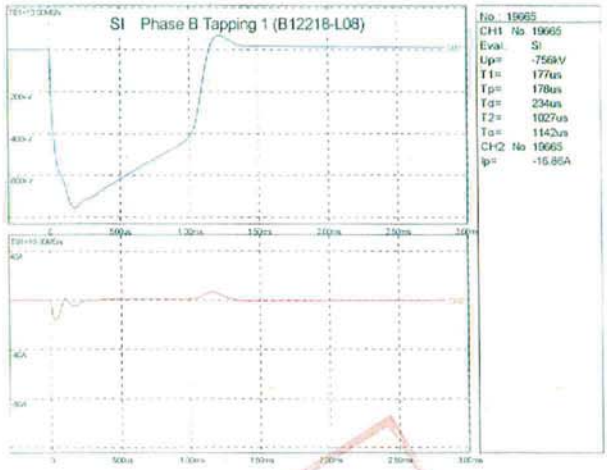
Test Report

Tested terminal: B Test polarity: Negative CH1.Voltage records CH2. Neutral current records









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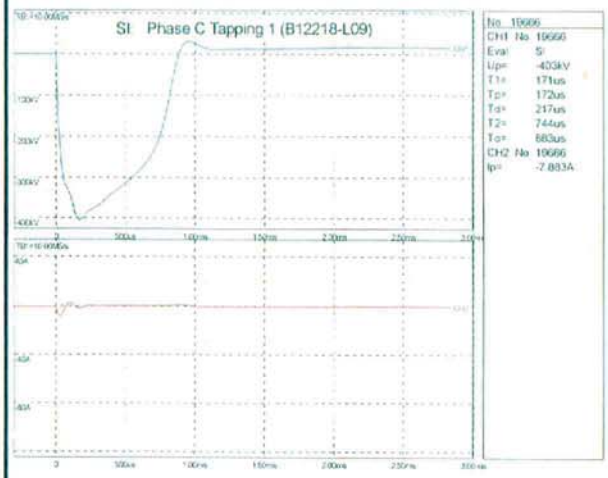
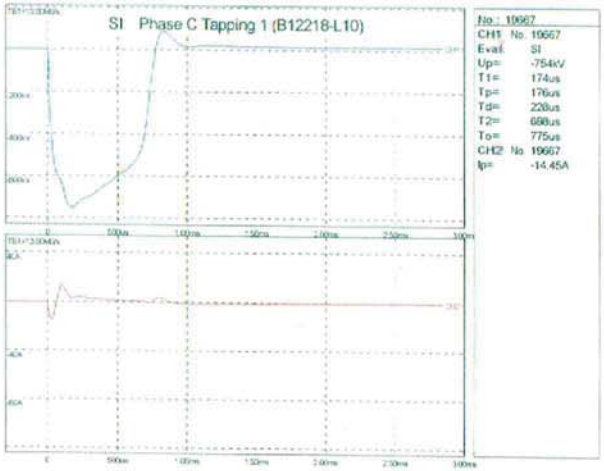
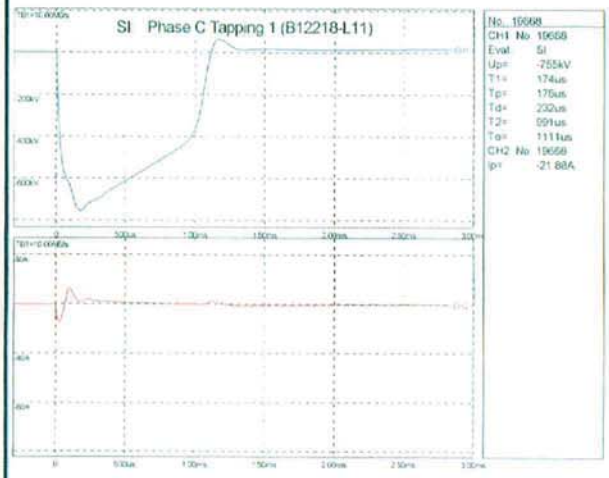
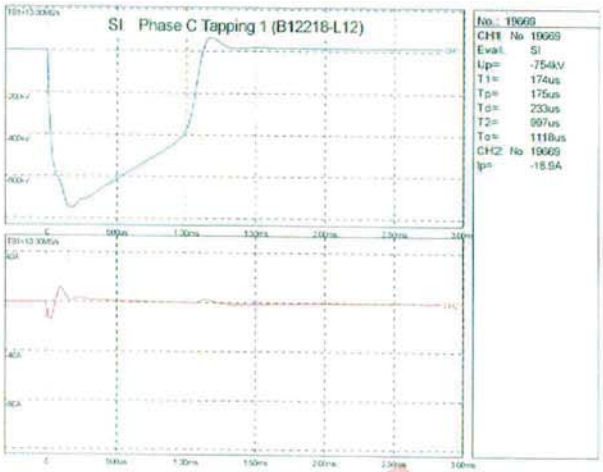
Test Report

Tested terminal: C Test polarity: Negative CH1.Voltage records CH2. Neutral current records









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Test Report

4.11 Separate-source AC withstand voltage test(Routine test) Test date: Sept.27,2012

Test circuit is given in Annex2-b

Humidity: 45%; Oil temperature: 24.0℃; Atmospheric pressure: 99.0kPa

Position	Applied voltage (kV)	Duration (s)	Result
H.V. neutral—L.V.&E	200	60	Passed
L.V.—H.V. &E	85	60	

4.12 Long-duration AC withstand voltage test (ACLD) (Routine test) Test date: Sept.28,2012

Test circuit is given in Annex2-c

Phase to earth test, tap position 10, frequency 200Hz.

Induced voltage		Duration	Partial discharge levels (pC)		
Multiple	Phase-to-earth (kV)		A	B	C
$1.1Um/\sqrt{3}$	160	5 min	<20	<20	<20
$U_2=1.5Um/\sqrt{3}$	218	5 min	<20	<20	<20
$U_1=1.7Um/\sqrt{3}$	247	30s	/	/	/
$U_2=1.5Um/\sqrt{3}$	218	5 min	<20	<20	<20
		10 min	<20	<40	<20
		15 min	<20	<40	<20
		20 min	<20	<40	<20
		25 min	<20	<40	<20
		30 min	<20	<40	<20
$1.1Um/\sqrt{3}$	160	5 min	<20	<20	<20

Note: Um=252kV

Background noise level is <20pC before and after test.

Start voltage: 218kV Extinction voltage: 160kV.

Result: Passed.

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Test Report

4.13 Measurement of short-circuit impedance and load loss (Routine test) Test date: Sept.28,2012
Test circuit is given in Annex2-d

Winding	Tap position	Applied current I		Measured voltage (kV)	H.V. short-circuit impedance (Each phase)		Load loss (kW)		Total loss (kW)
					(Ω)	(%)	Measured value	Corrected value	Corrected value
		(A)	I/Ir (%)		t=75℃ I=Ir	t=75℃ I=Ir	t=23.5℃	t=75℃ I=Ir	t=75℃ I=Ir
H.V. | L.V.	1	122.33	51.27	16.963	80.06	13.67	65.59	277.53	338.63
	10	146.62	55.87	16.098	63.40	13.10	76.13	274.74	335.84
	17	155.37	53.28	13.888	51.59	13.16	81.51	327.89	388.99

Result: Passed.

4.14 Test on transformer oil (Routine test) Test date: Sept.26, 2012

tan δ (90℃)	Breakdown voltage (kV)	Water dissolved in oil (mg/L)
0.00049	62.7	8.68

Gas chromatography(before routine tests) Test date: Sept.26, 2012

μ L/L

H_2	CO	CO_2	CH_4	C_2H_6	C_2H_4	C_2H_2	Hydrocardons
0.00	9.82	63.31	0.07	0.00	0.00	0.00	0.07

Gas chromatography (after S.C.T test) Test date: Oct.11, 2012

μ L/L

H_2	CO	CO_2	CH_4	C_2H_6	C_2H_4	C_2H_2	Hydrocardons
0.00	10.46	77.09	0.36	0.00	0.00	0.00	0.36

Gas chromatography (after insulation test, before long-duration no-load test,) Test date: Oct.15, 2012

μ L/L

H_2	CO	CO_2	CH_4	C_2H_6	C_2H_4	C_2H_2	Hydrocardons
0.00	12.01	79.54	0.37	0.00	0.00	0.00	0.37

Gas chromatography (after long-duration no-load test, before temperature-rise test) Test date: Oct.17, 2012

μ L/L

H_2	CO	CO_2	CH_4	C_2H_6	C_2H_4	C_2H_2	Hydrocardons
0.00	15.25	86.45	0.51	0.00	0.00	0.00	0.51

Gas chromatography (after temperature-rise test) Test date: Oct.18, 2012

μ L/L

H_2	CO	CO_2	CH_4	C_2H_6	C_2H_4	C_2H_2	Hydrocardons
0.00	20.27	180.60	0.58	0.00	0.00	0.00	0.58

Result: Passed.

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Test Report

4.15 Short-circuit withstand test(Special test) Test date: Oct.10,2012

4.15.1 Calculated short-circuit current (Reference temperature 75℃)

Tap position	H.V. current value (A)		L.V. current value (kA)		Multiple ($K\sqrt{2}$)
	The first peak of the asymmetrical short-circuit current	The r.m.s value of the symmetrical short-circuit current	The first peak of asymmetrical 1.5 phase short-circuit current	The r.m.s. value of the symmetrical 1.5 phase short-circuit current	
1	4320	1694	24.47	9.60	2.550
10	4922	1930	25.34	9.94	2.550
19	5398	2117	25.02	9.81	2.550

4.15.2 Measurement of short-circuit current

Test circuit is given in Annex 2-e

Perform single-phase test, supply is provided between one line terminal and the other two line terminals connected together, 9 times. Test waveshapes have no distortion. Test oscillograms are shown in Page 50~58.

Tap position	Phase	H.V. current value				I_{tank} (A)	Duration (s)	Serial №.
		The first peak of the asymmetrical short-circuit current (A)		The r.m.s. value of the symmetrical short-circuit current (A)				
		Measured value (A)	(%)	Measured value (A)	(%)			
1	A-BC	4492	104.0	1598	94.3	0	0.25	B12218-S01
		4529	104.8	1608	94.9	0	0.25	B12218-S02
		4534	105.0	1621	95.7	0	0.25	B12218-S03

L.V. current value					
The first peak of the asymmetrical 1.5 phase short-circuit current(kA)			The r.m.s. value of the symmetrical 1.5 phase short-circuit current(kA)		
a	b	c	a	b	c
24.11	/	24.03	8.92	/	8.91
24.01	/	23.96	8.89	/	8.89
23.86	/	23.81	8.82	/	8.82

Note: I_{tank} is the earthing current of oil tank.

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Tap position	Phase	H.V. current value				I_{tank} (A)	Duration (s)	Serial №.
		The first peak of the asymmetrical short-circuit current (A)		The r.m.s value of the symmetrical short-circuit current (A)				
		Measured value (A)	(%)	Measured value (A)	(%)			
10	B-AC	4997	101.5	1821	94.4	0	0.25	B12218-S04
		4992	101.4	1823	94.5	0	0.25	B12218-S05
		4992	101.4	1829	94.8	0	0.25	B12218-S06

L.V. current value					
The first peak of the asymmetrical 1.5 phase short-circuit current(kA)			The r.m.s. value of the symmetrical 1.5 phase short-circuit current(kA)		
a	b	c	a	b	c
25.44	25.54	/	9.41	9.40	/
25.44	25.39	/	9.41	9.41	/
25.34	25.29	/	9.42	9.40	/

Tap position	Phase	H.V. current value				I_{tank} (A)	Duration (s)	Serial №.
		The first peak of the asymmetrical short-circuit current (A)		The r.m.s value of the symmetrical short-circuit current (A)				
		Measured value (A)	(%)	Measured value (A)	(%)			
19	C-AB	5387	99.8	1980	93.5	0	0.25	B12218-S07
		5397	100.0	1984	93.7	0	0.25	B12218-S08
		5382	99.7	1980	93.5	0	0.25	B12218-S09

L.V. current value					
The first peak of the asymmetrical 1.5 phase short-circuit current(kA)			The r.m.s. value of the symmetrical 1.5 phase short-circuit current(kA)		
a	b	c	a	b	c
/	25.06	25.01	/	9.19	9.19
/	25.16	25.11	/	9.20	9.19
/	25.06	25.04	/	9.18	9.18

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4.15.3 Measurement of short-circuit reactance each shot

Tap position	№.	Measured reactance value (Ω)			Deviation of reactance (%)		
		A	B	C	A	B	C
1	Before	80.20	80.96	79.89	/	/	/
	1	80.24	80.96	79.95	<0.1	<0.1	<0.1
	2	80.17	80.96	79.92	<0.1	<0.1	<0.1
	3	80.02	80.93	79.91	-0.22	<0.1	<0.1
10	Before	63.64	63.99	63.31	/	/	/
	1	63.68	64.01	63.35	<0.1	<0.1	<0.1
	2	63.70	64.01	63.32	<0.1	<0.1	<0.1
	3	63.70	64.00	63.26	<0.1	<0.1	<0.1
19	Before	51.92	52.11	51.53	/	/	/
	1	51.99	52.12	51.57	0.13	<0.1	<0.1
	2	51.99	52.12	51.57	0.13	<0.1	<0.1
	3	51.99	52.13	51.56	0.13	<0.1	<0.1

Measurement of short-circuit reactance after all the S.C.T.:

Tap position	Measured reactance value (Ω)			Deviation of reactance (%)		
	A	B	C	A	B	C
1	80.30	80.99	79.95	0.12	<0.1	<0.1
10	63.73	64.01	63.35	0.14	<0.1	<0.1
19	51.99	52.13	51.56	0.13	<0.1	<0.1

The maximum deviation of short-circuit reactance is 0.14%.

4.15.4 The visual inspection

There is no deformation of winding, connection or supporting structures, no traces of electrical discharge was found after S.C.T. The active part photos taken before and after S.C.T. are shown in Page 59 and Page 60.

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4.15.5 Repeated routine tests after short-circuit withstand test

4.15.5.1 Test on transformer oil Test date: Oct.11, 2012

tan δ (90℃)	Breakdown voltage (kV)	Water dissolved in oil (mg/L)
0.00053	62.4	8.70

Gas chromatography see 4.14 item.

Result: Passed.

4.15.5.2 Switching impulse test Test date: Oct.11, 2012

Humidity: 46.3%; Ambient temperature: 16.6℃; Atmospheric press: 100.9kPa.

Test items and voltage

Tested terminals	Rated withstand voltage (kV)	Tap position
A, B, C	750	1

Test sequence:

One reduced negative polarity switching impulse;

Three rated negative polarity switching impulse.

Test records:

T1:Front time; T_0:A total duration from the virtual origin to the first zero passage;
Td:Time above 90%Up; Up:Peak voltage.

Result: Passed.

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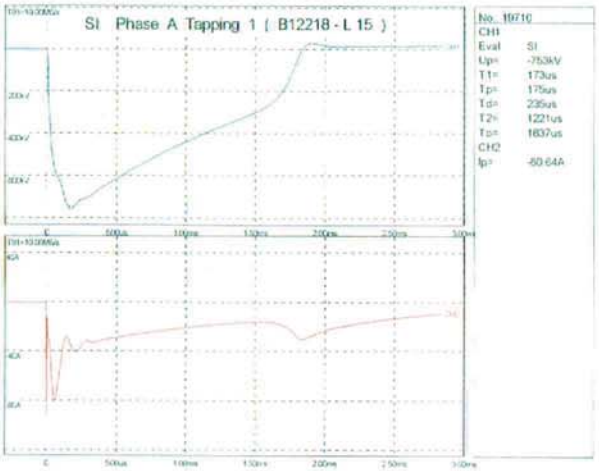
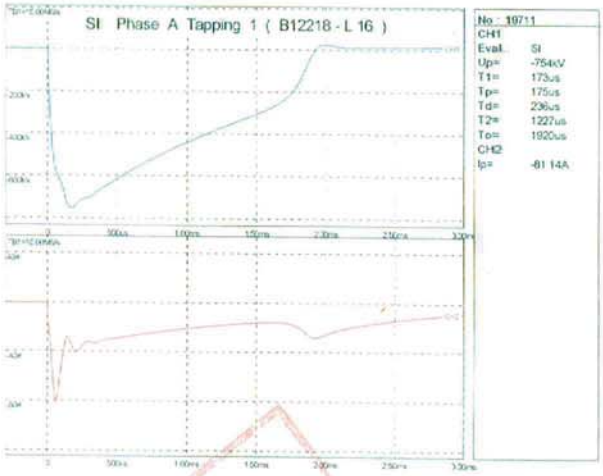
Test Report

Tested terminal: A Test polarity: Negative CH1.Voltage records CH2. Neutral current records





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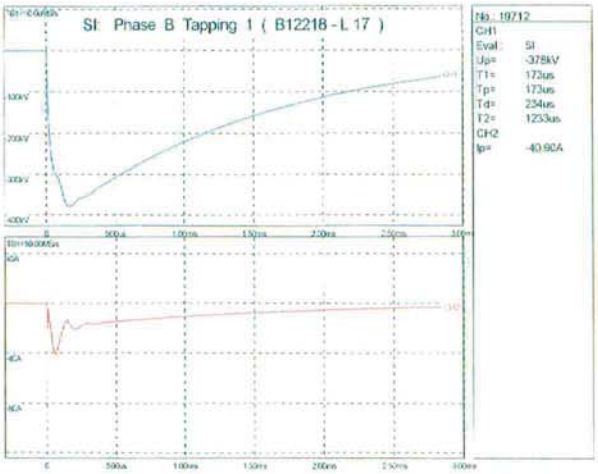
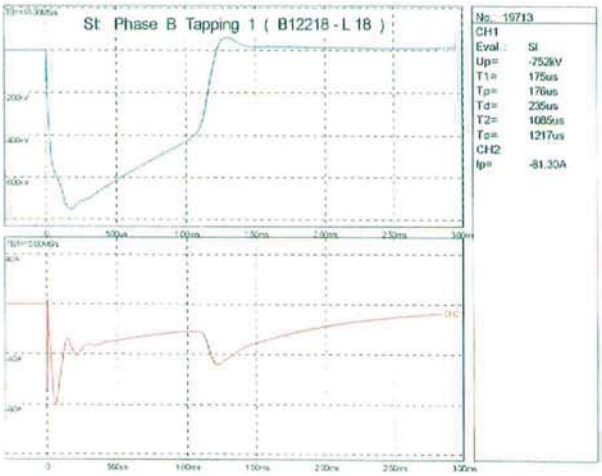
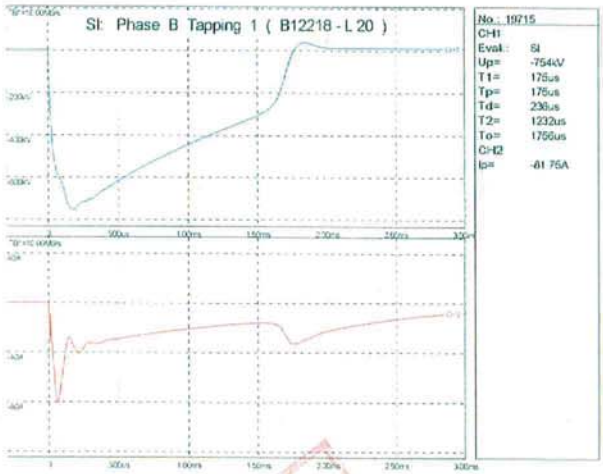
Test Report

Tested terminal: B Test polarity: Negative CH1.Voltage records CH2. Neutral current records







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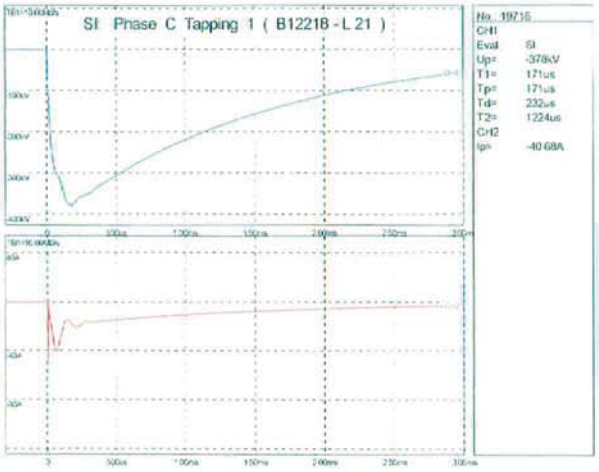
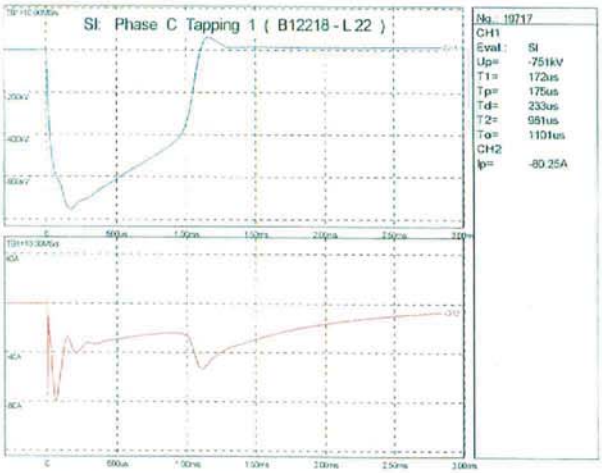
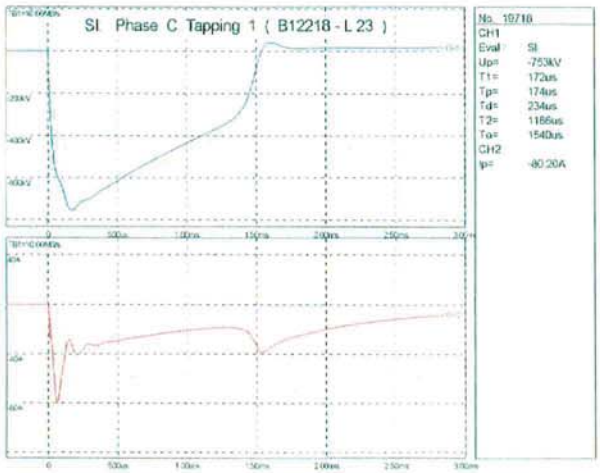
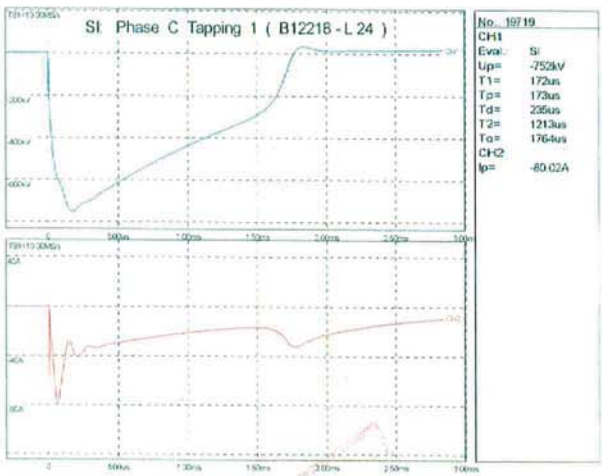
Test Report

Tested terminal: C Test polarity: Negative CH1.Voltage records CH2. Neutral current records









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4.15.5.3 Measurement of dissipation factor (tan δ) of the insulation system capacitances

Test date: Oct.12,2012

Humidity: 45%; Oil temperature: 16.3℃

Measurement position	Cx (pF)	tan δ
H.V.—L.V. &E	10230	0.0029
L.V.—H.V. E	16230	0.0033
H.V., L.V.—E	15480	0.0034
H.V.—L.V.	5506	0.0029

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

See 4.15.5.3

4.15.5.5 Measurement of d.c. insulation resistance between each winding to earth and between windings Test date: Oct.12,2012

Humidity: 45%; Oil temperature: 16.3℃

Measurement position	Insulation resistance (MΩ)			R_{60}/R_{15}	R_{600}/R_{60}
	R_{600}	R_{60}	R_{15}		
H.V.—L.V. &E	54700	30700	27100	1.13	1.78
L.V.—H.V. E	72500	23200	15500	1.50	3.13
H.V., L.V.—E	51500	35800	23100	1.55	1.44
H.V.—L.V.	/	50500	48800	1.03	/
Core—E	/	13900	/		
Clamp—E	/	10600	/		

4.15.5.6 Check of the ratio and polarity of built-in current transformers Test date: Oct.12,2012

Because the sample doesn't fix current transformer, it doesn't put up this test item.

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4.15.5.7 Measurement of voltage ratio and check of connection group Test date: Oct.12,2012

H.V.		L.V.		Ratio	Measured deviation (%)			Connection group
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AB/ab	BC/bc	CA/ca	
1	242.000			6.541	0.02	0.04	0.04	
2	239.250			6.466	0.02	0.03	0.04	
3	236.500			6.392	0.02	0.03	0.04	
4	233.750			6.318	0.02	0.04	0.04	
5	231.000			6.243	0.02	0.04	0.05	
6	228.250			6.169	0.02	0.04	0.05	
7	225.500			6.095	0.04	0.05	0.06	
8	222.750			6.020	0.04	0.05	0.07	
9,10,11	220.000	/	37	5.946	0.04	0.06	0.07	Dyn1
12	217.250			5.872	0.04	0.06	0.07	
13	214.500			5.797	0.05	0.06	0.07	
14	211.750			5.723	0.05	0.06	0.07	
15	209.000			5.649	0.05	0.06	0.08	
16	206.250			5.574	0.05	0.07	0.08	
17	203.500			5.500	0.05	0.06	0.08	
18	200.750			5.426	0.05	0.07	0.09	
19	198.000			5.351	0.05	0.07	0.09	

Result: Passed.

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4.15.5.8 Measurement of winding resistance Test date: Oct.12,2012

Oil temperature:16.3℃

Winding	Tap position	Measured values (Ω)			Unbalancedness (%)
		A~O a~b	B~O b~c	C~O c~a	
H.V.	1	0.5925	0.5961	0.5953	0.61
	2	0.5825	0.5863	0.5856	0.65
	3	0.5730	0.5765	0.5757	0.61
	4	0.5631	0.5665	0.5660	0.60
	5	0.5534	0.5568	0.5563	0.61
	6	0.5434	0.5470	0.5465	0.66
	7	0.5338	0.5374	0.5369	0.67
	8	0.5237	0.5274	0.5270	0.70
	9,10,11	0.5133	0.5162	0.5154	0.56
	12	0.5239	0.5274	0.5271	0.67
	13	0.5338	0.5371	0.5367	0.62
	14	0.5436	0.5470	0.5465	0.62
	15	0.5533	0.5568	0.5562	0.63
	16	0.5632	0.5667	0.5662	0.62
	17	0.5728	0.5763	0.5757	0.61
	18	0.5828	0.5863	0.5858	0.60
	19	0.5922	0.5960	0.5954	0.64
L.V.	/	0.02249	0.02246	0.02247	0.13

Result: Passed.

4.15.5.9 Test on on-load tap-changers Test date: Oct.12,2012

Operation test:

a. 8 complete operating cycles with the transformer not energized(a cycle of operation goes from one end of the tapping range to the other and back again).

b. 1 complete operate cycle with the transformer is not energized, with 85% of the rated operation voltage.

c. 1 complete operating cycle with the transformer is energized at rated voltage and rated frequency at no-load.

d. With one winding short-circuited and made rated current in the tapped winding, 10 cyclesof 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 tapchangger will pass 20 times through the changeover position).

Result: Passed.

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4.15.5.10 Separate-source AC withstand voltage test Test date: Oct.13,2012

Humidity: 49%; Oil temperature: 16.8℃; Atmospheric pressure: 99.0kPa

Position	Applied voltage (kV)	Duration (s)	Result
H.V. neutral—L.V.&E	200	60	Passed
L.V.—H.V. &E	85	60	

4.15.5.11 Measurement of no-load loss and current Test date: Oct.13,2012

Voltage multiple	Applied voltage (kV)		No-load current		No-load loss (kW)	
	Reading of mean value voltmeter	Reading of r.m.s. voltmeter	(A)	(%)	Measured value	Corrected value
90% U_r	33.300	33.264	0.98	0.06	46.59	46.64
100% U_r	37.000	37.015	1.68	0.11	62.12	62.09
110% U_r	40.700	41.348	7.79	0.50	99.28	97.70

Result: Passed.

4.15.5.12 Measurement of no-load loss and current at 90% and 110% of rated voltage

See 4.15.5.11

4.15.5.13 Measurement of short-circuit impedance and load loss Test date: Oct.13,2012

Winding	Tap position	Applied current I		Measured voltage (kV)	H.V. short-circuit Impedance (Each phase)		Load loss (kW)		Total loss (kW)
		(A)	I/Ir (%)		(Ω)	(%)	Measured value	Corrected value	Corrected value
					t=75℃ I=Ir	t=75℃ I=Ir	t=16.8℃	t=75℃ I=Ir	t=75℃ I=Ir
H.V.	1	124.73	52.28	17.297	80.06	13.67	66.87	275.70	337.79
|	10	147.32	56.13	16.172	63.40	13.10	75.08	272.57	334.66
L.V.	19	159.89	54.49	14.199	51.59	13.16	83.36	326.06	388.15

Result: Passed.

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Test Report

4.15.5.14 Long-duration AC withstand voltage test (ACLD) Test date: Oct.15,2012

Phase to earth test, tap position 10, frequency 200Hz。

Induced voltage		Duration	Partial discharge levels (pC)		
Multiple	Phase-to-earth (kV)		A	B	C
$1.1Um/\sqrt{3}$	160	5 min	<10	<10	<10
$U_2=1.5Um/\sqrt{3}$	218	5 min	<10	<10	<10
$U_1=1.7Um/\sqrt{3}$	247	30s	/	/	/
$U_2=1.5Um/\sqrt{3}$	218	5 min	<10	<10	<10
		10 min	<10	<10	<10
		15 min	<10	<10	<10
		20 min	<10	<20	<10
		25 min	<10	<20	<10
		30 min	<10	<20	<10
$1.1Um/\sqrt{3}$	160	5 min	<10	<10	<10

Note: Um=252kV
Background noise level is <10pC before and after test.

Result: Passed.

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Test Report

4.16 Lightning impulse test(Routine test, type test) Test date: Oct.12,2012

Test circuit is given in Annex 2-f

.

Humidity: 46.3%; Ambient temperature: 16.6℃; Atmospheric press: 100.9kPa

Test items and voltage

Tested terminals	Rated withstand voltage (kV)		Tap position
	Full wave	Chopped wave	
A, B, C	950	1050	A:1; B:19; C:10
O	400	/	1
a,b,c	200	220	/

Test sequence:

Line terminal:

One reduced negative polarity full wave impulse;
One rated negative polarity full wave impulse;
One reduced negative polarity chopped wave impulse;
Two rated negative polarity chopped wave impulse;
Two rated negative polarity full wave impulse.

Neutral:

One reduced negative polarity full wave impulse;
Three rated negative polarity full wave impulse;

Test oscillogram records:

T1:Front time; T2:Time to half value; Tc:Time to chopping;
Up2:Factor of over crossing; Up:Peak voltage.

Result: Passed.

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Test Report

Tested terminal: A Test polarity: Negative CH1. Voltage records CH2. Neutral current records

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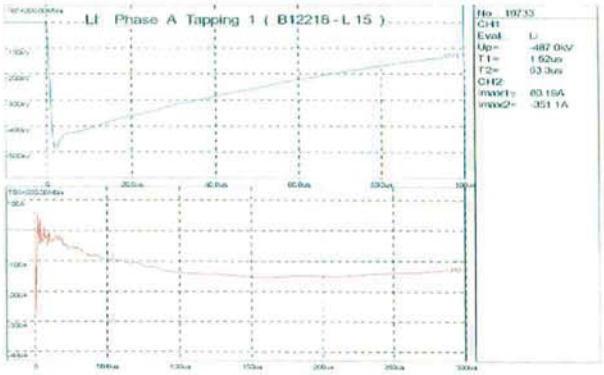

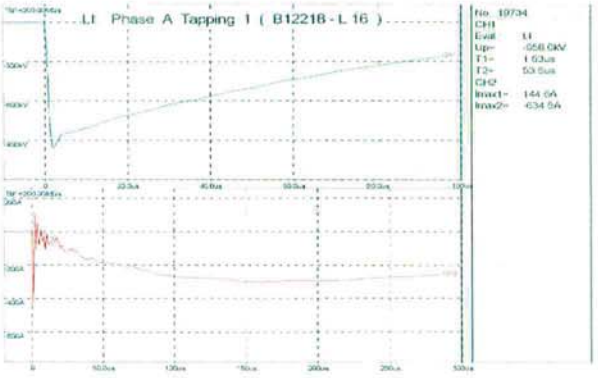

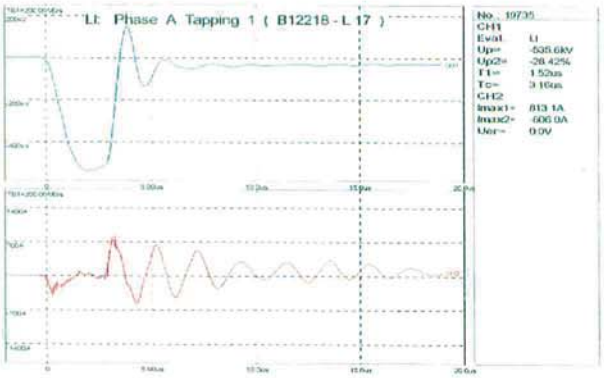

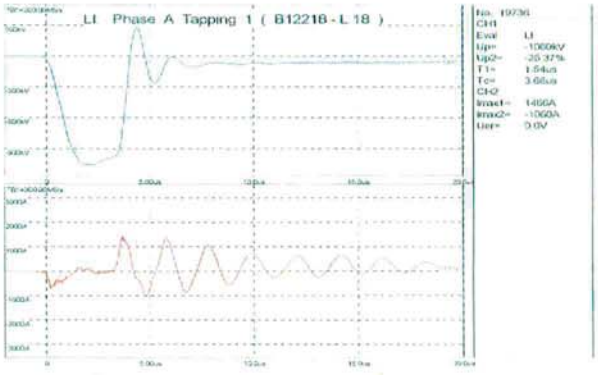

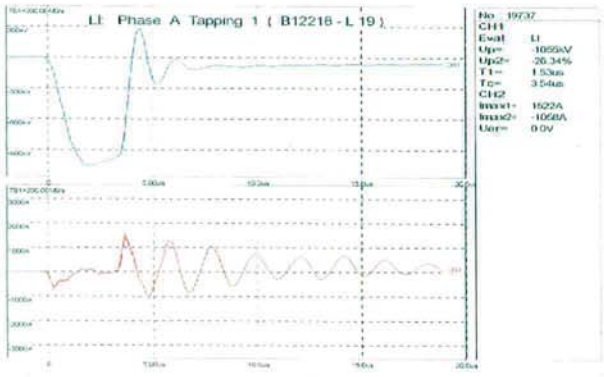

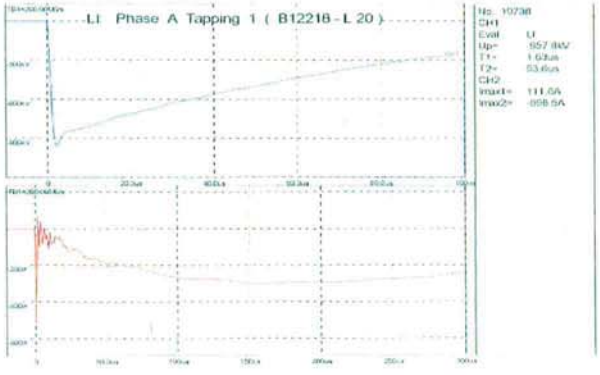

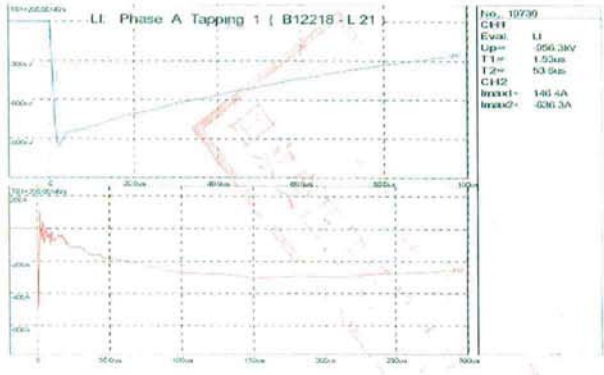

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Test Report

Tested terminal: B Test polarity: Negative CH1.Voltage records CH2. Neutral current records

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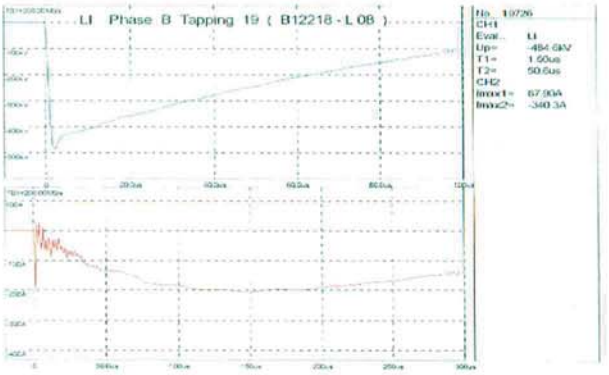

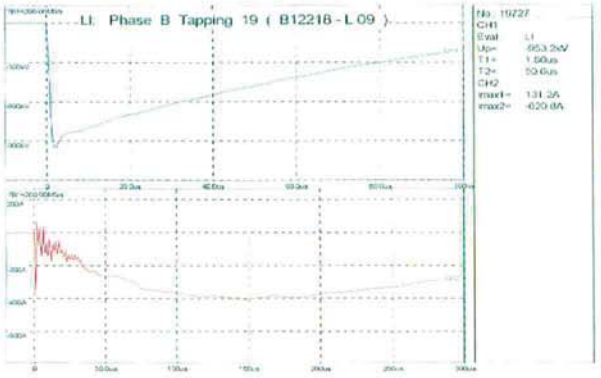

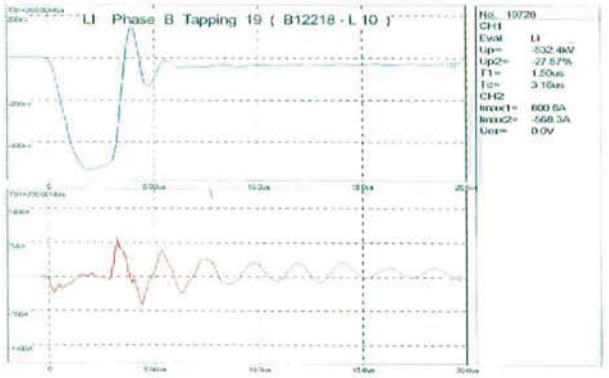

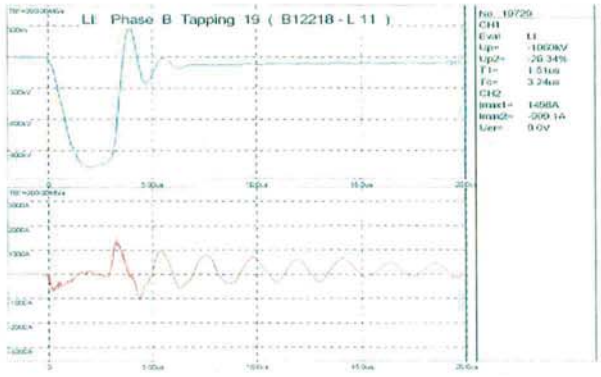

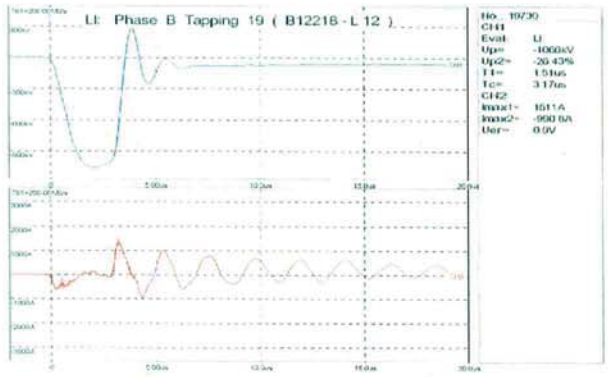

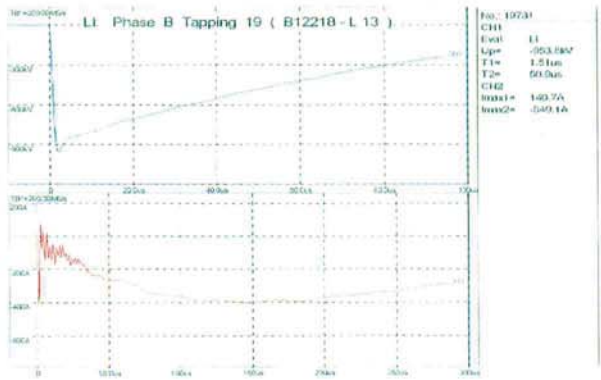

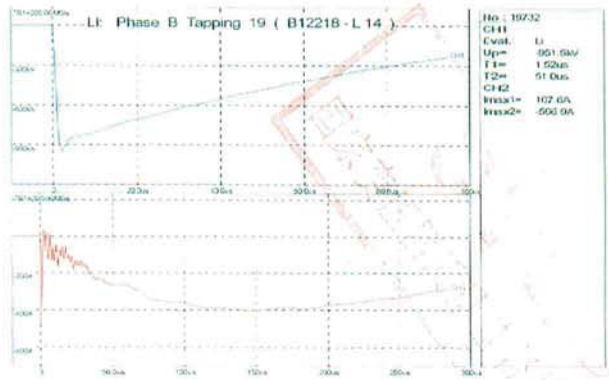

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Test Report

Tested terminal: C Test polarity: Negative CH1.Voltage records CH2. Neutral current records

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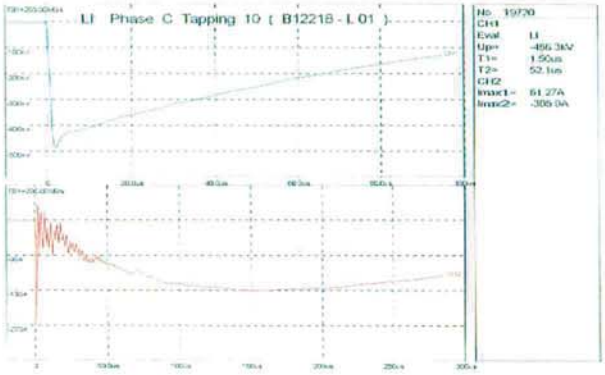

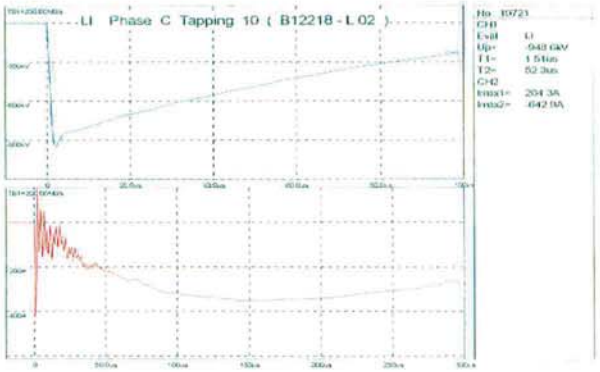

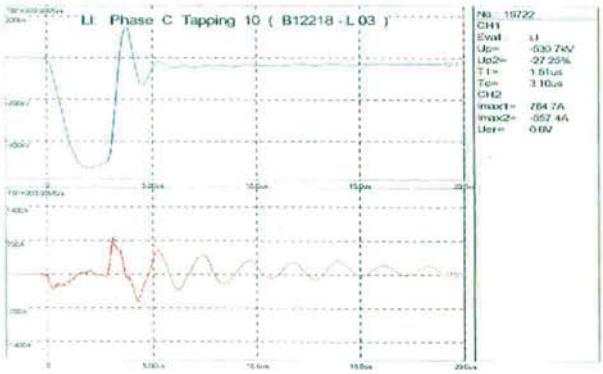

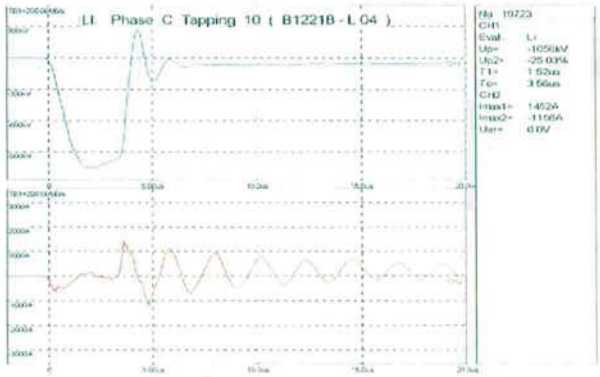

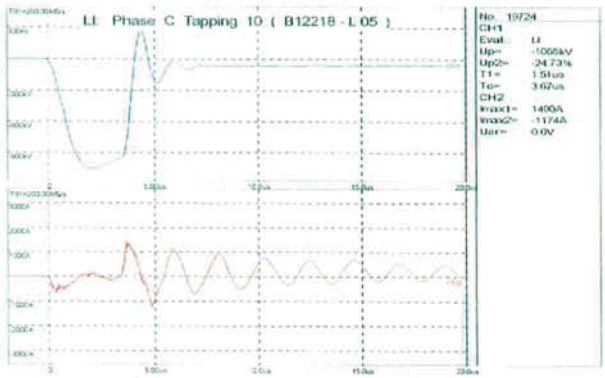

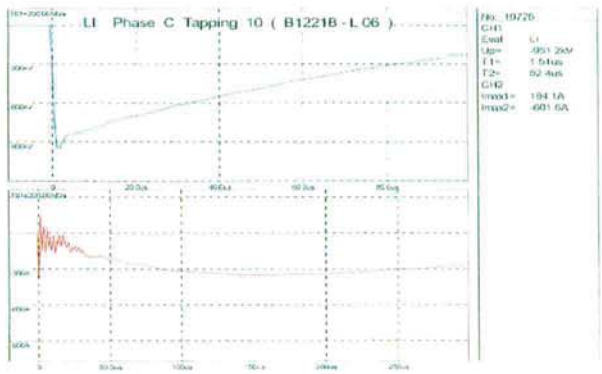

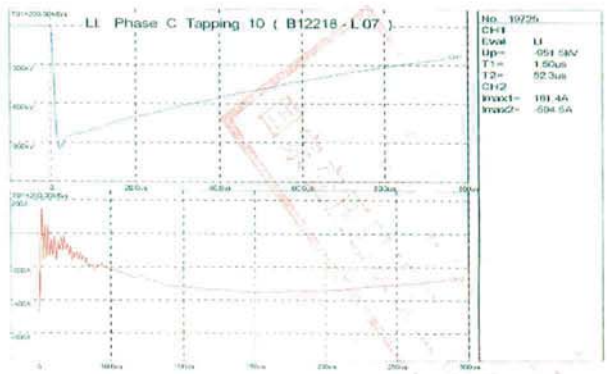

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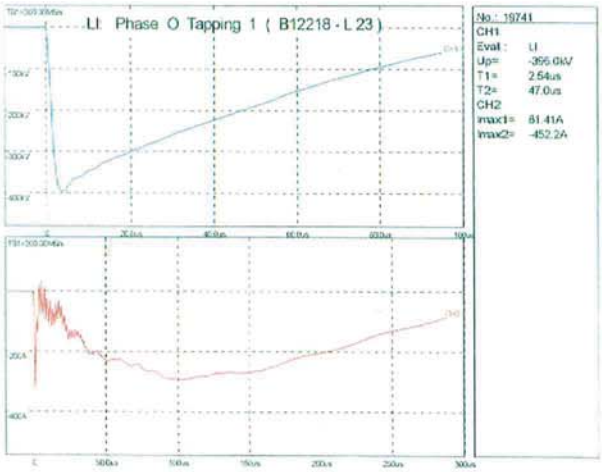
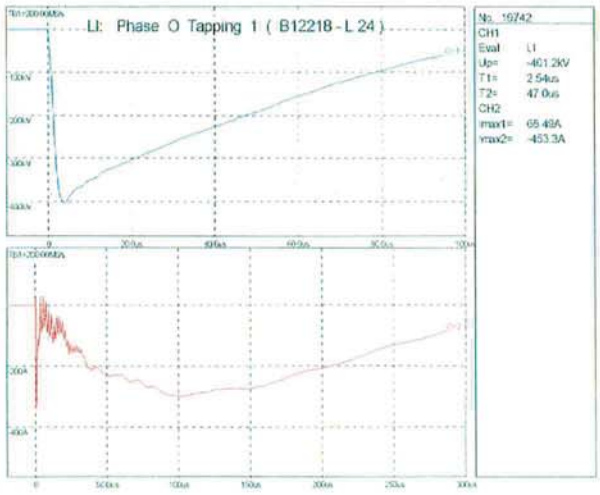
Test Report

Tested terminal: O Test polarity: Negative CH1. Voltage records CH2. Neutral current records





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Test Report

Tested terminal: a Test polarity: Negative CH1.Voltage records CH2. Neutral current records

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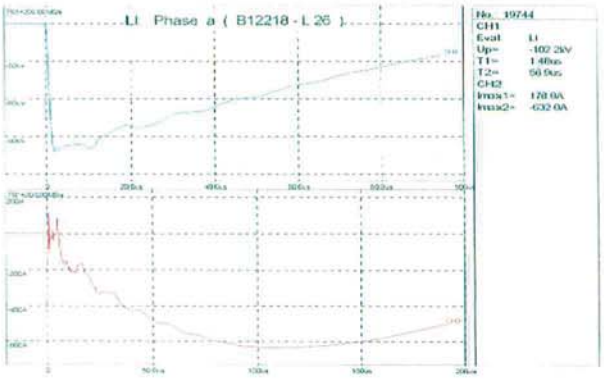

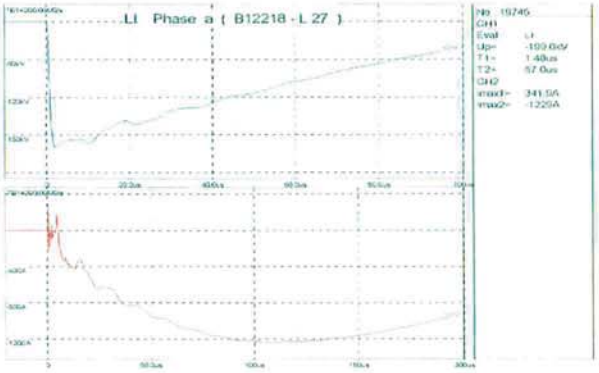

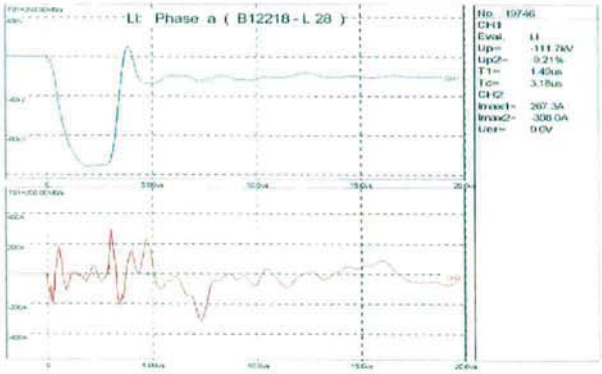

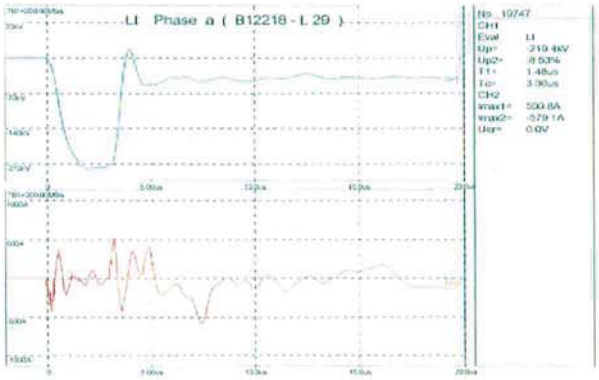

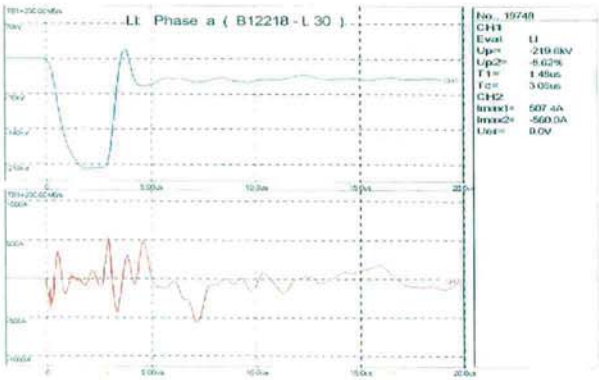

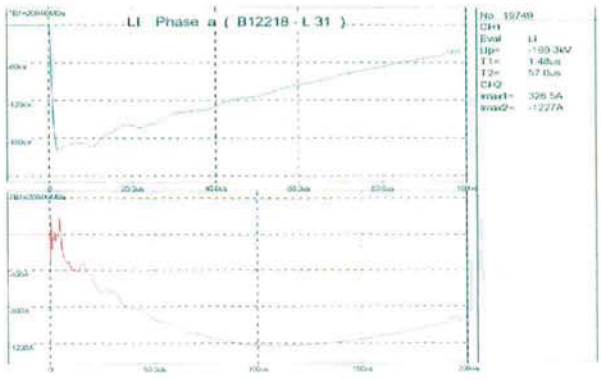

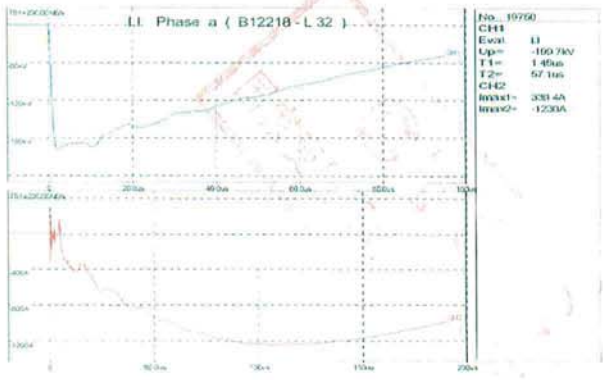

Test Report

№: CTQC/B-12.218
Total 60 Page 36

Tested terminal: b Test polarity: Negative CH1.Voltage records CH2. Neutral current records

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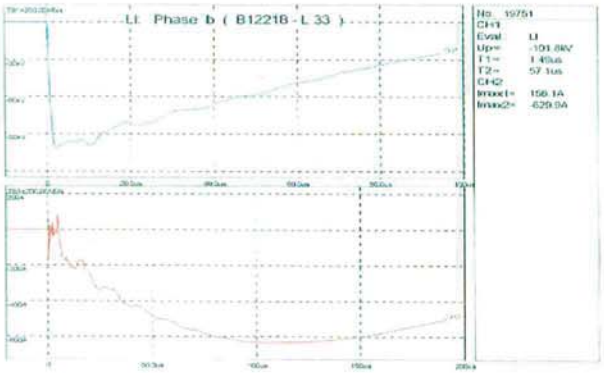

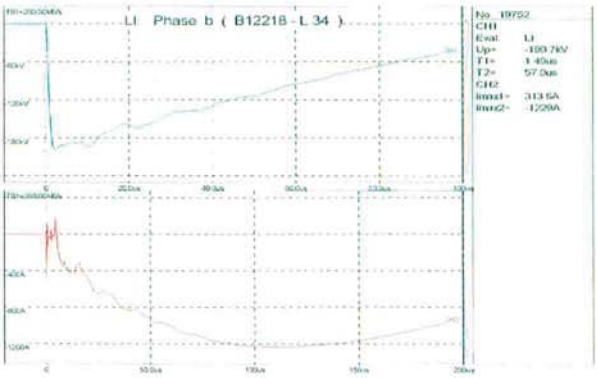

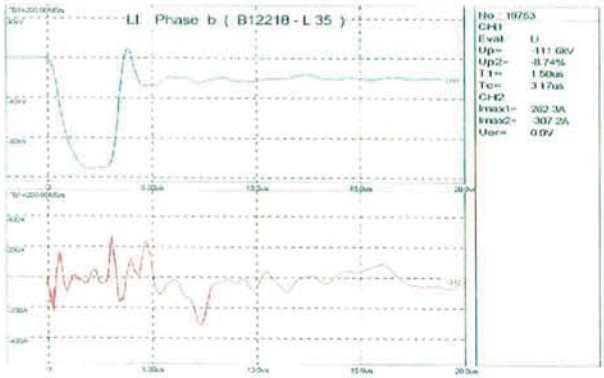

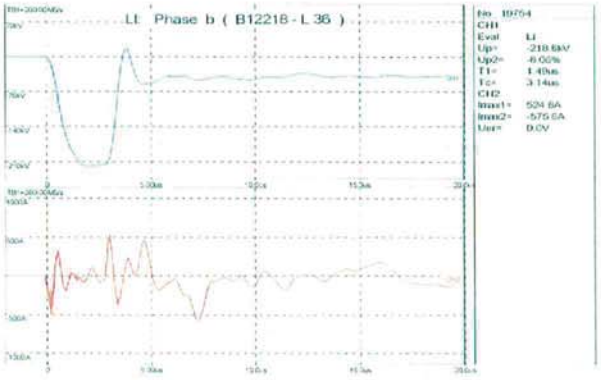

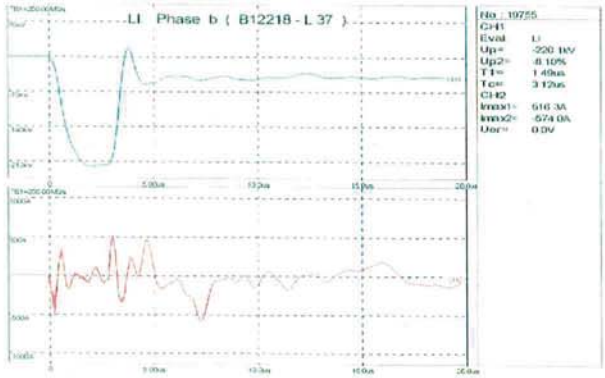

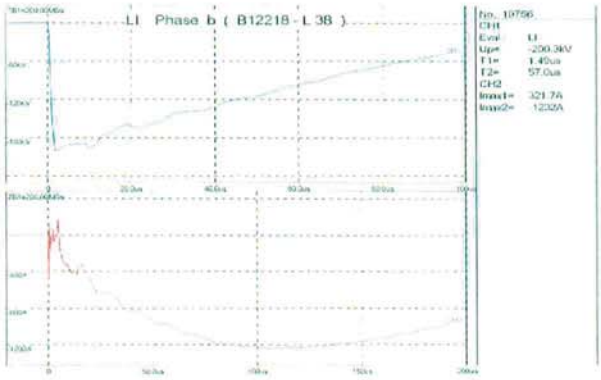

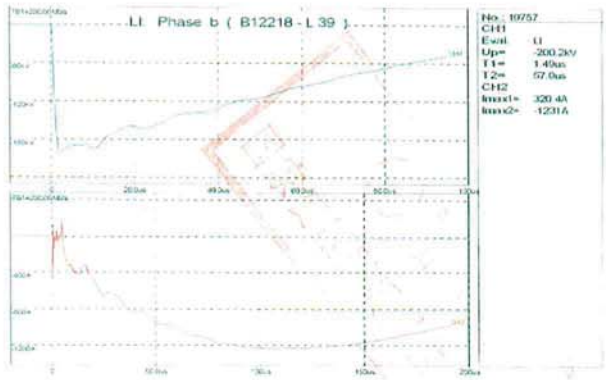

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Test Report

Tested terminal: c Test polarity: Negative CH1. Voltage records CH2. Neutral current records

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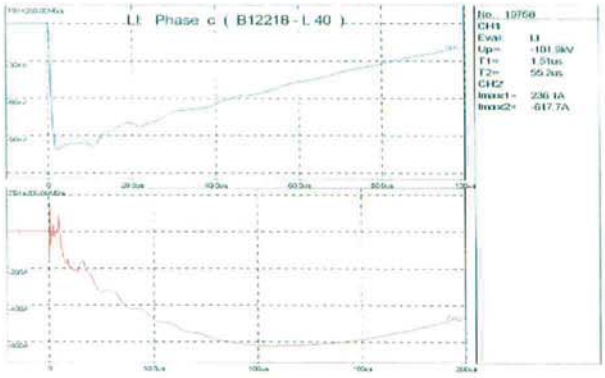
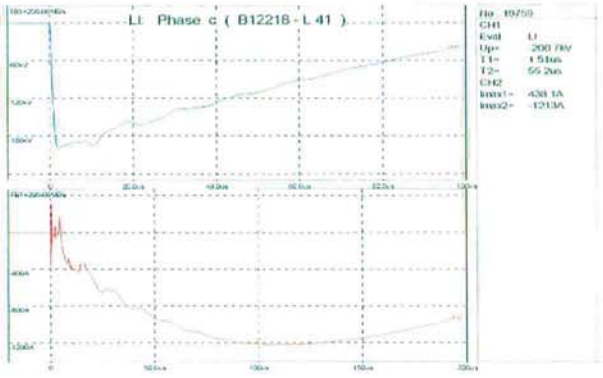
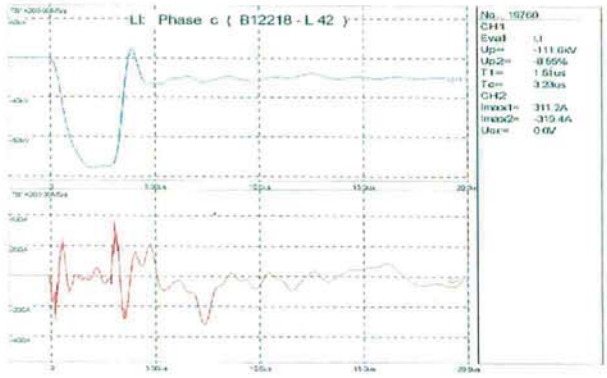
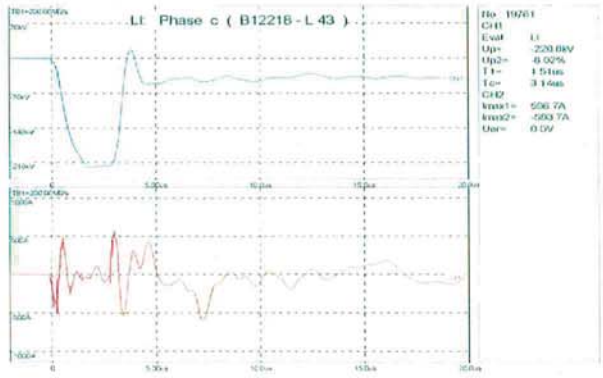
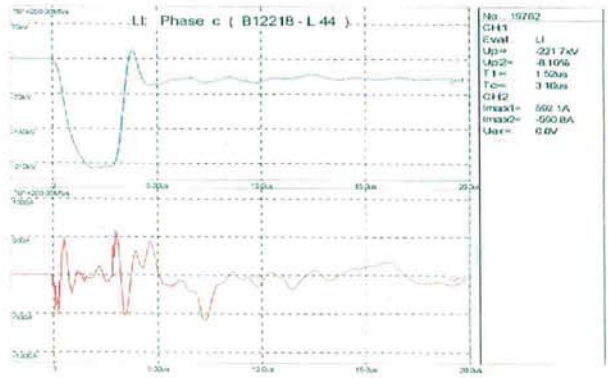
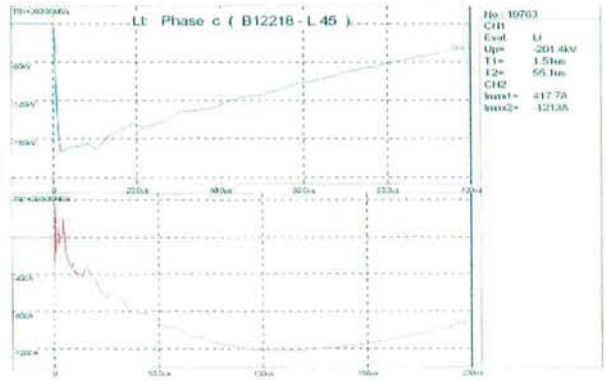


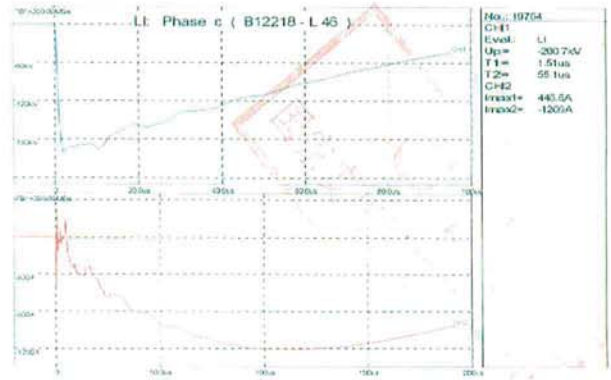






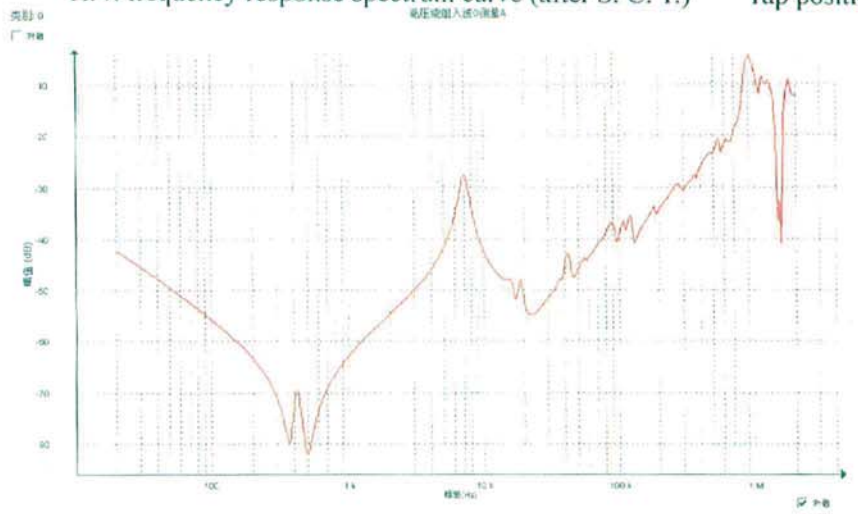


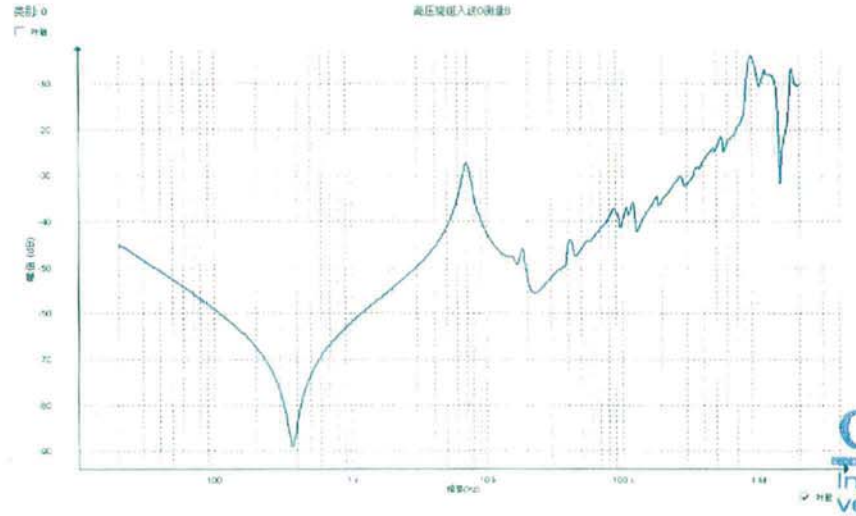


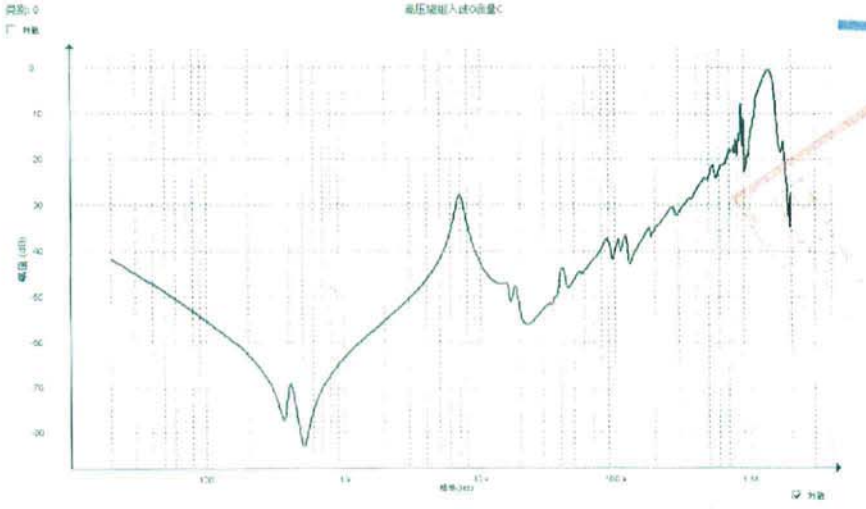


4.17 Measurement of analysis of winding frequency response spectrum (Special test)
Test date: Oct.12,2012

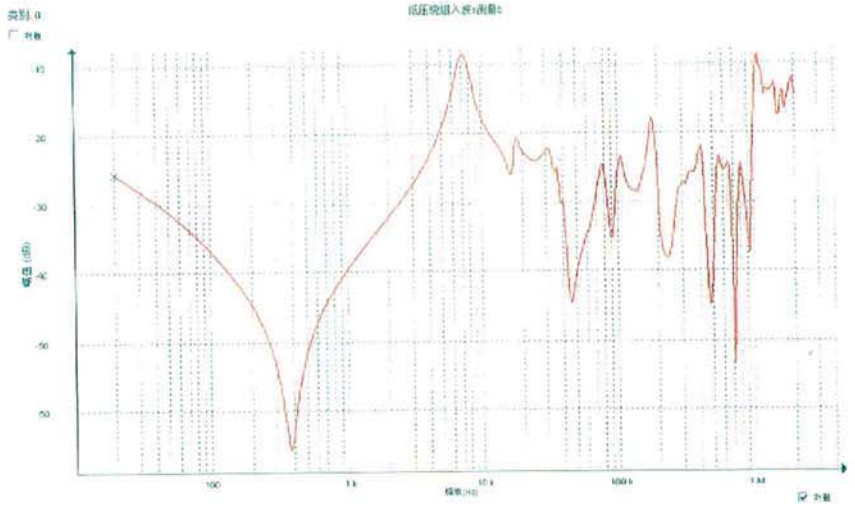
H.V. frequency response spectrum curve (after S. C. T.) Tap position.:1

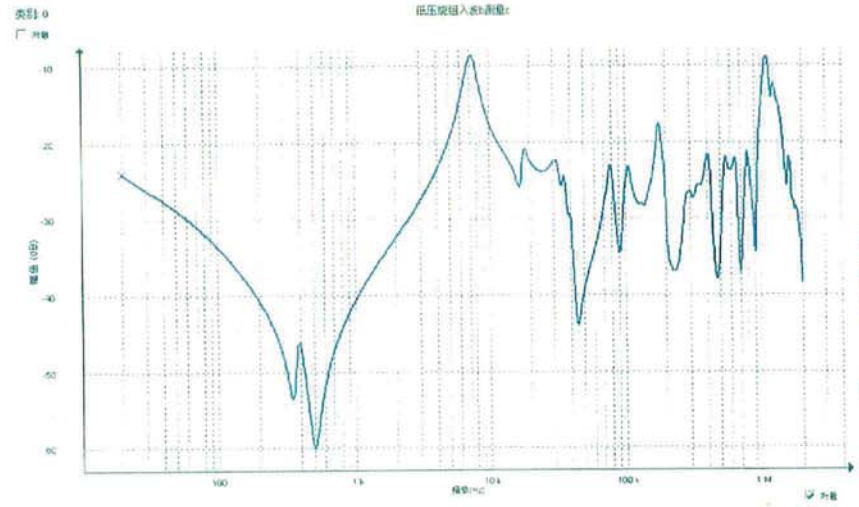


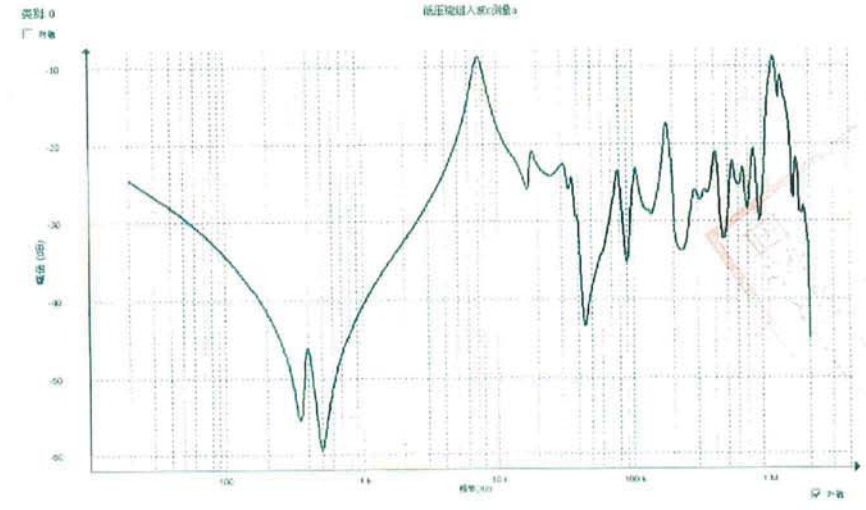




L.V. frequency response spectrum curve (after S. C. T.)







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4.18 Short-duration AC withstand voltage test(Special test) Test date: Oct.13,2012

Test circuit is given in Annex2-g

4.18.1 A phase-to-earth test with single-phase supply

H.V. tap position 6, frequency 200Hz.

Induced voltage		Duration	Partial discharge levels (pC)		
Multiple	Phase-to-earth (kV)		A	B	C
$1.1Um/\sqrt{3}$	160	5 min	<10	<10	<10
$U_2=1.5Um/\sqrt{3}$	218	5 min	<10	<10	<10
U_1	395	30s	/	/	/
$U_2=1.5Um/\sqrt{3}$	218	5 min	<10	<10	<10
$1.1Um/\sqrt{3}$	160	5 min	<10	<10	<10

Note: Um=252kV

Background noise level is <10pC before and after test.

4.18.2 A phase-to-phase test with three-phase supply

H.V. tap position 10, frequency 200Hz.

Induced voltage		Duration	Partial discharge levels (pC)		
Multiple	Phase-to-phase (kV)		A	B	C
1.1Um	277.2	5 min	<10	<10	<10
$U_2=1.3Um$	327.6	5 min	<10	<10	<10
U_1	395	30s	/	/	/
$U_2=1.3Um$	327.6	5 min	<10	<10	<10
1.1Um	277.2	5 min	<10	<10	<10

Note: Um=252kV; Background noise level is <10pC before and after test.

Result: Passed.

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4.19 Determination of sound levels(Special test) Test date: Oct.17,2012

4.19.1 Sound power level calculation under on load current:

Calculation equation: $L_{WA.IN} \approx 39 + 18\lg\frac{Sr}{Sp} = 75dB\ (A)$

In which: Sr—Rated power 100MVA;

Sp—Reference power 1MVA。

$L_{WA.IN}$ is found to be 19dB(A) below the guaranteed sound power level 94dB(A), so load current sound measurements are not appropriate.

4.19.2 Sound pressure level measurement and sound power level calculation

Transformer is energized at rated voltage. There are 33 measurement points, the measurement point interval is 0.74m, The height of oil tank is 3.92m, the height of measurement points is 1.31m and 2.62m.

Environmental conditions

Area of the surface of the test room Sv (㎡)	Mean sound absorption coefficient α	Sound absorption A (㎡)	d (m)	Area of effective surface S (㎡)	Environmental correction factor K dB(A)
13968	0.5	6984	0.3	120.25	0.29

d—Distance between specified contour and principal radiating surface.

Test results dB (A)

Cooling method	The average noise level of background		The average noise level of transformer $\overline{L_{PAO}}$	A-weighted surface sound pressure level $\overline{L_{PA}} = 10\lg(10^{0.1\overline{L_{p,in}}} - 10^{0.1\overline{L_{bgA}}}) - K$	A-weighted sound power level $L_{WA.UN} = \overline{L_{PA}} + 10\lg(S/S_0)$
	Before	After			
ONAN	35.7	35.9	64.9	65	86

$\overline{L_{PAO}}$—Uncorrected average A-weighted sound pressure level. $\overline{L_{PAO}} = 10\lg(\frac{1}{N}\sum_{i=1}^{N} 10^{0.1L_{PAi}})$

$\overline{L_{bgA}}$—The lower of the two calculated average A-weighted background sound pressure level.

According to 4.19.1, $L_{WA.SN}$= 86dB(A)

Result: Passed.

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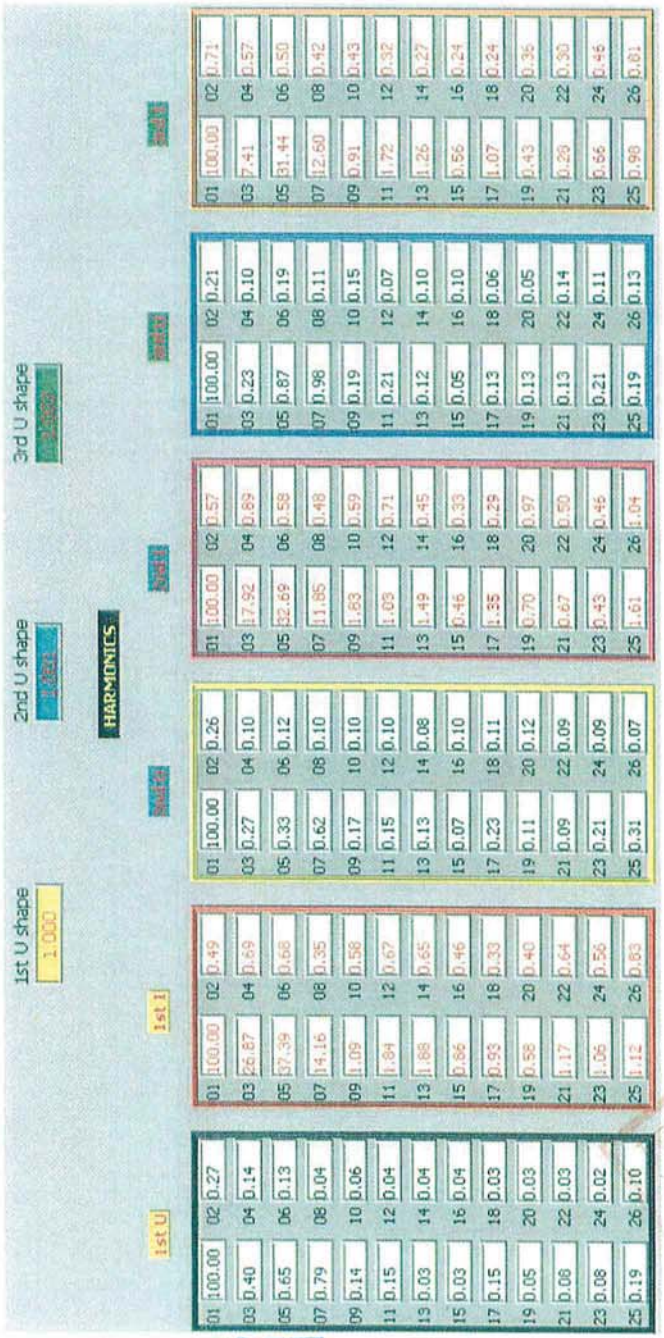
4.20 Measurement of the harmonics of the no-load current (Special test) Test date: Oct.17,2012

Test circuit is given in Annex2-h



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4.21 Radio interference voltage measurement (Special test) Test date: Oct.17, 2012

Measured frequency (MHz)	Term-inal	Attenuation factorof resistance network (dB)	Attenuation factor of measurement circuit (dB)	Radio interference Level B (dB)	Applie Voltage (kV)	Radio interference level (μv)
1.475	A	22	18	13	277.2	467
	B		19	10		355
	C		17.5	14		473

Result: No apparent discharge, passed.

(*)4.22 Long duration no-load test(Special test) Test date: Oct.17, 2012

Apply 1.1 rated voltage 40.7kV on L.V. winding side. There is not any C_2H_2 in oil before and after 12 hours no load test. Hydro carbons has no apparent change, gas chromatography shown in clause 4.8 item.

Duration (h)	Applied voltage (kV)		Measured current (A)	Load loss (kW)
	Reading of r.m.s. voltmeter	Reading of mean value voltmeter		
1	41.569	40.700	8.184	98.301
2	41.533	40.700	8.615	98.181
3	41.495	40.700	8.665	98.111
4	41.481	40.700	8.490	97.989
5	41.470	40.700	8.465	97.755
6	41.463	40.700	8.447	97.546
7	41.493	40.700	8.669	98.215
8	41.575	40.700	8.726	98.148
9	41.662	40.700	8.855	98.314
10	41.670	40.700	8.910	98.554
11	41.699	40.700	9.100	98.610
12	41.688	40.700	9.572	98.663

Result: Passed.

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ONLY (*)

4.23 Measurement of zero sequence impedance on three phase transformers(Special test)

Test circuit is given in Annex2-i Test date: Oct.18, 2012

Connection group	Tap position	Applied voltage terminal	Short circuit terminal	Applied current (A)	Measured voltage (V)	Impedance (Ω)
YNd11	10	A.B.C-O	/	117.29	2243	57.37

4.24 Leakage test(Routine test) Test date: Oct.18, 2012

Test method	Applied pressure (kPa)	Duration (h)	Residual pressure (kPa)	Result
Atmospheric pressure	30	24	30	No leakage oil and damage,passed.

4.25 Temperature-rise test(Type test) Test date: Oct.18, 2012

The test is conducted by means of short-circuit method, test duration is 14h, stability duration is 4h. Tap 19.
Measure top oil temperature-rise: Specified total loss is 388.15kW, injected total loss of 388.15kW during test.
Measure winding temperature-rise: Specified current is 291.59A, injected test current of 291.59A during test.

Conclusions of temperature-rise

Top oil temperature-rise (K)		55.7
Winding temperature-rise (K)	H.V.	60.1
	L.V.	61.9

Result: Passed.

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Legend: Data to be inserted

Time interval	Δt=	1	min
Initial average liquid temp.	θom_start=	57.5	℃
Final average-liquid temp.	θom_end=	52.0	℃
Liquid temperature slope	k=	0.18	K/min

Estimated winding time constant	Tw=	8.32	min
Estimated average liquid temp.	Ao=	62.73	℃
Estimated winding to liquid temp.	B=	15.06	K
Average winding temp. at the instant of shut down	θwo=	77.8	℃

Auxiliary variables:

tc= -8.0078

te= 0.1276

	n	sa	sb	sc	sd	se
Abs Sums:	28	11.44	1846.17	782.47	121949.39	5.95

Time (min)	R(i) (Ω) ×10^{-1}	θom(i)= Ao-kt	θwm(i) as measured	θwval(i)	θwcor(i)	u{_ (0/1)	θw(i) as corrected and validated	△θw(i) as per eq. (C.5)	θw(i) × △θw(i)	(θw(i))^2	e$^{(-i/Tw)}$	θw(i) as calculated
0		62.73										77.80
1		62.55										75.91
2	7.351	62.37	74.14	74.14	74.50	1						74.21
3	7.313	62.18	72.54	72.54	73.09	1	73.09	-1.415	-103.40	5342.14	0.6974	72.69
4	7.280	62.00	71.15	71.15	71.89	1	71.89	-1.204	-86.58	5167.53	0.6185	71.32
5	7.252	61.82	69.97	69.97	70.89	1	70.89	-0.994	-70.48	5025.58	0.5485	70.08
6	7.225	61.63	68.84	68.84	69.94	1	69.94	-0.952	-66.59	4891.50	0.4864	68.96
7	7.202	61.45	67.87	67.87	69.16	1	69.16	-0.784	-54.21	4782.46	0.4313	67.95
8	7.181	61.27	66.99	66.99	68.46	1	68.46	-0.700	-47.91	4686.16	0.3825	67.03
9	7.162	61.08	66.19	66.19	67.84	1	67.84	-0.616	-41.77	4602.24	0.3392	66.19
10	7.145	60.90	65.47	65.47	67.31	1	67.31	-0.532	-35.78	4530.40	0.3008	65.43
11	7.129	60.72	64.80	64.80	66.82	1	66.82	-0.490	-32.71	4464.74	0.2667	64.74
12	7.114	60.53	64.17	64.17	66.37	1	66.37	-0.447	-29.70	4405.14	0.2366	64.10
13	7.100	60.35	63.58	63.58	65.97	1	65.97	-0.405	-26.74	4351.49	0.2098	63.51
14	7.088	60.17	63.08	63.08	65.64	1	65.64	-0.321	-21.09	4309.20	0.1860	62.97
15	7.076	59.98	62.57	62.57	65.32	1	65.32	-0.321	-20.99	4267.12	0.1650	62.47
16	7.066	59.80	62.15	62.15	65.09	1	65.09	-0.237	-15.44	4236.19	0.1463	62.01
17	7.055	59.62	61.69	61.69	64.81	1	64.81	-0.279	-18.10	4199.91	0.1297	61.57
18	7.045	59.43	61.27	61.27	64.57	1	64.57	-0.237	-15.32	4169.22	0.1151	61.17
19	7.035	59.25	60.85	60.85	64.33	1	64.33	-0.237	-15.26	4138.65	0.1020	60.79
20	7.026	59.07	60.47	60.47	64.14	1	64.14	-0.195	-12.52	4113.58	0.0905	60.43
21	7.018	58.88	60.13	60.13	63.98	1	63.98	-0.153	-9.80	4093.96	0.0802	60.09
22	7.010	58.70	59.80	59.80	63.83	1	63.83	-0.153	-9.77	4074.39	0.0712	59.77
23	7.002	58.52	59.46	59.46	63.68	1	63.68	-0.153	-9.75	4054.87	0.0631	59.47
24	6.995	58.33	59.17	59.17	63.57	1	63.57	-0.111	-7.06	4040.74	0.0560	59.18
25	6.988	58.15	58.87	58.87	63.46	1	63.46	-0.111	-7.05	4026.64	0.0496	58.90
26	6.981	57.97	58.58	58.58	63.34	1	63.34	-0.111	-7.03	4012.56	0.0440	58.63
27	6.975	57.78	58.33	58.33	63.28	1	63.28	-0.069	-4.37	4003.82	0.0390	58.37
28	6.969	57.60	58.07	58.07	63.21	1	63.21	-0.069	-4.36	3995.10	0.0346	58.12
29	6.963	57.42	57.82	57.82	63.14	1	63.14	-0.069	-4.36	3986.38	0.0307	57.88
30	6.957	57.23	57.57	57.57	63.07	1	63.07	-0.069	-4.35	3977.67	0.0272	57.64

H.V. Winding temp.-rise (K): $\Delta\theta_{WH} = (\theta_{w0} - \theta_{om\_start}) \times \left(\frac{I_{rated}}{I_{start}}\right)^{y} + \Delta\theta_{om} = (77.8 - 57.5) \times \left(\frac{291.59}{291.59}\right)^{1.6} + 39.8 = 60.1$

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Legend: Data to be inserted

Time interval	△t=	1	min
Initial average liquid temp.	θom_start=	57.5	℃
Final average-liquid temp.	θom_end=	52.0	℃
Liquid temperature slope	k=	0.18	K/min

Estimated winding time constant	Tw=	8.81	min
Estimated average liquid temp.	Ao=	62.58	℃
Estimated winding to liquid temp.	B=	17.02	K
Average winding temp. at the instant of shut down	θwo=	79.6	℃

Auxiliary variables:

tc= -7.5210

te= 0.1202

	n	sa	sb	sc	sd	se
Abs Sums:	27	11.54	1785.67	790.41	118323.76	5.64

Time (min)	R(i) (Ω) ×10 $^{-2}$	θom(i)= Ao-kt	θwm(i) as measured	θwval(i)	θwcor(i)	u_i (0/1)	θw(i) as corrected and validated	△θw(i) as per eq. (C.5)	θw(i) × △θw(i)	(θw(i)) ^{2}	e $^{(-i/Tw)}$	θw(i) as calculated
0		62.58										79.59
1		62.40										77.59
2	2.805	62.21	77.53	74.14	77.90	0						75.77
3	2.774	62.03	74.07	74.07	74.62	1	73.09	-1.415	-103.40	5342.14	0.6974	74.13
4	2.760	61.85	72.51	72.51	73.25	1	73.25	-1.377	-100.83	5365.28	0.6351	72.65
5	2.748	61.66	71.18	71.18	72.09	1	72.09	-1.154	-83.17	5197.60	0.5670	71.31
6	2.737	61.48	69.95	69.95	71.05	1	71.05	-1.042	-74.06	5048.40	0.5061	70.09
7	2.728	61.30	68.95	68.95	70.23	1	70.23	-0.819	-57.55	4932.63	0.4518	68.98
8	2.719	61.11	67.95	67.95	69.41	1	69.41	-0.819	-56.88	4818.20	0.4034	67.98
9	2.710	60.93	66.94	66.94	68.59	1	68.59	-0.819	-56.21	4705.11	0.3601	67.06
10	2.703	60.75	66.16	66.16	68.00	1	68.00	-0.597	-40.57	4623.62	0.3214	66.22
11	2.697	60.56	65.50	65.50	67.51	1	67.51	-0.485	-32.76	4557.87	0.2870	65.45
12	2.690	60.38	64.72	64.72	66.92	1	66.92	-0.597	-39.92	4477.68	0.2562	64.74
13	2.685	60.20	64.16	64.16	66.54	1	66.54	-0.374	-24.87	4427.79	0.2287	64.09
14	2.680	60.01	63.60	63.60	66.17	1	66.17	-0.374	-24.73	4378.19	0.2042	63.49
15	2.675	59.83	63.04	63.04	65.79	1	65.79	-0.374	-24.59	4328.87	0.1823	62.93
16	2.671	59.65	62.60	62.60	65.53	1	65.53	-0.262	-17.19	4294.42	0.1627	62.41
17	2.666	59.46	62.04	62.04	65.16	1	65.16	-0.374	-24.35	4245.57	0.1452	61.93
18	2.662	59.28	61.60	61.60	64.90	1	64.90	-0.262	-17.02	4211.45	0.1297	61.49
19	2.658	59.10	61.15	61.15	64.63	1	64.63	-0.262	-16.96	4177.47	0.1157	61.07
20	2.654	58.91	60.70	60.70	64.37	1	64.37	-0.262	-16.89	4143.63	0.1033	60.67
21	2.651	58.73	60.37	60.37	64.22	1	64.22	-0.151	-9.69	4124.22	0.0922	60.30
22	2.647	58.55	59.92	59.92	63.96	1	63.96	-0.262	-16.78	4090.60	0.0823	59.95
23	2.644	58.36	59.59	59.59	63.81	1	63.81	-0.151	-9.63	4071.31	0.0735	59.61
24	2.642	58.18	59.37	59.37	63.77	1	63.77	-0.040	-2.52	4066.27	0.0656	59.30
25	2.638	58.00	58.92	58.92	63.51	1	63.51	-0.262	-16.66	4032.89	0.0586	58.99
26	2.636	57.81	58.70	58.70	63.47	1	63.47	-0.040	-2.51	4027.87	0.0523	58.70
27	2.633	57.63	58.36	58.36	63.31	1	63.31	-0.151	-9.56	4008.74	0.0467	58.42
28	2.631	57.45	58.14	58.14	63.28	1	63.28	-0.040	-2.50	4003.74	0.0417	58.16
29	2.628	57.26	57.81	57.81	63.12	1	63.12	-0.151	-9.53	3984.66	0.0372	57.90
30	2.626	57.08	57.58	57.58	63.08	1	63.08	-0.040	-2.49	3979.67	0.0332	57.64

L.V. Winding temp.-rise (K): $\Delta\theta_{WL} = (\theta_{w0} - \theta_{om\_start}) \times \left(\frac{I_{rated}}{I_{start}}\right)^{y} + \Delta\theta_{om} = (79.6 - 57.5) \times \left(\frac{291.59}{291.59}\right)^{1.6} + 39.8 = 61.9$

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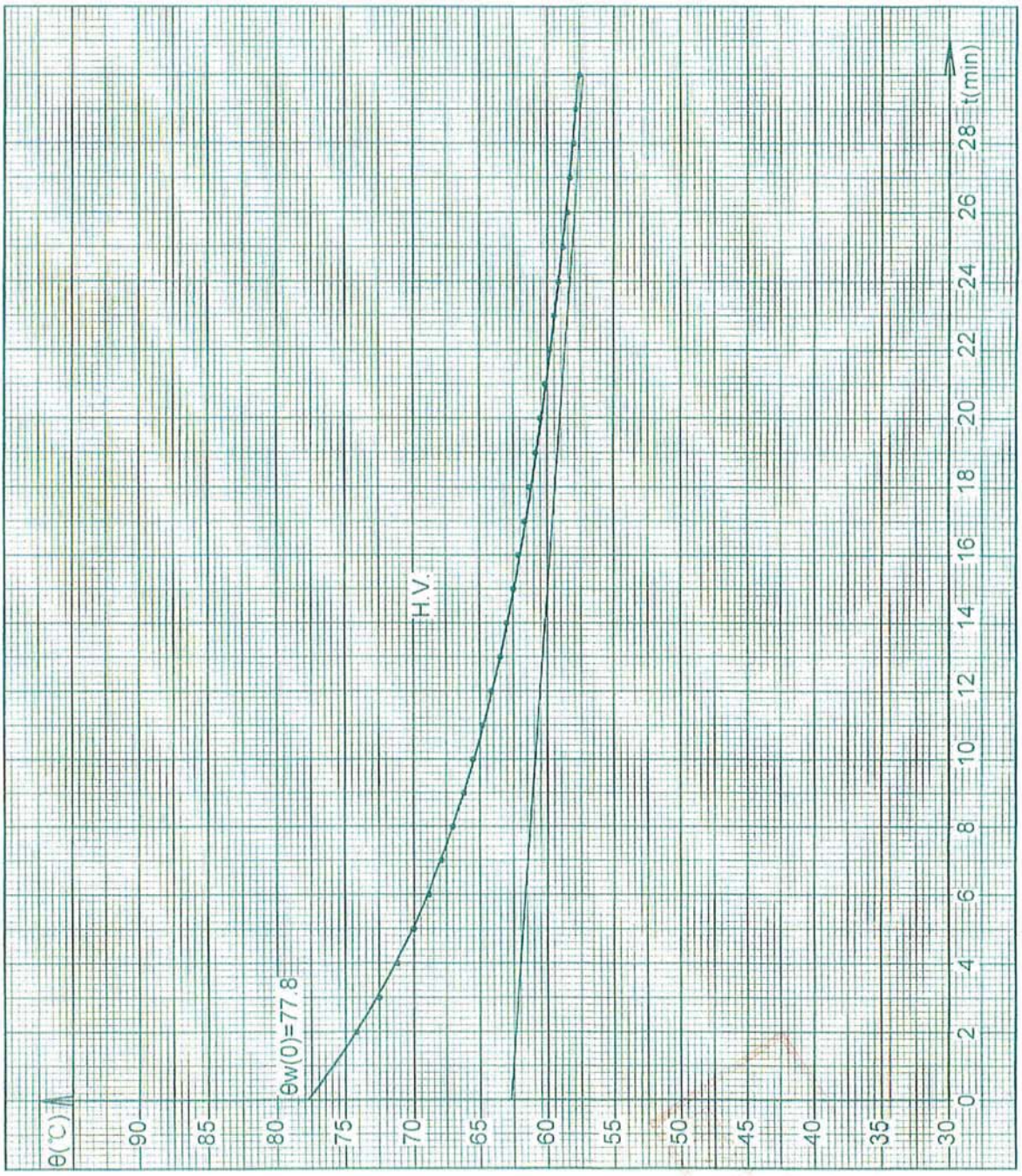

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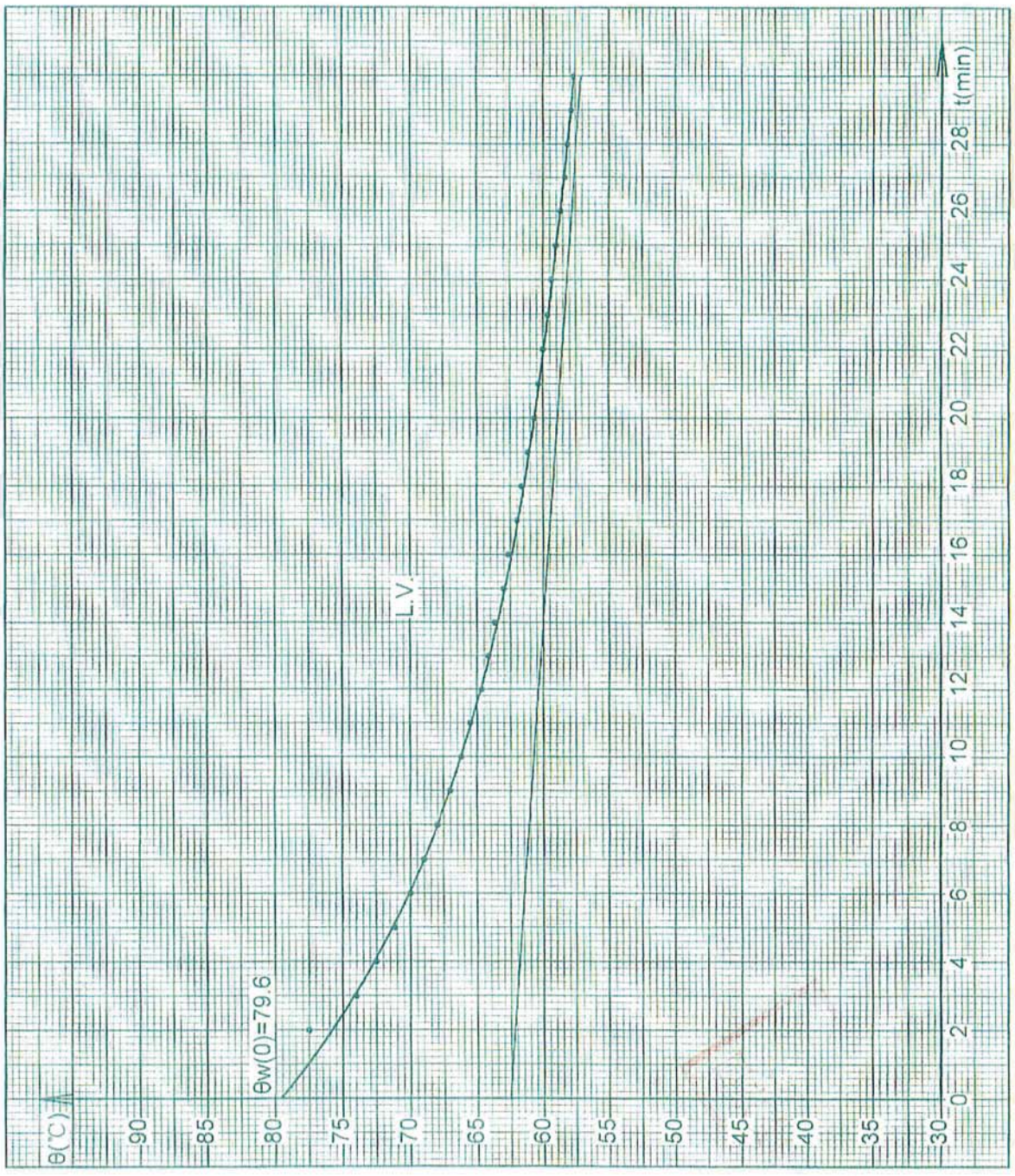

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4.26 Determination of transient voltage transfer characteristics Test date: Oct.19, 2012

Test circuit is given in Annex 2-j

Full wave voltage parameter	U1=100V(1.52/40.0 μ s)								
Measured resistance (Ω)	45	60	120	160	260	500	620	740	∞
Measured voltage(V)	3.3	4.2	7.5	9.2	12.9	18.3	20.8	22.4	39.8

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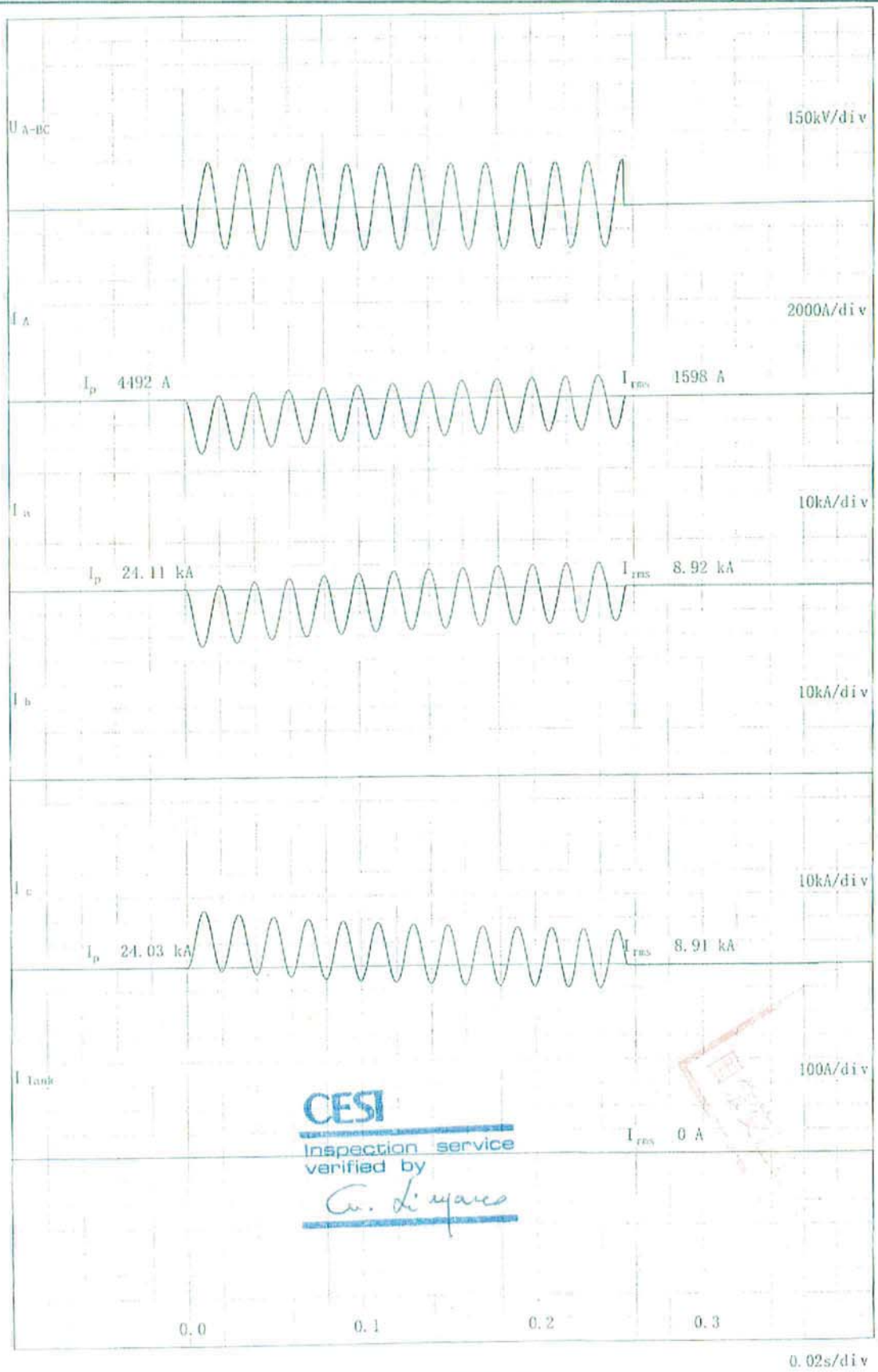

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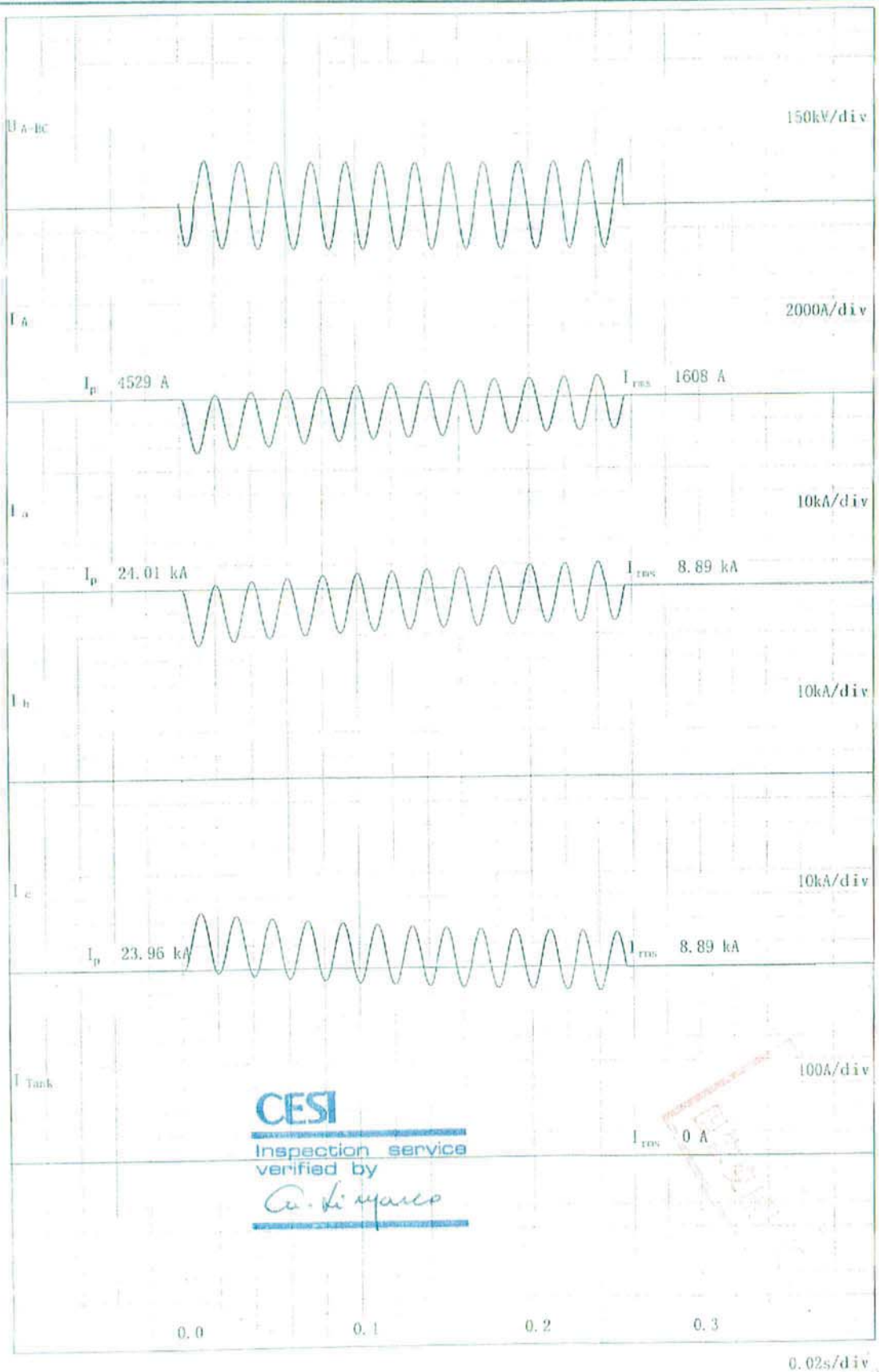

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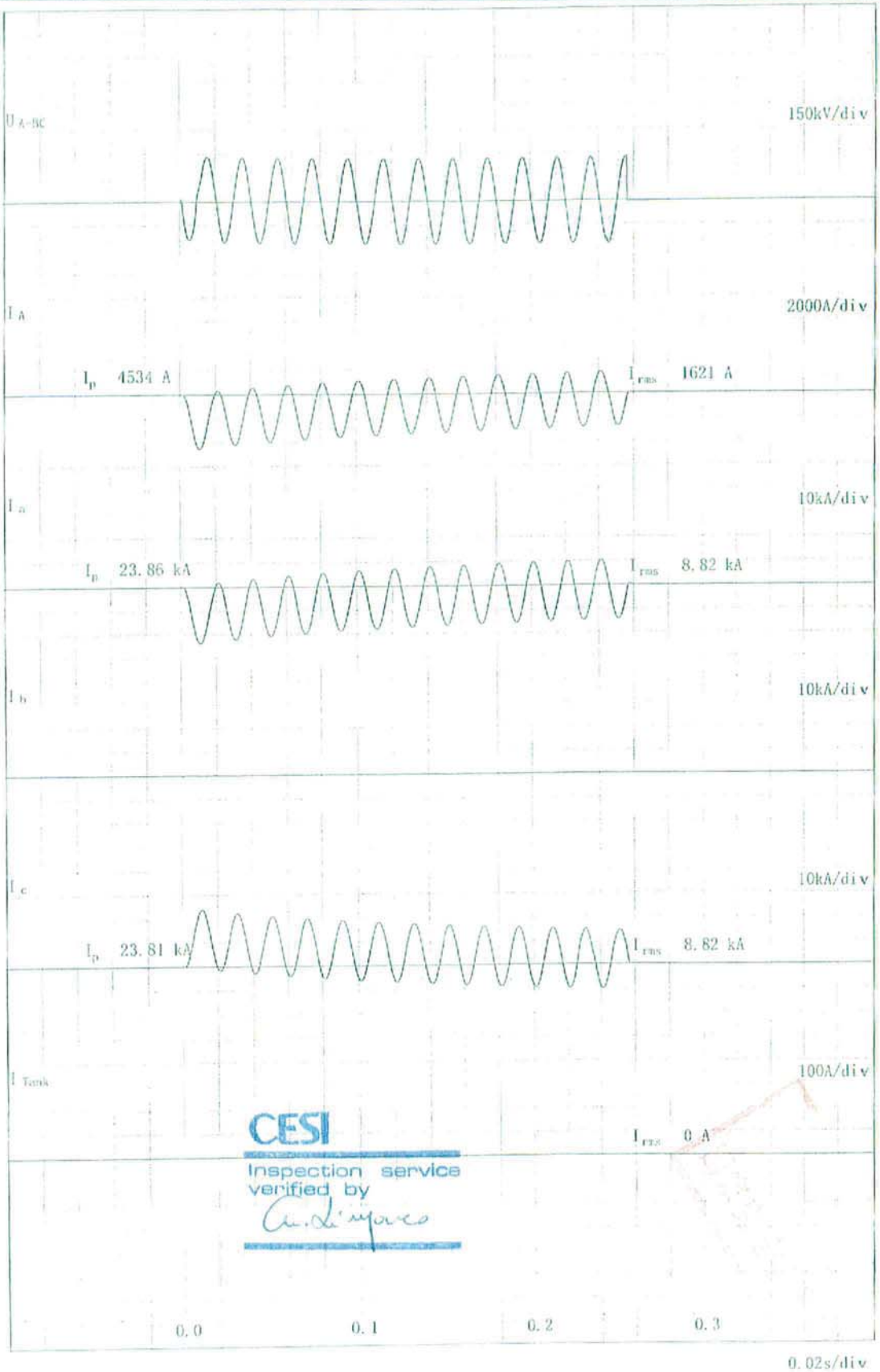

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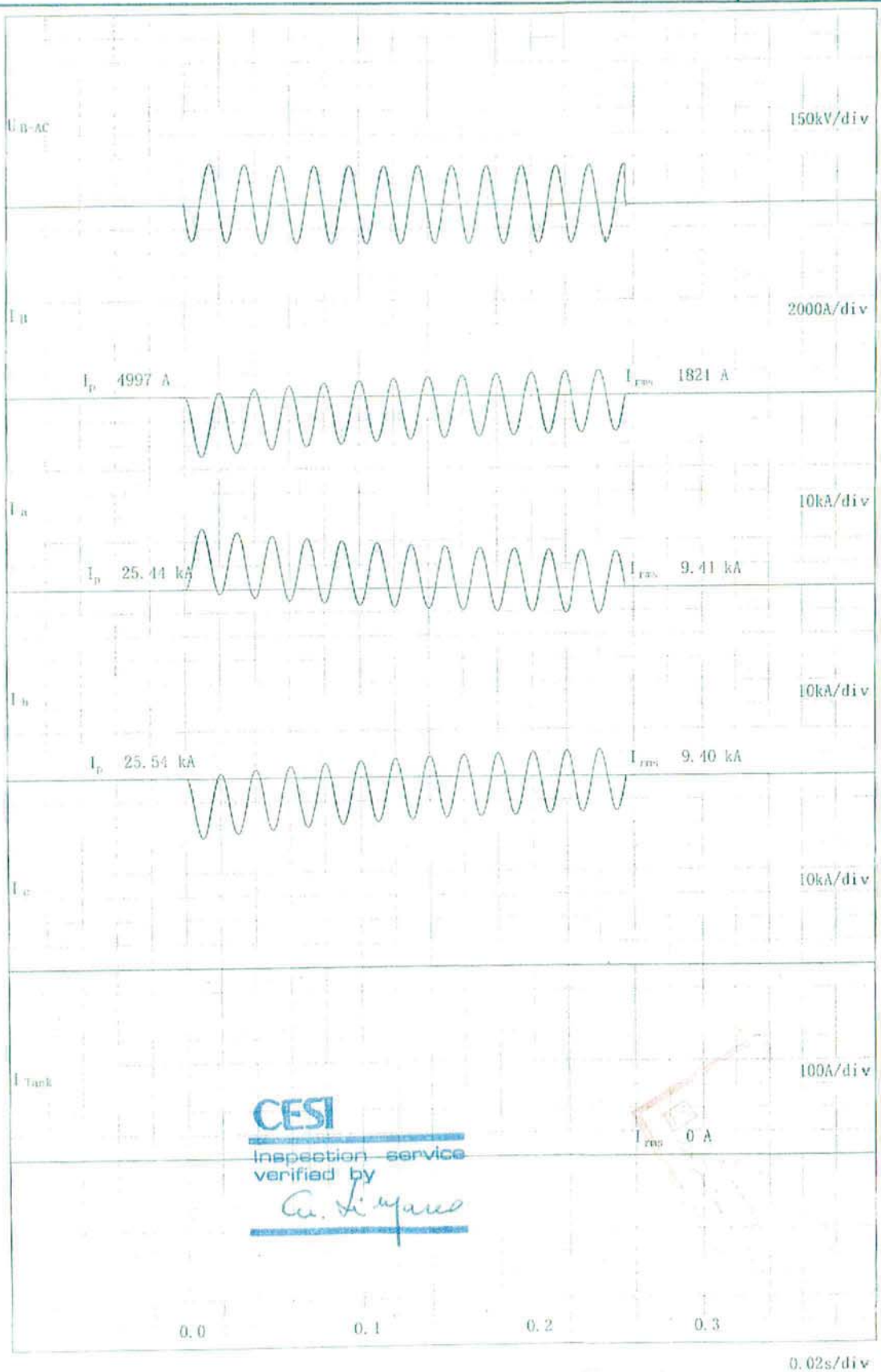

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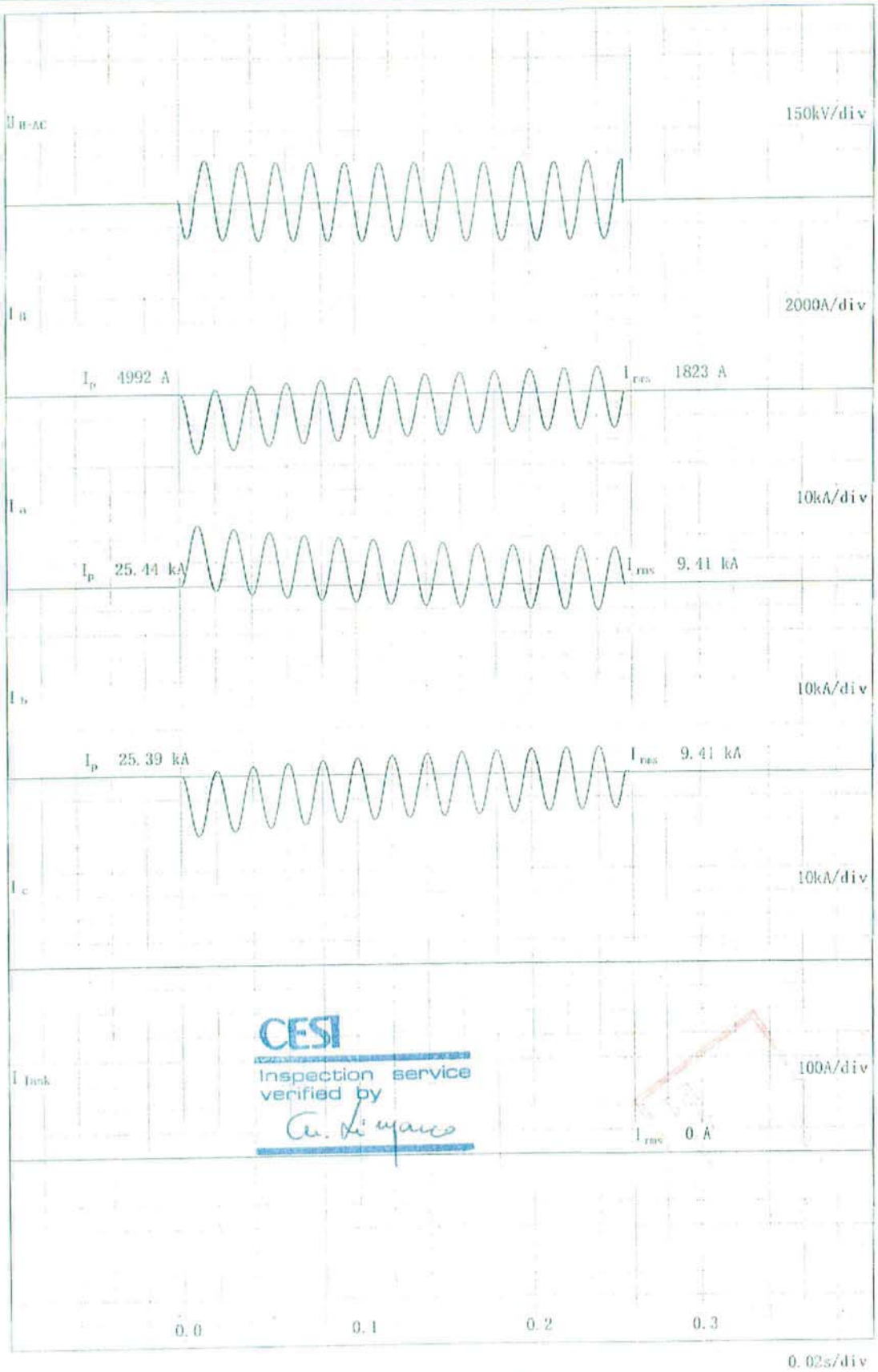

CESI
Inspection service
verified by

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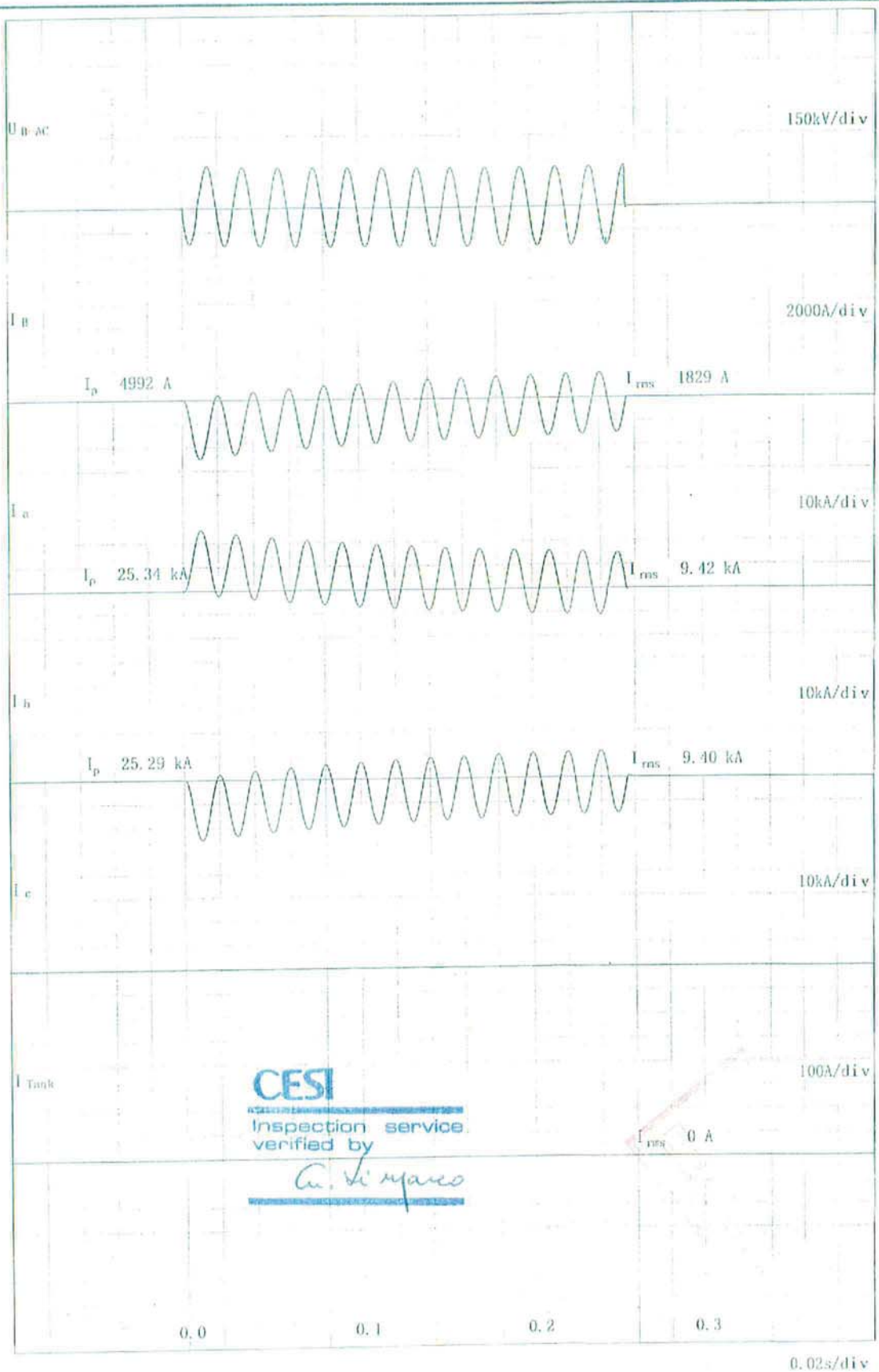
Test Report



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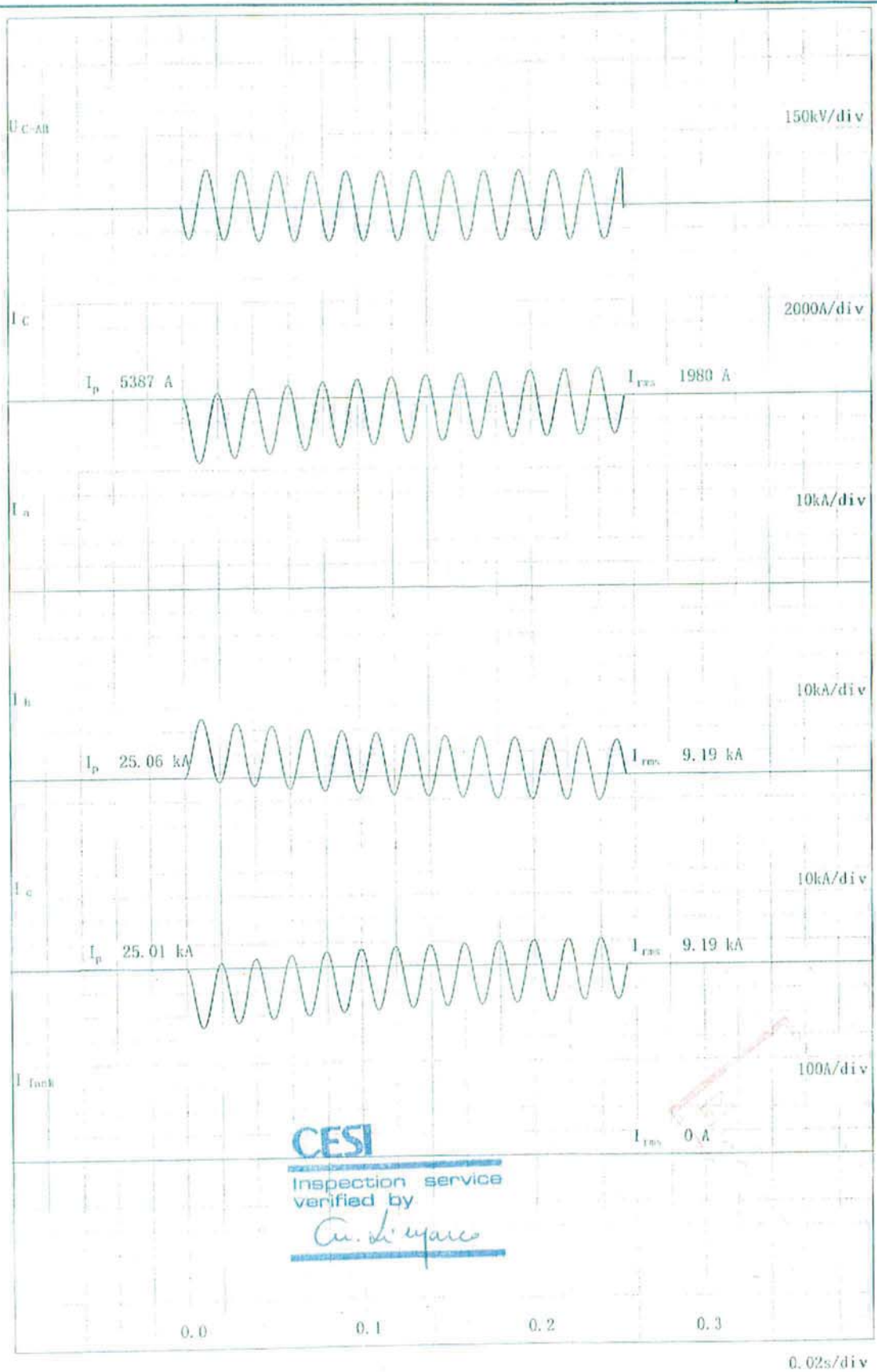
E-mail: ctqc@vip.sina.com http: //www.ctn.cn Fax: (024)89707949 Tel: (024)89872527

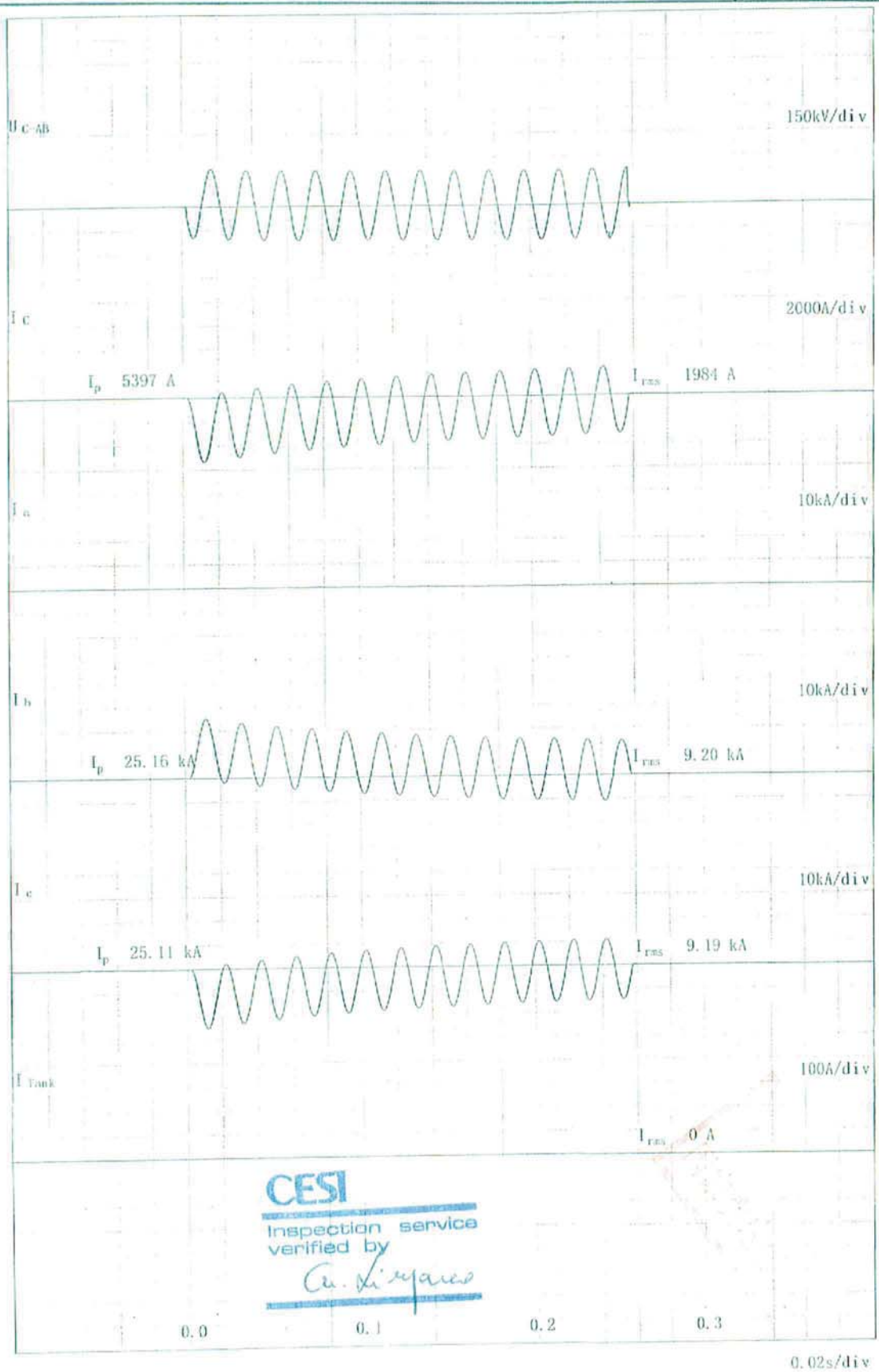
Test Report



B12218-S07

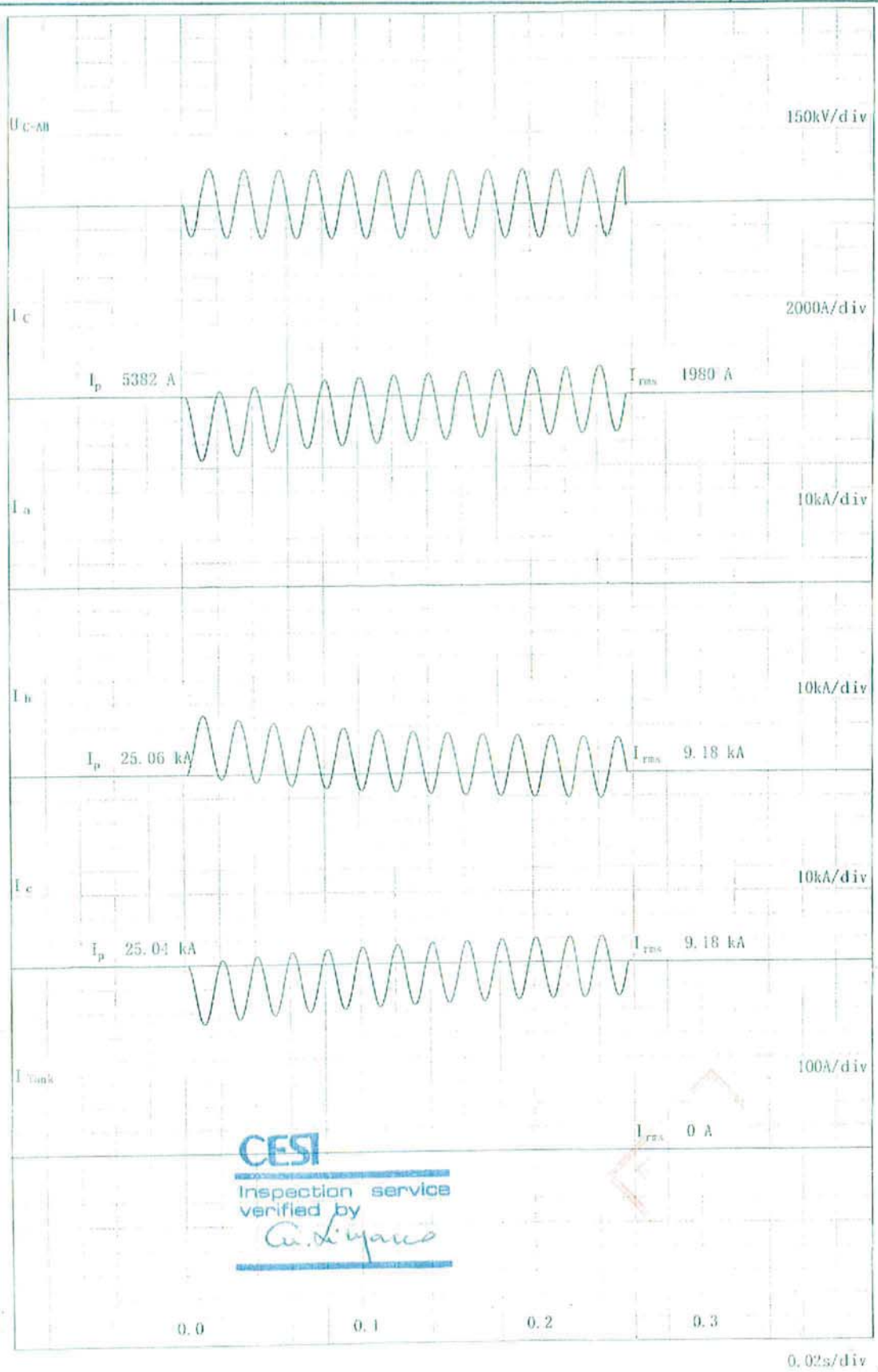
Address: Hushitai Sounth Avenue No. 18, Shenbei New District, Shenyang Postal code: 110122 Tel: (024)89874449
E-mail: ctqc@vip.sina.com http: //www.ctn.cn Fax: (024)89707949 Tel: (024)89872527

Test Report



B12218-S08

Address: Hushitai South Avenue No. 18, Shenbei New District, Shenyang Postal code: 110122 Tel: (024)89874449
E mail: ctqc@vip.sina.com http: //www.ctn.cn Fax: (024)89707949 Tel: (024)89872527


U_{C-AB}
150kV/div
I_C
2000A/div
I_p 5382 A
I_{rms} 1980 A
I_a
10kA/div
I_b
10kA/div
I_p 25.06 kA
I_{rms} 9.18 kA
I_c
10kA/div
I_p 25.04 kA
I_{rms} 9.18 kA
I_{Tank}
100A/div
I_{rms} 0 A
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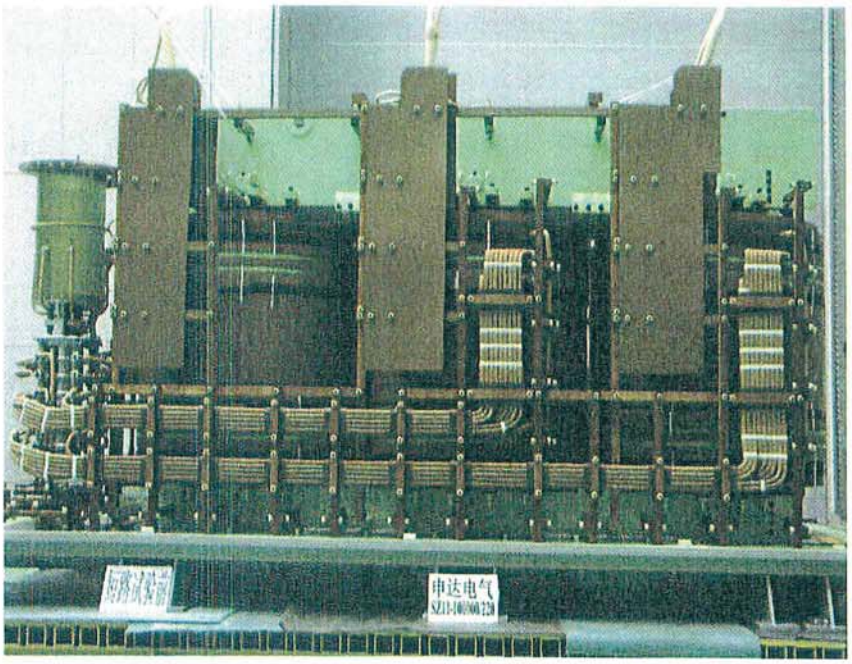
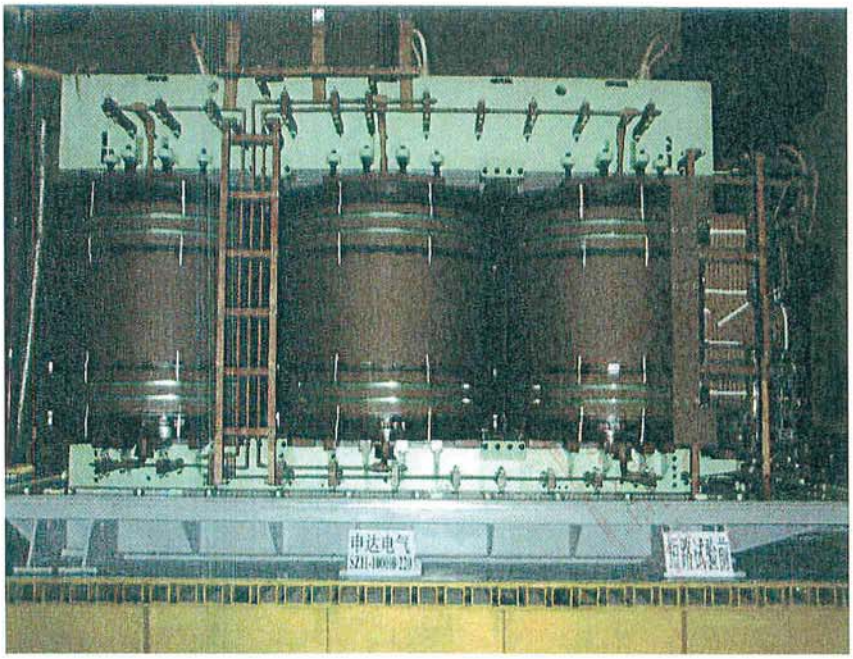
0.0
0.1
0.2
0.3
0.02s/div

B12218-S09

H.V. before S.C.T.:



L.V. before S.C.T.:



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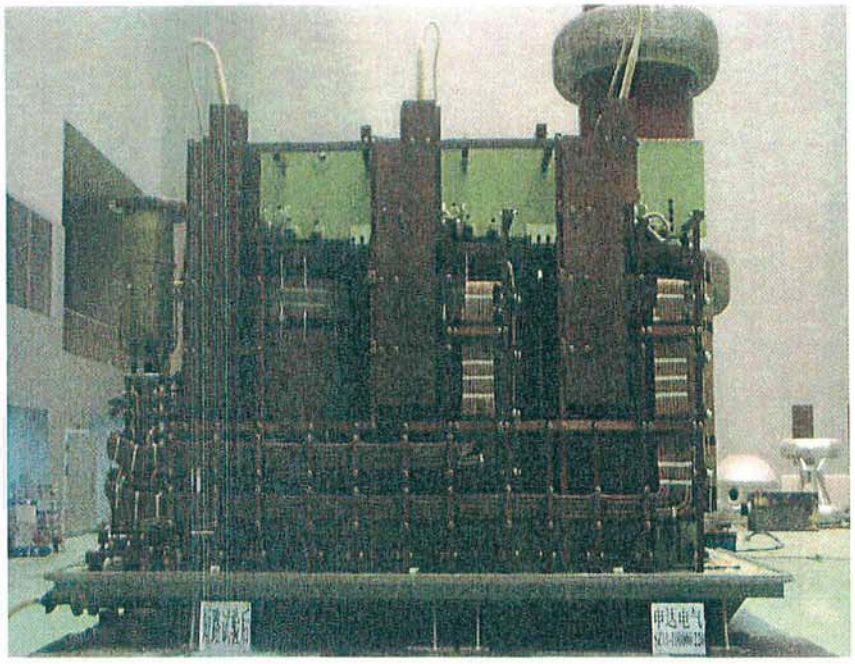
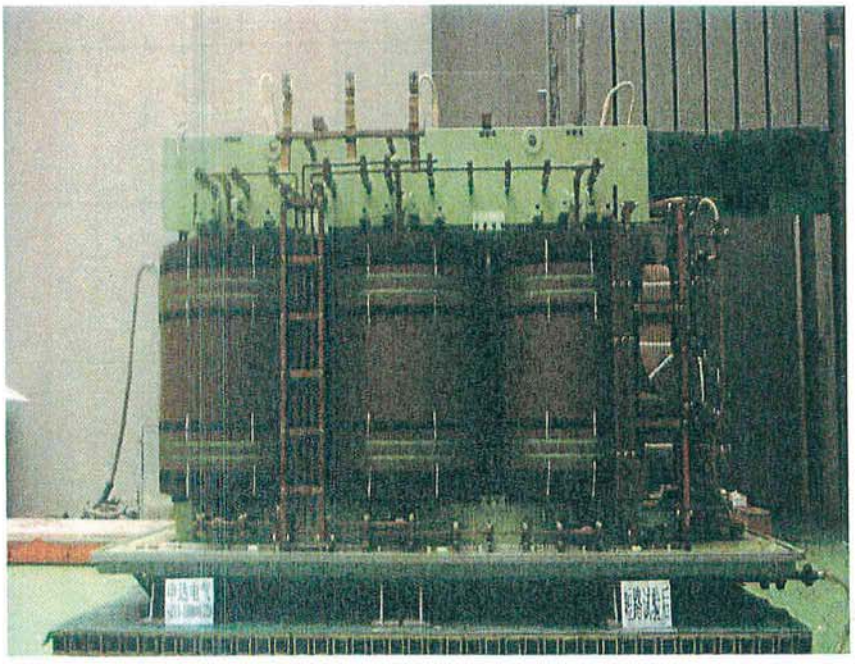
H.V. after S.C.T.:



L.V. after S.C.T.:



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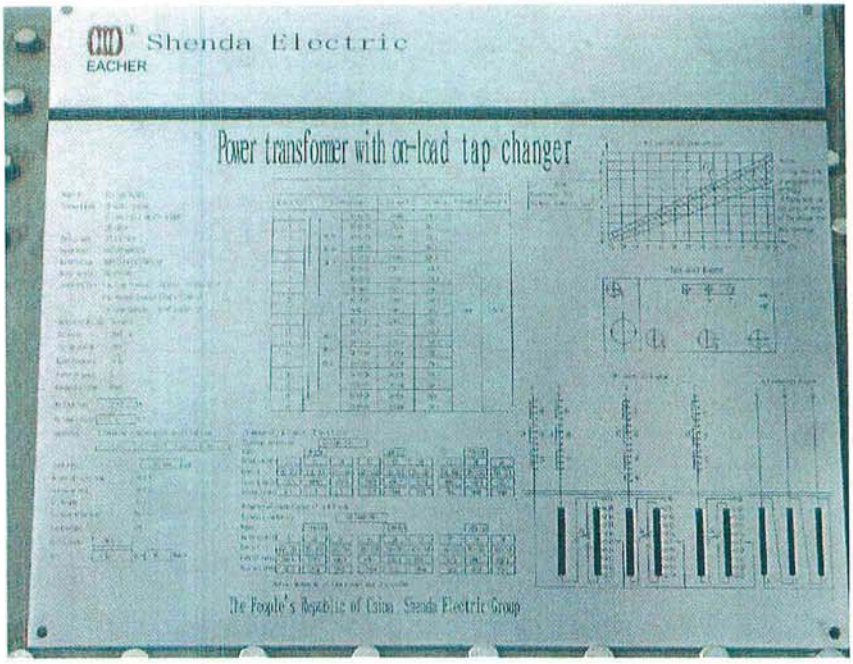
ANNEX 1

RATING PLATE AND OUTLINE PHOTO

№: CTQC/B-12.218

Rating plate:



Outline:

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ANNEX 2

TEST CIRCUITS

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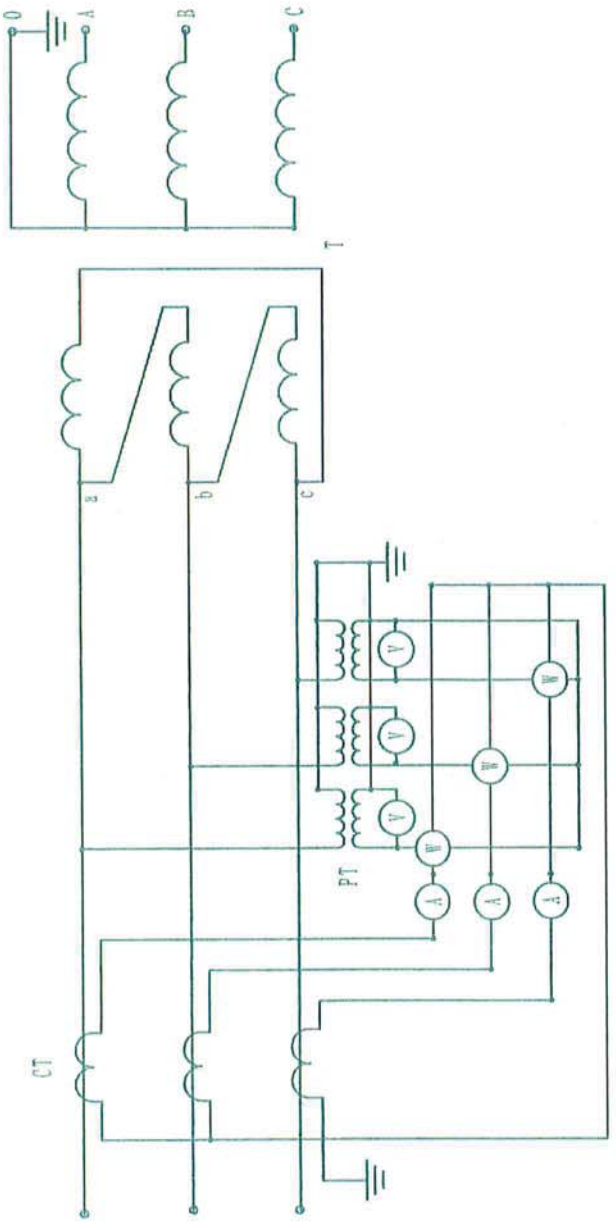
Annex2-a



空载损耗及空载电流测量线路图

No-load loss and current measurement circuit

T-被试变压器 Sample　　CT-电流互感器 Current transformer

PT-电压互感器 Voltage transformer　　A-电流表 Amperemeter

W-瓦特表 Wattmeter　　V-电压表 voltmeter

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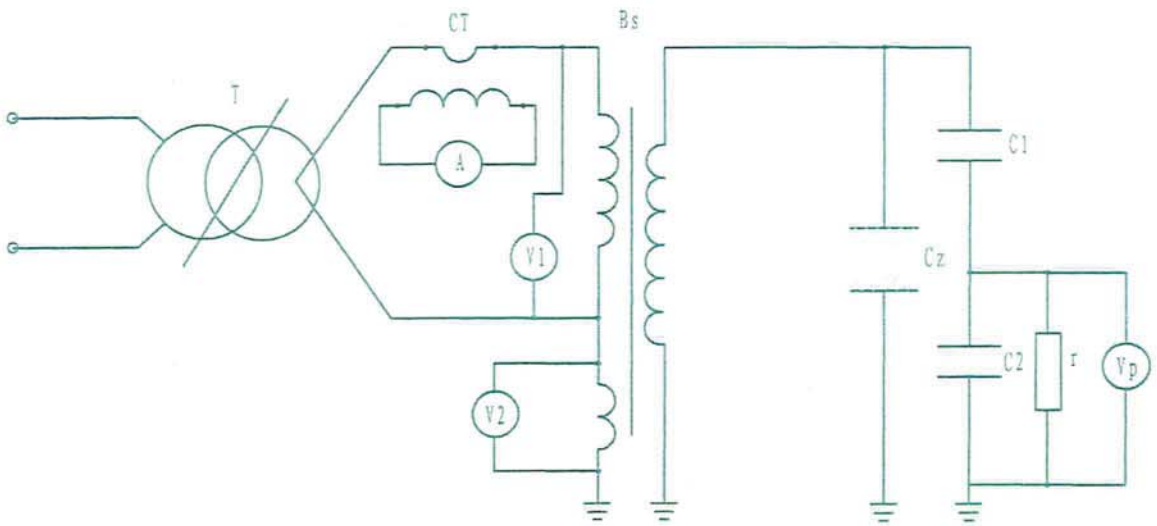

外施耐压试验线路图

Separate-source voltage withstand diagram

T-调压器 Regulator　　A-电流表 Amperemeter　　Bs-试验变压器 Testing transformer

CT-电流互感器 Current transformer　　V1,V2-电压表 Voltmeter

C1,C2-分压电容 Capacitive devider　　Cz-试品 Sample

r-放电电阻 Discharge resistance　　Vp-峰值电压表 Peak value voltmeter

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Annex 2-c

长时感应电压试验

Long-duration AC withstand voltage test

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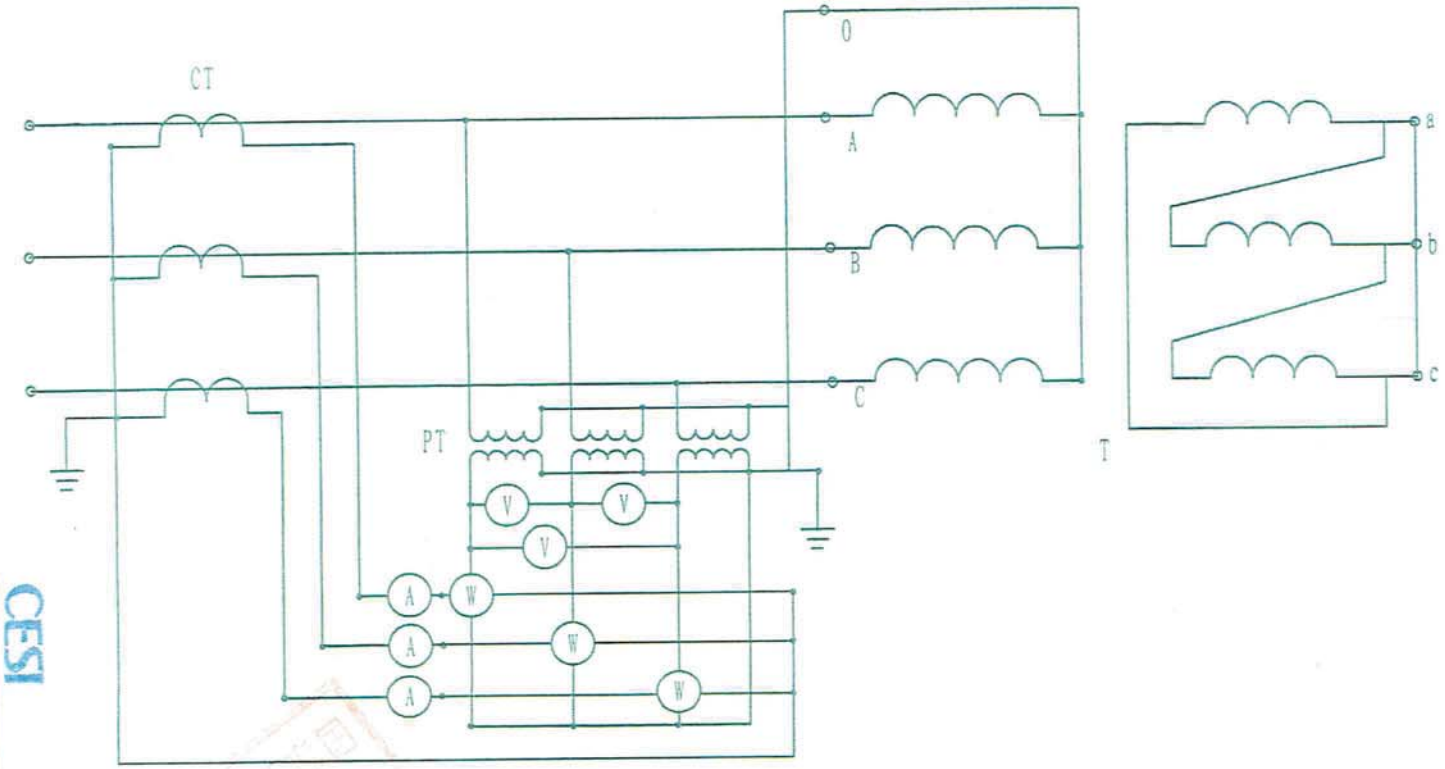


短路阻抗及负载损耗测量线路图

Short circuit impedance and on load loss measurement circuit

T-被试变压器 Sample

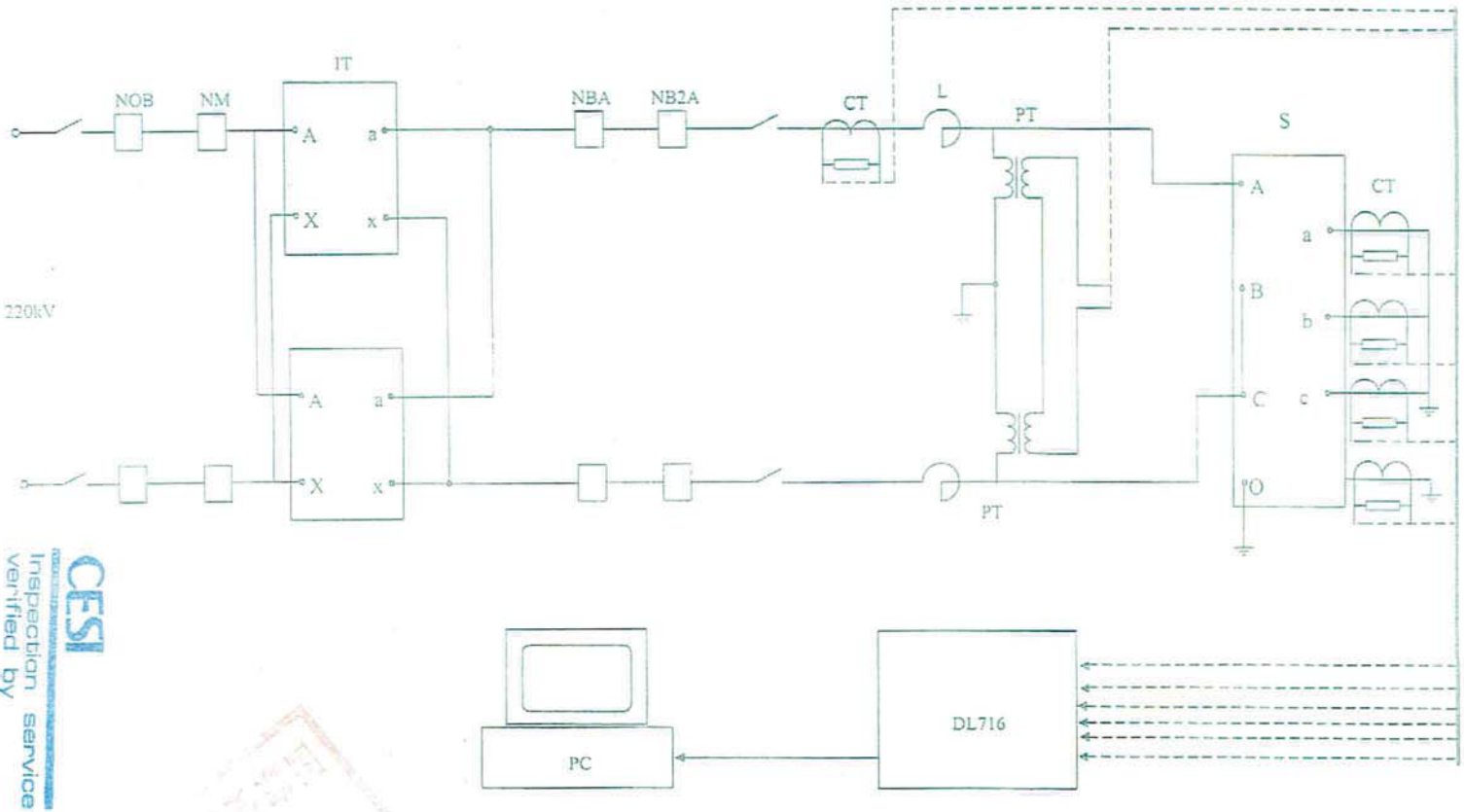
CT-电流互感器 Current transformer

PT-电压互感器 Voltage transformer

A-电流表 Amperemeter

W-瓦特表 Wattmeter

V-电压表 voltmeter



短路承受能力试验线路图　　Short circuit tests of transformer:

IT：中间变压器 Intermediate transformer　CT：电流互感器 Standard current transformer　PC：计算机 Computer

L：限流电抗器 Reactors　　PT：电压互感器 Voltage transformer　　DL716：瞬态记录仪 16 channels analyzer

S：被试变压器 Sample　　NOB,NM,NB,NB2：SF6断路器 SF6 switchgear

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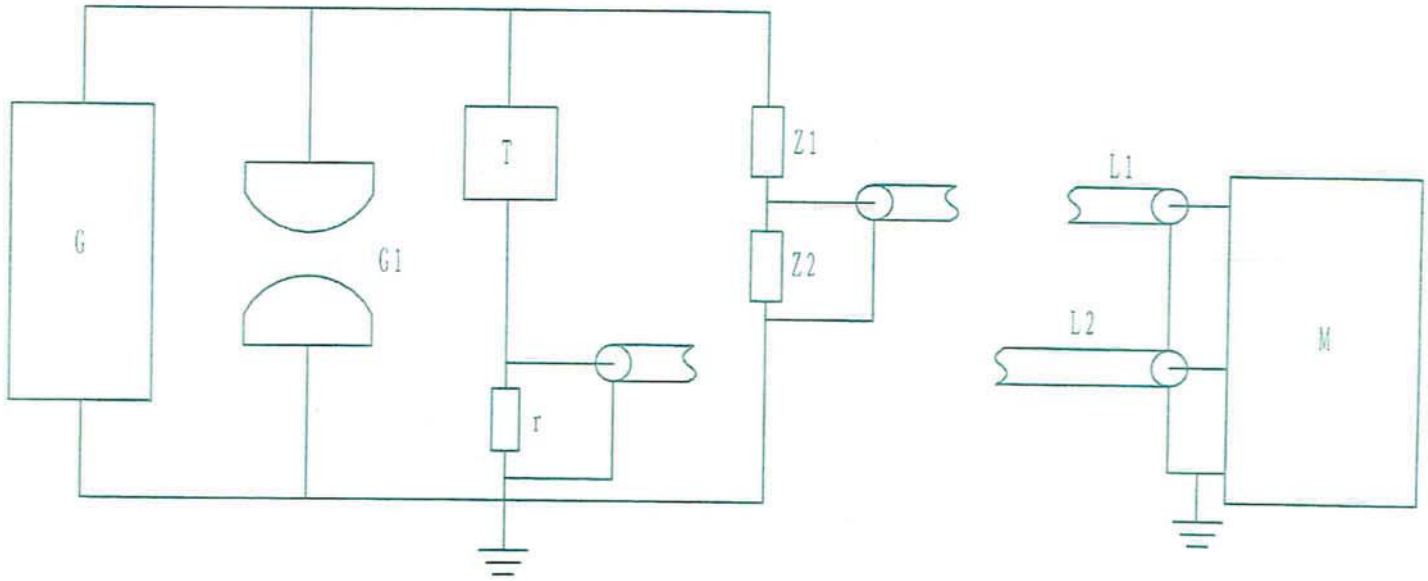
Annex 2-e



雷电冲击试验线路图

Lightning impulse withstand test system circuit

G-冲击电压发生器 Impulse generator

G1-截断装置 Chopping device

Z1,Z2-阻容分压器 Voltage divider

M-测量仪器 Measurement instrument

L1,L2-高频传输电缆 High frequency transmission cable

T-试品 Sample

r-分流器 Shunt

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Annex 2-g

短时交流耐压试验

Short duration AC withstand voltage test circuit

单相施加电压的相对地试验

A phase-to-earth test with single-phase supply

三相施加电压的相间试验

A phase to phase test with three phase supply

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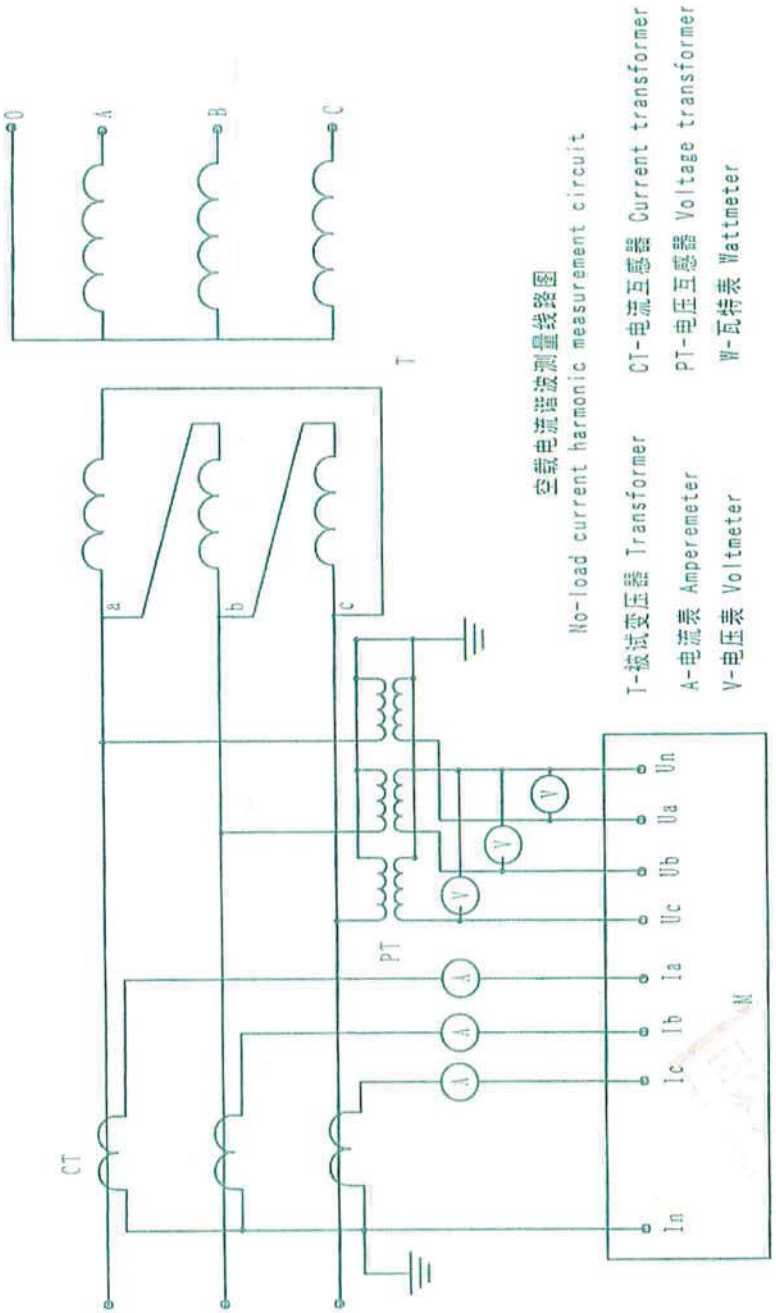
Annex 2-h



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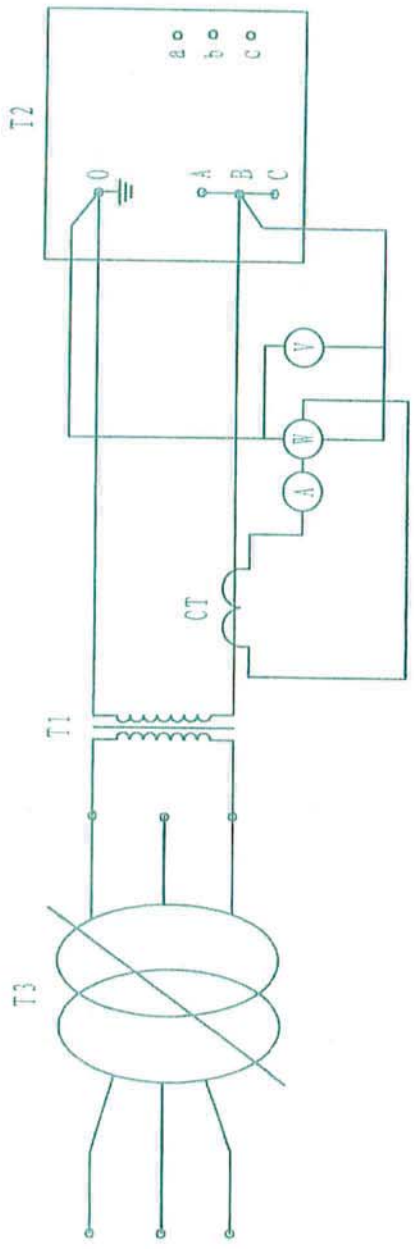
Annex 2-i



零序阻抗测量线路图

Zero-sequence impedance measurement circuit

T1-大电流变压器 Heavy current testing transformer

T2-被试变压器 Sample

T3-调压器 Regulator

V-电压表 Voltmeter

A-电流表 Amperemeter

W-瓦特表 Wattmeter

CT-电流互感器 Current transformer

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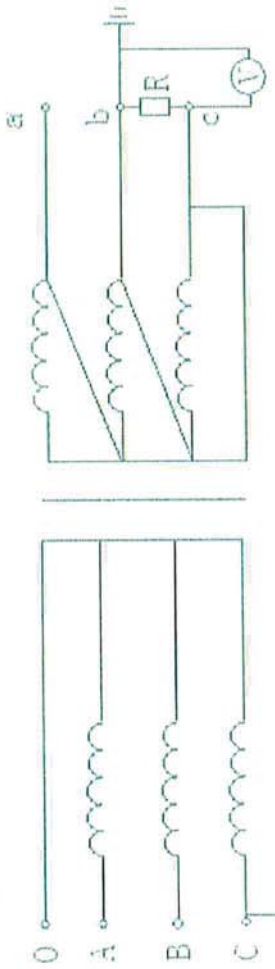

暂态电压传输特性试验接线图

Determination of transient voltage transfer characteristics

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ANNEX 3

TRANSFORMER DRAWINGS

ANNEX 4

THE TABLE OF CHECK INSTRUMENTS

The table of check instruments
仪器、仪表一览表

Type 型号	Name 名称	Precision 准确级	Serial No. 序号	Available date 有效日期	Manufacture 制造企业
D6000	Wideband power analyzer 宽带功率分析仪	0.05	YB-114150	2012.12.04	LEM 莱姆公司
ASQJ-1	Ratio bridge 变比电桥	0.05	YB-107198	2012.12.06	Shenyang zhong chuan 沈阳中川
3391	Resistance bridge 电阻电桥	0.2	YB-107191	2013.06.08	Baoding sirui 保定斯锐
SR3301	Resistance detector 电阻检测仪	0.2	YB-104204	2013.01.05	Baoding sirui 保定斯锐
HL-D40	Current transformer 电流互感器	0.01	YB-109189	2012.12.13	Dandong luote 丹东罗特
HL-D40	Current transformer 电流互感器	0.01	YB-109188	2012.12.13	Dandong luote 丹东罗特
HL-D40	Current transformer 电流互感器	0.01	YB-109190	2012.12.13	Dandong luote 丹东罗特
DL716	Digital oscilloscope 数字示波器	12bit	YB-312730	2013.08.28	Japan 日本
SR3301	Resistance detector 电阻检测仪	0.2	YB-104203	2013.01.05	Baoding sirui 保定斯锐
QS40	Dielectric loss and capacitance bridge 介损电容电桥	1.5	YB-117161	2012.12.05	Heilongjiang 黑龙江

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Type 型号	Name 名称	Precision 准确级	Serial No. 序号	Available date 有效日期	Manufacture 制造企业
HL-28	Current transformer 电流互感器	0.05	YB-109065	2013.05.12	Dandong luote 丹东罗特
HL-28	Current transformer 电流互感器	0.05	YB-109066	2013.05.12	Dandong luote 丹东罗特
HL-28	Current transformer 电流互感器	0.05	YB-109067	2013.05.12	Dandong luote 丹东罗特
BLY-1	Voltage transformer 电压互感器	0.05	YB-111083	2013.05.12	Shenyang zhong chuan 沈阳中川
BLY-1	Voltage transformer 电压互感器	0.05	YB-111084	2013.05.12	Shenyang zhong chuan 沈阳中川
BLY-1	Voltage transformer 电压互感器	0.05	YB-111085	2013.05.12	Shenyang zhong chuan 沈阳中川
HL28-26	Current transformer 电流互感器	0.1	YB-109061	2013.05.12	Dandong 丹东
JZF-9	Calibration pulse generator 校准脉冲发生器		YB-114207	2013.10.08	Shanghaisongbao 上海松宝
KMSB-30	Dielectric dissipation bridge 介损电桥	0.005	YB-107205	2013.04.09	Shanghai xilin 上海熙林
DL716	Transient recorder 瞬态记录仪	12bit	YB-312729	2012.10.31	Japan 日本

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Type 型号	Name 名称	Precision 准确级	Serial No. 序号	Available date 有效日期	Manufacture 制造企业
LRBT-220	Current transformer 电流互感器	0.5	YB-309786	2013.03.21	Shenyang transformer factory 沈阳变压器厂
LRBT-220	Current transformer 电流互感器	0.5	YB-309787	2013.03.21	Shenyang transformer factory 沈阳变压器厂
LRBT-220	Current transformer 电流互感器	0.5	YB-309788	2013.03.21	Shenyang transformer factory 沈阳变压器厂
LMZC-10	Current transformer 电流互感器	0.5	YB-309781	2013.10.26	Shenyang special transformer factory 沈阳特种变压器厂
LMZC-10	Current transformer 电流互感器	0.5	YB-309780	2013.10.26	Shenyang special transformer factory 沈阳特种变压器厂
LMZC-10	Current transformer 电流互感器	0.5	YB-309779	2013.05.12	Shenyang special transformer factory 沈阳特种变压器厂
FL-5/5000	Standard resistance 标准电阻	0.2	YB-316797	2013.06.01	Shenyang 沈阳
FL-5/5000	Standard resistance 标准电阻	0.2	YB-316798	2013.06.01	Shenyang 沈阳
FL-5/5000	Standard resistance 标准电阻	0.2	YB-316799	2013.06.01	Shenyang 沈阳
FL-10/1000	Standard resistance 标准电阻	0.2	YB-316804	2013.03.26	Shenyang 沈阳

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Type 型号	Name 名称	Precision 准确级	Serial No. 序号	Available date 有效日期	Manufacture 制造企业
FL-10/1000	Standard resistance 标准电阻	0.2	YB-316806	2013.03.26	Shenyang 沈阳
CT106	Open-circuit voltage meter 开路电压测量仪	1.0	YB-114140	2012.12.04	Shenyang zhongchuan 沈阳中川
HESD	Transformer checkout meter 互感器检验仪	1.0	YB-114138	2012.12.12	Shenyang zhongchuan 沈阳中川
T24-AV	Amperometer 安培表	0.2	YB-105035	2012.12.02	Shanghai 上海
FY49-1	Current transformer load 电流互感器负荷箱	3.0	YB-111096	2013.08.29	Shenyang zhong chuan 沈阳中川
ZN3950	Radio interference detecter 无线电干扰测试仪		YB-114147	2013.06.14	Beijing 北京
SR3301	Resistance detector 电阻检测仪	0.2	YB-104202	2013.01.05	Baoding sirui 保定斯锐
SR3301	Resistance detector 电阻检测仪	0.2	YB-104201	2013.01.05	Baoding sirui 保定斯锐
FL-10/1000	Standard resistance 标准电阻	0.2	YB-316805	2013.03.26	Shenyang 沈阳

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