



CNACL

No. 0299



国质监认字080号



(2000)量认(国)字(A0394)号

No. : CTQC/B-02. 205

TEST REPORT

Apparatus: POWER TRANSFORMER

Manufacturer: HANGZHOU QIANJIANG ELECTRIC
CO., LTD.

Kind of testing: TRUST TESTING

CHINA NATIONAL TRANSFORMER QUALITY
SUPERVISION TESTING CENTER



China National Transformer Quality Supervision Testing Center

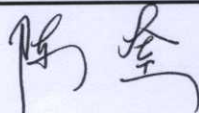
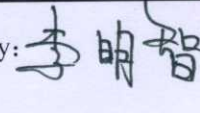
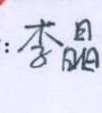
Test Report

No: CTQC/B-02.205

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Test object name	Power Transformer	Test Object type	SZ9-40000/110
		Brand	/
Entrusted by	HANGZHOU QIANJIANG ELECTRIC CO., LTD.	Kind of testing	Trust testing
Manufacturer	HANGZHOU QIANJIANG ELECTRIC CO., LTD.	Sample	Qualified
Sampling place	/	Sampling date	May 08, 2002
Sampling quantity	1	Sampling unit	HANGZHOU QIANJIANG ELECTRIC CO., LTD.
Sample cardinal No	/	Serial No	02374.10001
Standards	GB1094.1-1996 GB1094.2-1996 GB1094.3-1985 GB1094.5-1985 GB/T6451-1999 JB/T10088-1999 Testing contract	Test items	Routine test; Temp.-rise test; Lightning impulse test; Sound level measurement; Zero-sequence impedance measurement for three phase transformer; No-load current harmonic measurement; Short circuit withstand test; Partial discharge measurement.
Results	<p>The test results of routine test, temp.-rise test, lightning impulse test, sound level measurement, zero-sequence impedance measurement for three phase transformer, no-load current harmonic measurement, short circuit withstand test and partial discharge measurement of SZ9-40000/110 are in accordance with GB1094.1-1996, GB1094.2-1996, GB1094.3-1985, GB1094.5-1985, GB/T6451-1999, JB/T10088-1999 standards and technical contract, the sample passed the above tests.</p> <p style="text-align: right;">Signing and issuing date: May 25 2002</p>		
Note:			



Approved by:  Checked by:  Compiled by: 

Test results

No	Test items	Specified values	Measured values		Conclusions
		Standard (technical requirements)	Before S.C.T.	After S.C.T.	
1	Measurement of insulation resistance (Routine test)	Providing Insulation resistance (GΩ), Providing absorption ratio(R ₆₀ /R ₁₅) and tan δ	R ₆₀ R ₆₀ /R ₁₅ tan δ H-L-E 5.80 1.54 0.0025 L-H-E 4.88 1.77 0.0030 H-L-E 5.62 1.44 0.0031	R ₆₀ R ₆₀ /R ₁₅ tan δ H-L-E 5.82 1.49 0.0024 L-H-E 3.76 1.72 0.0030 H-L-E 5.18 1.53 0.0032	Passed
2	Measurement of voltage ratio and check of connection group (Routine test)	The tolerances of voltage ratio : ±0.5% Connection group: YNd11	-0.01%~-0.02% YNd11	0.00%~0.06% YNd11	Passed
3	Measurement of winding resistances (Routine test)	Maximum unbalancedness Phase: ≤2% Line: ≤1%	H.V.(phase): 0.94% L.V.(line): 0.47%	H.V.(phase): 0.98% L.V.(line): 0.37%	Passed
4	Separate source voltage withstand test (Routine test)	H.V. neutral : 95kV; 60s L.V.: 35kV; 60s (After S.C.T. × 85%)	95kV; 60s 35kV; 60s	80.75kV; 60s 29.75kV; 60s	Passed
5	Induced overvoltage withstand test (Routine test)	Applied voltage (kV): 2Ur Induced voltage (kV): 200 Frequency (Hz): Duration (s): 40 (After S.C.T. × 85%)	21 200 150 40	17.85 170 150 40	Passed
6	Measurement of no-load loss and current (Routine test)	I ₀ %: 0.70 +30% P ₀ (kW): 40.4 +15%	0.06 20.25	0.06 20.32	Passed

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Test results						
№	Test items	Specified values		Measured values		Conclu- sions
		Standard (technical requirements)		Before S.C.T.	After S.C.T.	
7	Measurement of short-circuit impedance and load loss (Routine test)	t: 75°C Z: 14.0 ±7.5% P _k (kW): 156.6 +15% P ₀ +P _k (kW): 197.0 +10%	14.0 155.59 175.84	14.0 158.53 178.85		Passed
8	Test on transformer oil (Routine test)	Breakdown voltage (kV): ≥40 tan δ (90°C): ≤0.01 Water dissolved in oil (10 ⁻⁶): ≤20 Providing gas chromatography	54.81 0.0008 8.13 Gas chromatography	54.76 0.0009 9.30 Gas chromatography		Passed
9	Test on on-load tap-changers (Routine test)	According to Clause 10.8 of GB1094.1-1996	Compliance with standard	Compliance with standard		Passed
10	Leakage test (Routine test)	Applied pressure (kPa): 50 Duration (h): 36 No leakage or damage	50 36 No leakage or damage			Passed
11	Temp.-rise test (Type test)	Temp. -rise limit (K): Top oil: 55 Winding: 65	Top oil: 50.1 H.V.: 52.8 L.V.: 59.7			Passed
12	Lightning impulse test (Type test)	Full wave Chopped wave H.V. (kV): 480 530 ±3% O (kV): 250 / ±3% L.V. (kV): 75 85 ±3%	Full wave Chopped wave H.V.: 471.7~474.8 521.0~523.4 O: 248.3~248.6 / L.V.: 72.9~77.1 83.9~84.2			Passed
13	Sound level measurement (Special test)	Sound level L _{PA} (dB): ≤76	62.7			Passed

Test results

No	Test items	Specified values	Measured values	Conclusions
		Standard (technical requirements)		
14	Zero sequence impedance measurement for three phase transformers (Special test)	Providing zero sequence impedance value (Ω)	40.5	Passed
15	No-load current harmonic measurement (Special test)	Providing no load current harmonic values of each phase	I ₁ -I ₁₉ no load current harmonics	Passed
16	Partial discharge measurement (Special test)	Applied voltage (kV) : 1.5Um/√3 Duration(min): 30 Partial discharge level (pC): ≤(100)	109.1 30 94.0~98.0	Passed
17	Short circuit withstand test (Special test)	Three times each phase Duration (s): 0.20±10% Test waveshapes are no distortion Deviation of reactance before and after S.C.T.≤2% The untanking inspection shows no apparent defects Successfully repeat routine test	3 0.19~0.21 No distortion 0.16% No apparent defects Passed	Passed

1. Test object parameters

Rated power: 40000 kVA

Rated voltage: 110/10.5kV

Rated current: 210/2199 A

Rated frequency: 50 Hz

Number of phase: 3

Tap range: $(110 \pm 8 \times 1.25\%) / 10.5 \text{ kV}$

Connection group: YNd11

Cooling method: ONAN

Temperature class of insulation: A

Insulation level: LI480AC200-LI250AC95/LI75AC35

2. Standards

GB1094.1-1996 《Power transformers Part1: General》

GB1094.2-1996 《Power transformers Part2: Temperature rise test》

GB1094.3-1985 《Power transformers Part3: Insulation level and dielectric test》

GB1094.5-1985 《Power transformers Part5: Ability to withstand short-circuit》

GB/T6451-1999 《Specification and technical requirements for three phase
oil-immersed power transformers》

JB/T10088-1999 《Sound level for 6~220kV transformers》

Technical contract

3. Test items and conclusions:

3.1 Measurement of insulation resistances (Routine test)

Test date: May 10, 2002

Humidity: 56% Oil temperature: 21°C

Measurement position	R ₆₀ (GΩ)	R ₁₅ (GΩ)	R ₆₀ /R ₁₅	Tan δ
H.V.—L.V.&E	5.80	3.76	1.54	0.0025
L.V.—H.V. &E	4.88	2.76	1.77	0.0030
H.V.&L.V.—E	5.62	3.91	1.44	0.0031

3.2 Measurement of voltage ratio and check of connection group (Routine test)

Test date: May 10, 2002

H.V.		L.V.		Ratio	Measured deviation (%)			Connec- tion group
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AB/ab	BC/bc	CA/ca	
1	121.002	/	10.5	11.52	0.03	0.06	0.07	YNd11
2	119.626			11.39	0.09	0.11	0.13	
3	118.251			11.26	0.02	0.04	0.06	
4	116.876			11.13	0.08	0.10	0.12	
5	115.500			11.00	0.01	0.03	0.05	
6	114.124			10.87	0.07	0.08	0.10	
7	112.749			10.74	0.00	0.01	0.03	
8	111.373			10.61	0.06	0.07	0.09	
9	110.000			10.48	-0.01	0.00	0.02	
10	108.622			10.35	0.05	0.06	0.08	
11	107.247			10.21	-0.02	-0.01	0.01	
12	105.872			10.08	0.03	0.05	0.06	
13	104.499			9.95	-0.04	-0.03	-0.01	
14	103.125			9.82	0.02	0.04	0.05	
15	101.750			9.69	-0.06	-0.04	-0.03	
16	100.375			9.56	0.01	0.02	0.04	
17	99.000			9.43	-0.07	-0.06	-0.04	

3.3 Measurement of winding resistances(Routine test) Test date: May 10, 2002

Oil temperature: 21.0°C

Winding	Tap position	Measured values (Ω)			Unbalancedness (%)
		A~O a~b	B~O b~c	C~O c~a	
H.V.	1	0.4525	0.4535	0.4544	0.42
	2	0.4447	0.4457	0.4461	0.31
	3	0.4358	0.4370	0.4373	0.34
	4	0.4279	0.4290	0.4292	0.30
	5	0.4190	0.4202	0.4205	0.36
	6	0.4111	0.4121	0.4126	0.36
	7	0.4025	0.4035	0.4040	0.37
	8	0.3941	0.3954	0.3960	0.71
	9	0.3834	0.3840	0.3870	0.94
	10	0.3957	0.3988	0.3977	0.88
	11	0.4040	0.4072	0.4072	0.79
	12	0.4121	0.4144	0.4146	0.52
	13	0.4211	0.4233	0.4225	0.52
	14	0.4292	0.4300	0.4312	0.47
	15	0.4379	0.4397	0.4408	0.66
	16	0.4457	0.4478	0.4482	0.56
	17	0.4565	0.4572	0.4571	0.15
L.V.	/	0.006552	0.006569	0.006583	0.47

3.4 Separate-source voltage withstand test(Routine test) Test date: May 10, 2002

Position	Applied voltage (kV)	Duration (s)	Results
H.V. neutral—L.V.&E	95	60	Passed
L.V.—H.V.&E	35	60	

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3.5 Induced overvoltage withstand test (Routine test) Test date: May 10, 2002								
Tap position	Applied voltage (kV)	Induced voltage (kV)	Induced multiple	Frequency (Hz)	Duration (s)	Results		
	L.V.	H.V.						
5	21	200	2	150	40	Passed		
3.6 Measurement of no-load loss and current (Routine test) Test date: May 10, 2002								
R.M.S. value voltage (kV)		No-load current		No-load loss (kW)				
Reading of mean value voltmeter	Reading of R.M.S. value voltmeter	(A)	(%)	Measured value	Corrected value			
10.5	10.5	1.28	0.06	20.25	20.25			
Note: The reading tolerance between R.M.S value voltmeter and mean value voltmeter is less than 3%.								
3.7 Measurement of short-circuit impedance and load loss (Routing test)								
Test date: May 10, 2002				Oil temperature: 21.0°C				
Winding	Tap position	Applied current I		Measured voltage (kV)	Short-circuit impedance (Each phase)		Load loss (kW)	Total loss (kW)
		(A)	I/Ir (%)		H.V. impedance (Ω)	(%)	Corrected value	Corrected value
					t=75°C I=Ir	t=75°C I=Ir	t=75°C I=Ir	t=75°C I=Ir
H.V. L.V.	1	191.1	100.0	17.78	53.8	14.7	152.62	172.87
	9	210.0	100.0	15.40	42.4	14.0	155.59	175.84
	17	233.1	100.0	13.16	32.6	13.3	170.83	191.08
3.8 Test on transformer oil (Routine test) Test date: May 08, 2002								
tan δ (90°C)		Breakdown voltage (kV)		Water dissolved in oil (10 ⁻⁶)				
0.0008		54.81		8.13				
Gas chromatography								
H ₂	CO	CO ₂	CH ₄	C ₂ H ₆	C ₂ H ₄	C ₂ H ₂	Hydro cardons	
0.00	3.66	137.6	0.51	0.00	0.00	0.00	0.51	

3.9 Test on on-load tap-changers (Routine test) Test date: May 10, 2002

Operation test:

- a. 8 complete operating cycles with the transformer not energized;
- 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. 10 tap-change operations with ± 2 steps on either side of the principal tap under on load test of transformer.

Auxiliary circuits dielectric test:

2kV (R.M.S.) 1 min separate-source voltage withstand test, passed.

3.10 Leakage test (Routing test) Test date: May 14, 2002

Test method	Applied pressure (kPa)	Duration (h)	Residual pressure (kPa)	Result
Atmospheric pressure	50	36	49	No leakage or damage

3.11 Temperature-rise test (Type test) Test date: May 13,2002

The test is conducted by means of short-circuit method, the test duration is 10h, stability duration is 4h. Specified total loss is 191.08kW, injected total loss of 187.50kW during test. Specified current is 230A, Injected test current of 234.5A during measurement of winding resistance. Tap 17.

Measured values

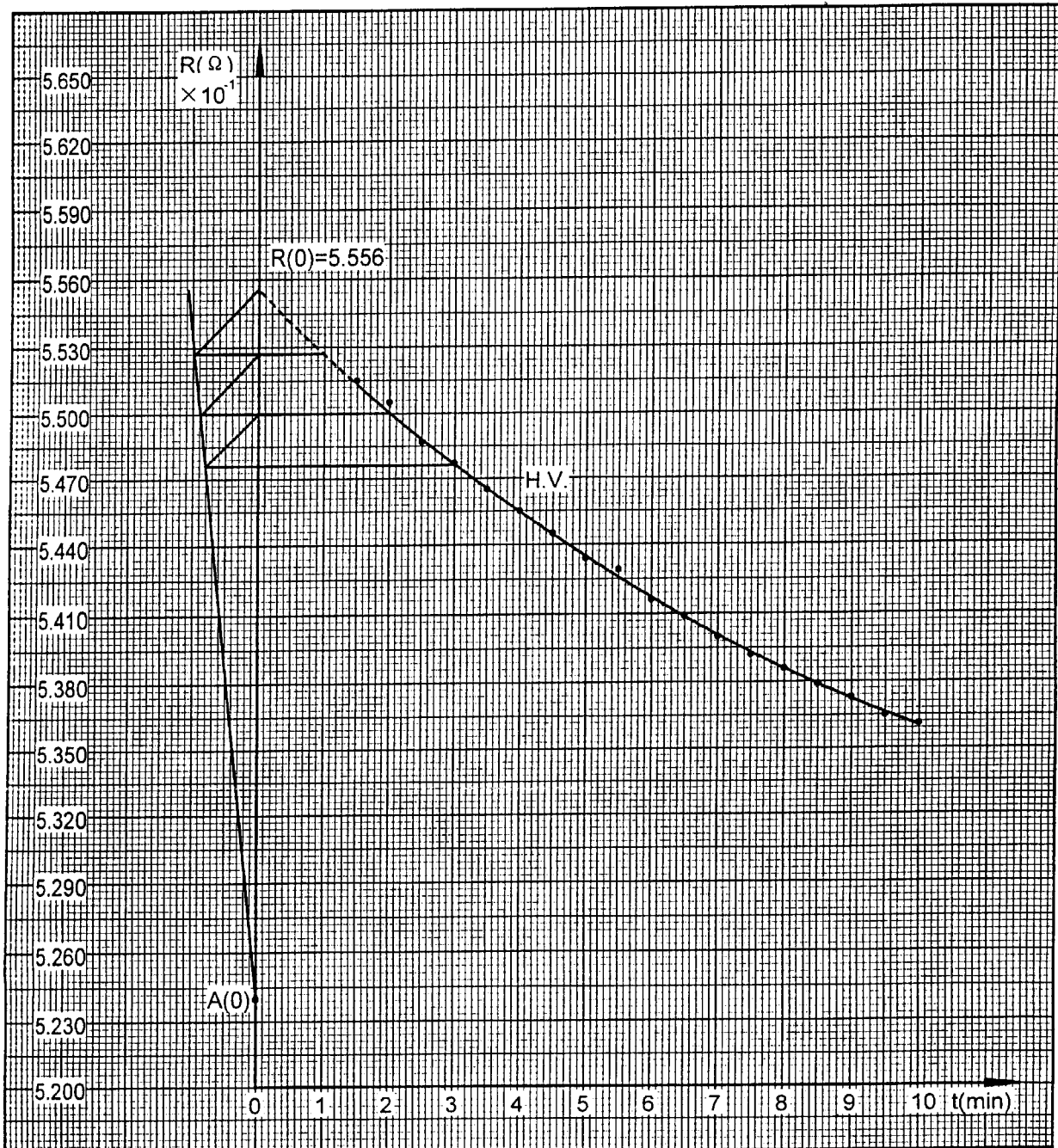
Winding	Temperature of top oil (°C)		Temperature of bottom oil (°C)		Average temperature of oil (°C)		Ambient temperature (°C)		Measurement of resistance (Ω) × 10 ⁻³	
	Total losses	Measured current	Total losses	Measured current	Total losses	Measured current	Total losses	Cold R	Cold R	Hot R
H.V.	74.8	74.8	30.9	30.9	52.9	52.9	25.4	21.0	453.5	555.6
L.V.		74.8		30.9		52.9			21.0	6.552

Conclusions of temperature-rise

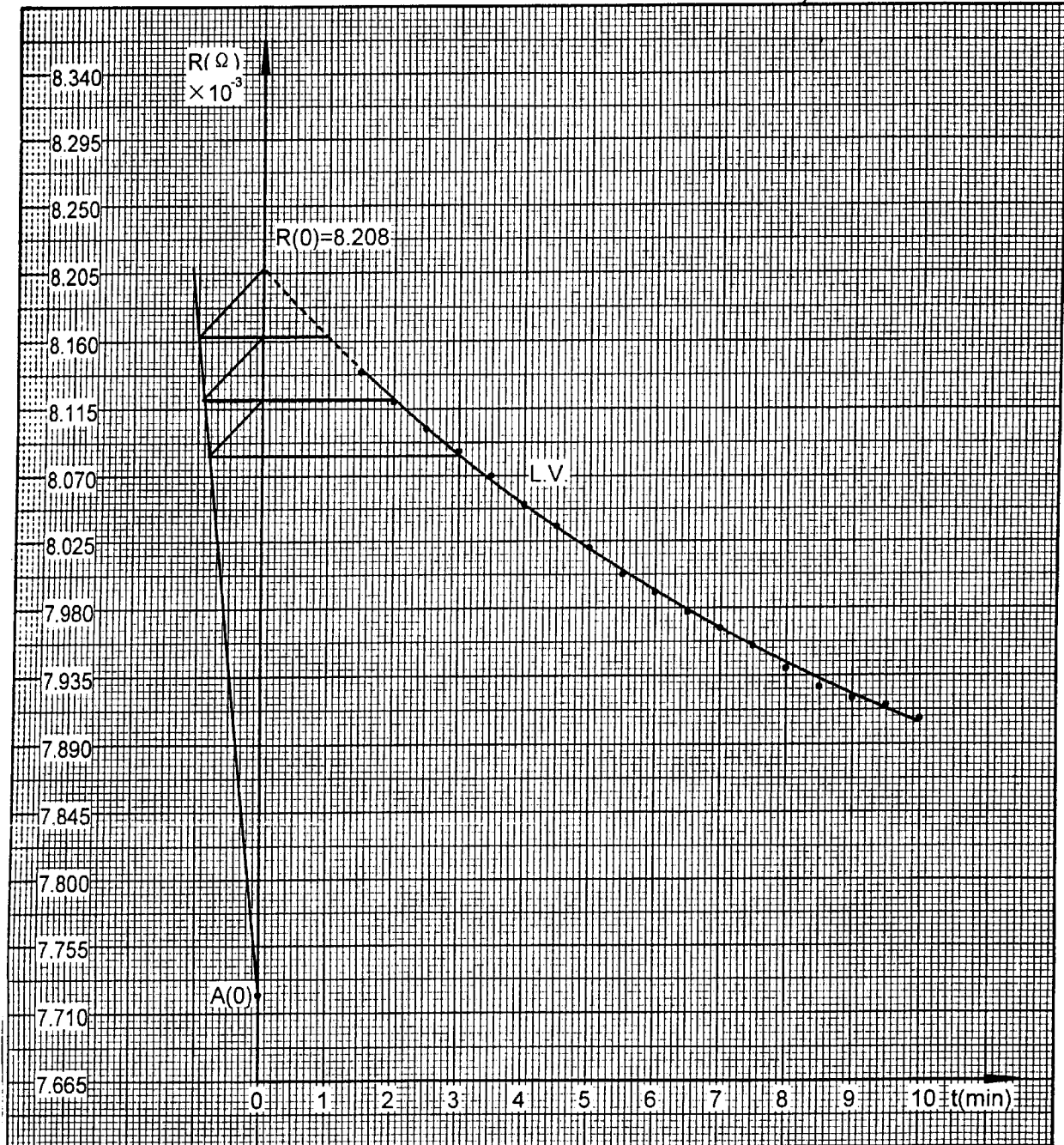
Top oil temp.-rise (K)	50.1	
Winding temp.-rise (K)	H.V.	50.9
	L.V.	59.7

Note: The results of temperature rise calculation are referred to the total losses and the rated current .

Hot resistance curve



Hot resistance curve



3. 12 Lightning impulse test(Type test) Test date: May 11,2002

Test items and voltage:

Tested terminals	Rated withstand voltage (kV)		Tap position
	Full wave	Chopped wave	
A, B, C	480	530	A:1, B:9, C:17
O	250	/	9
a,b,c	75	85	/

Test sequence:

Tested terminals: A,B,C and a,b,c

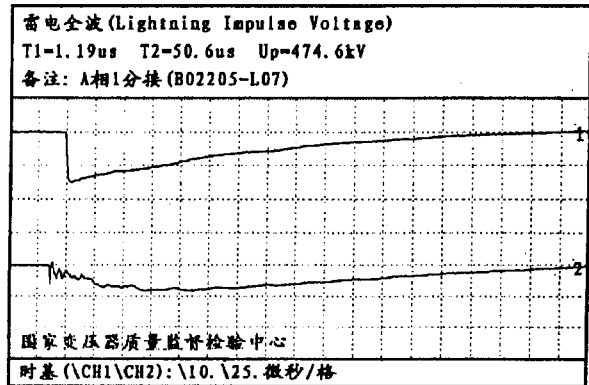
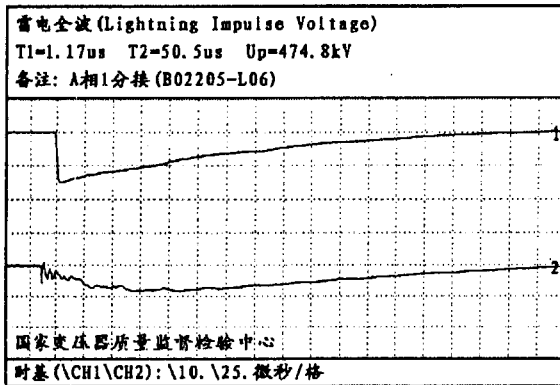
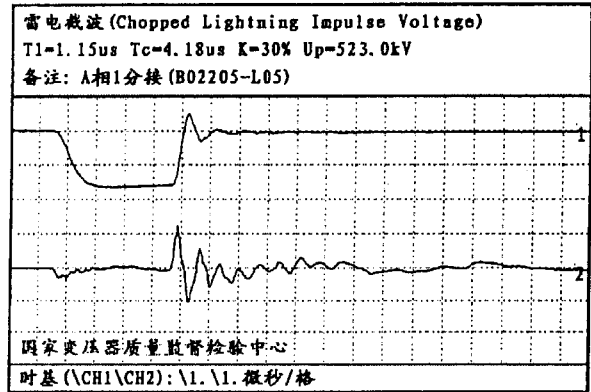
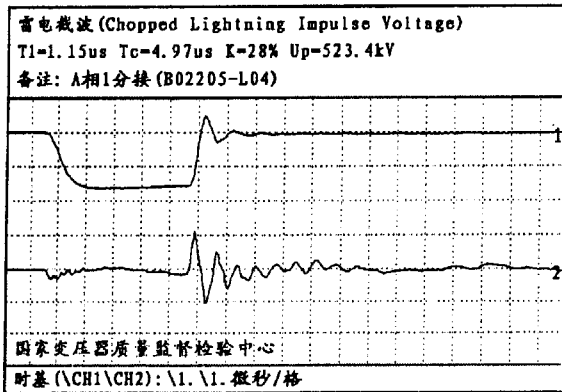
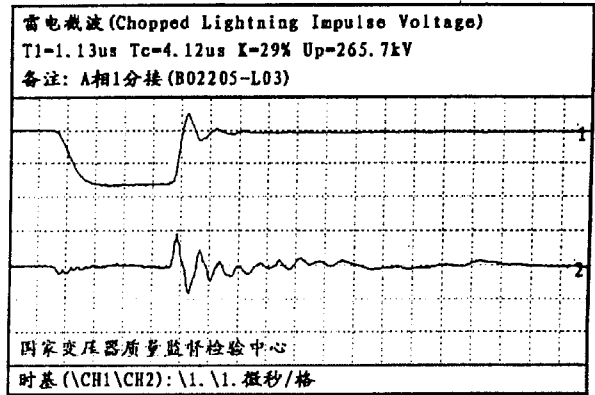
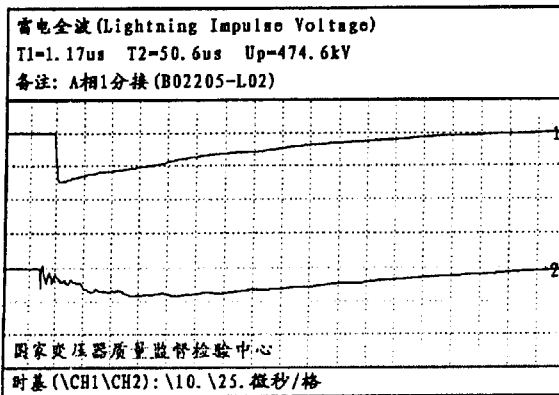
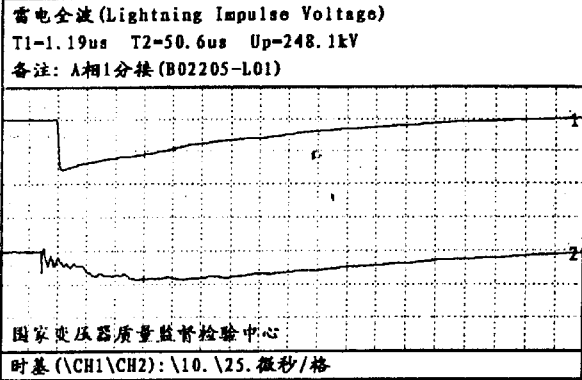
- One reduced negative polarity full wave impulse;
- One rated negative polarity full wave impulse;
- One reduced negative polarity chopped wave impulse;
- Two rated negative polarity chopped wave impulse;
- Two rated negative polarity full wave impulse.

Tested terminals: O

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

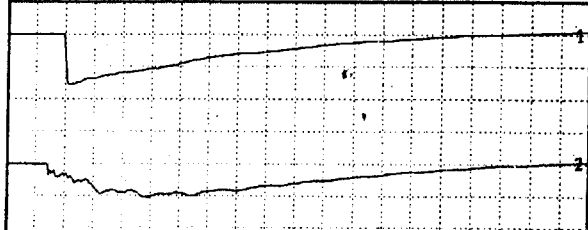
Test oscillogram records are shown in Page 14 to Page 20:

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



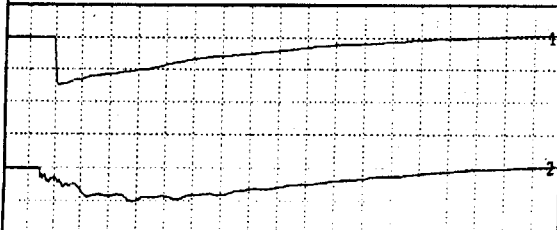
Tested terminal: B
Test polarity: Negative
CH1.Voltage Records
CH2. Neutral current records

雷电全波 (Lightning Impulse Voltage)
T1=1.16us T2=48.7us Up=248.5kV
备注: B相9分接 (B02205-L08)



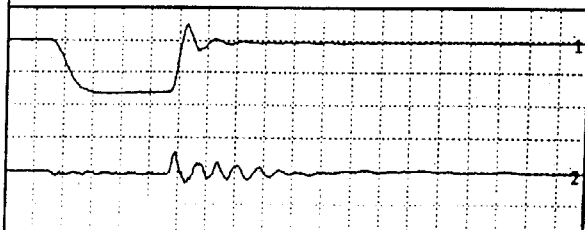
国家变压器质量监督检验中心
时基 (\CH1\CH2): \10. \25. 微秒/格

雷电全波 (Lightning Impulse Voltage)
T1=1.17us T2=48.7us Up=473.2kV
备注: B相9分接 (B02205-L09)



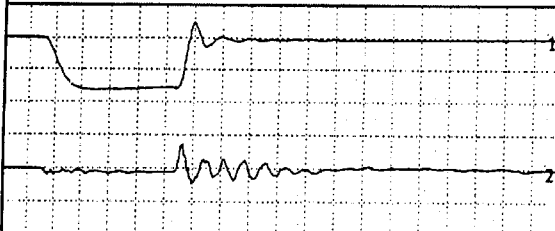
国家变压器质量监督检验中心
时基 (\CH1\CH2): \10. \25. 微秒/格

雷电截波 (Chopped Lightning Impulse Voltage)
T1=1.15us Tc=4.21us K=29% Up=265.2kV
备注: B相9分接 (B02205-L10)



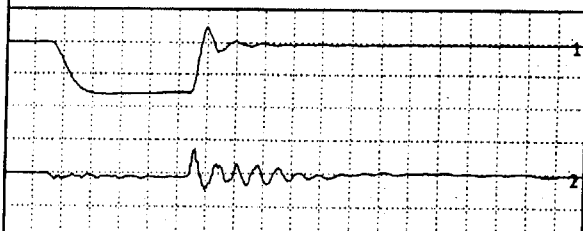
国家变压器质量监督检验中心
时基 (\CH1\CH2): \1. \1. 微秒/格

雷电截波 (Chopped Lightning Impulse Voltage)
T1=1.15us Tc=4.87us K=29% Up=522.9kV
备注: B相9分接 (B02205-L11)



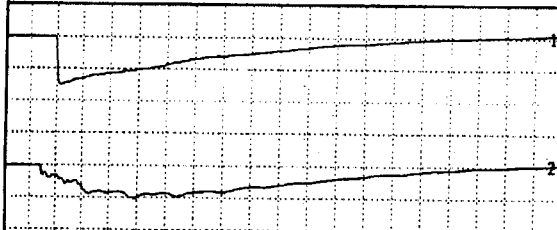
国家变压器质量监督检验中心
时基 (\CH1\CH2): \1. \1. 微秒/格

雷电截波 (Chopped Lightning Impulse Voltage)
T1=1.17us Tc=4.95us K=29% Up=522.9kV
备注: B相9分接 (B02205-L12)



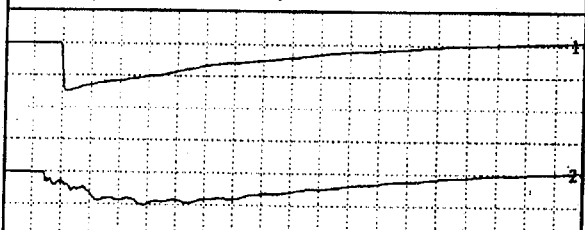
国家变压器质量监督检验中心
时基 (\CH1\CH2): \1. \1. 微秒/格

雷电全波 (Lightning Impulse Voltage)
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备注: B相9分接 (B02205-L13)



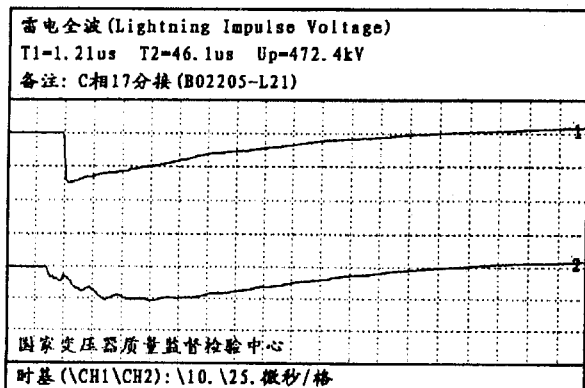
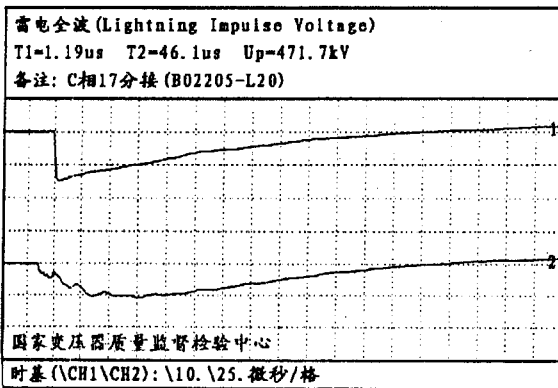
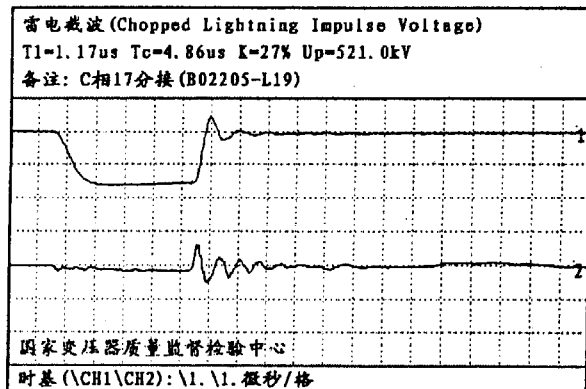
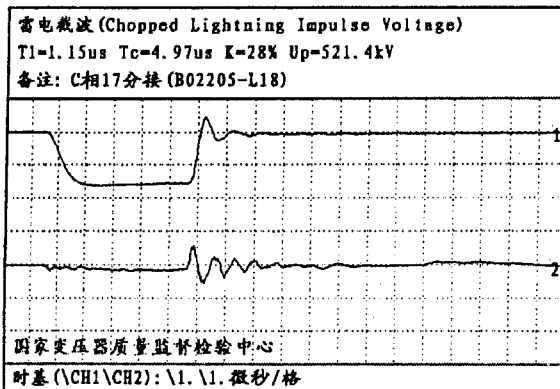
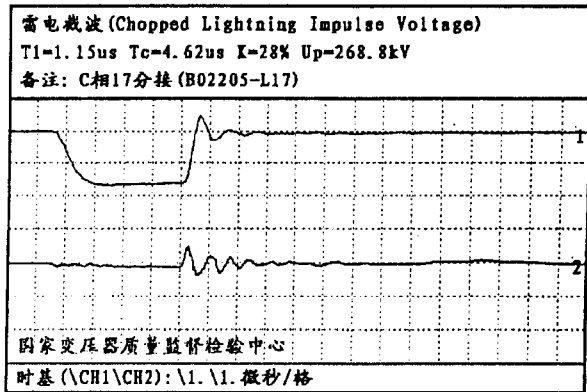
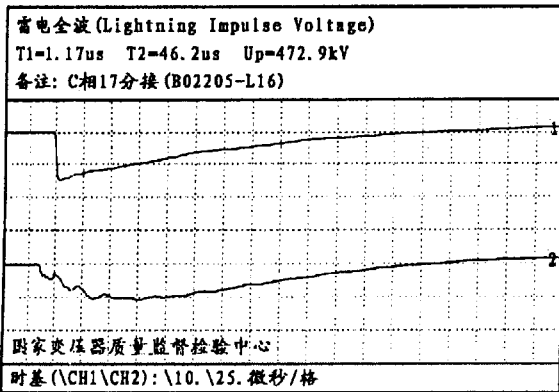
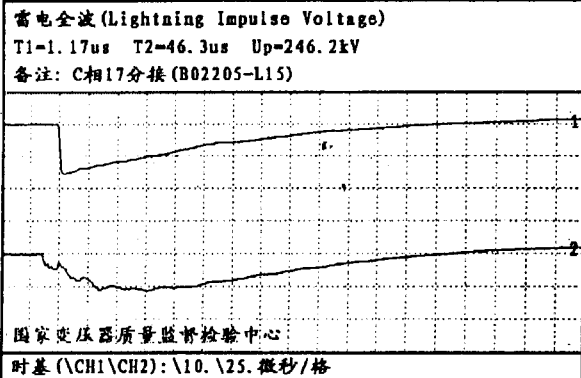
国家变压器质量监督检验中心
时基 (\CH1\CH2): \10. \25. 微秒/格

雷电全波 (Lightning Impulse Voltage)
T1=1.19us T2=48.6us Up=473.1kV
备注: B相9分接 (B02205-L14)

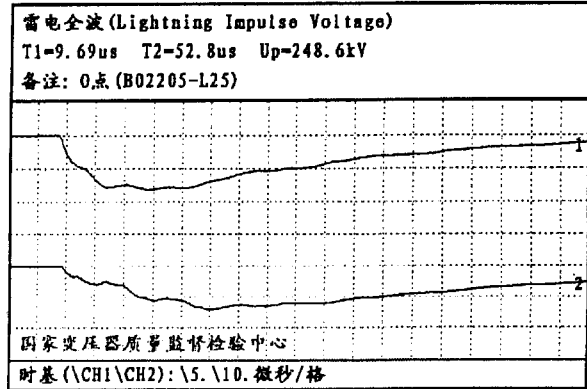
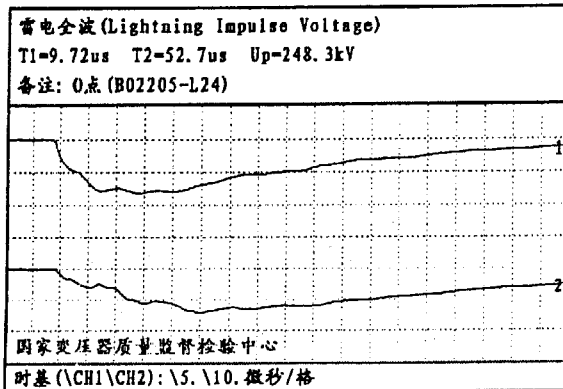
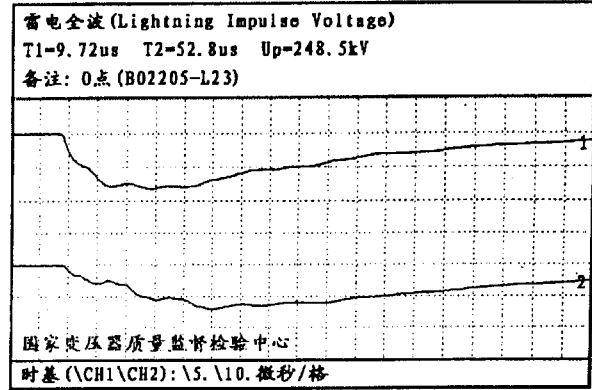
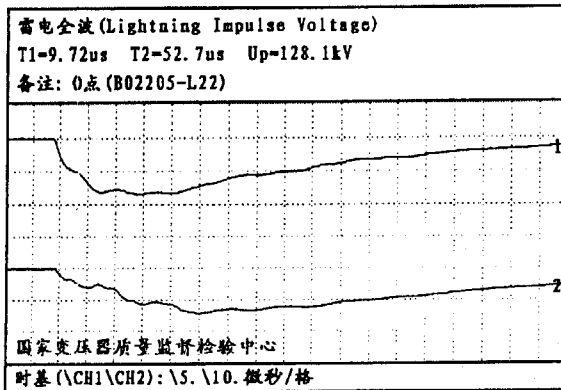


国家变压器质量监督检验中心
时基 (\CH1\CH2): \10. \25. 微秒/格

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

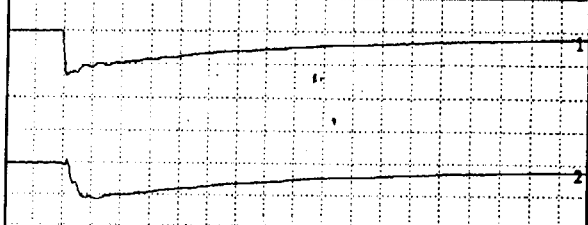


Tested terminal: O
Test polarity: Negative
CH1. Voltage Records
CH2. Neutral current records



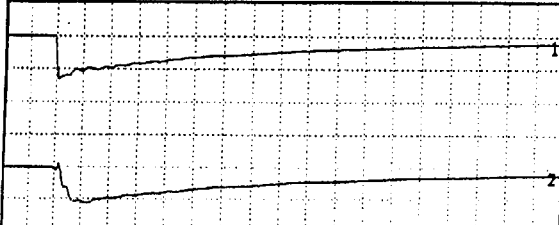
Tested terminal: a
Test polarity: Negative
CH1. Voltage Records
CH2. Neutral current records

雷电全波 (Lightning Impulse Voltage)
T1=1.14us T2=54.8us Up=38.0kV
备注: a相 (B02205-L26)



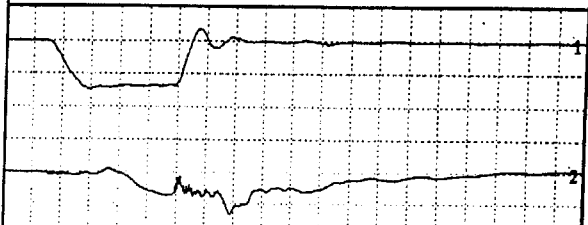
国家变压器质量监督检验中心
时基 (\CH1\CH2): \10. \10. 微秒/格

雷电全波 (Lightning Impulse Voltage)
T1=1.12us T2=55.2us Up=74.0kV
备注: a相 (B02205-L27)



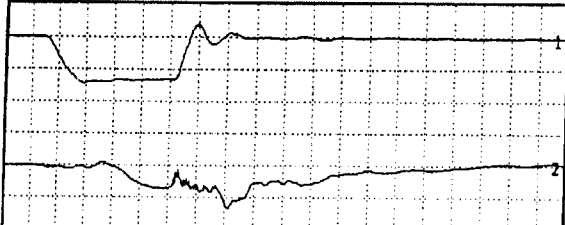
国家变压器质量监督检验中心
时基 (\CH1\CH2): \10. \10. 微秒/格

雷电截波 (Chopped Lightning Impulse Voltage)
T1=1.17us Tc=4.5us K=26% Up=43.1kV
备注: a相 (B02205-L28)



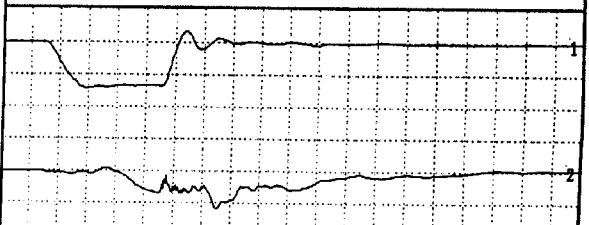
国家变压器质量监督检验中心
时基 (\CH1\CH2): \1. \1. 微秒/格

雷电截波 (Chopped Lightning Impulse Voltage)
T1=1.18us Tc=4.74us K=28% Up=84.2kV
备注: a相 (B02205-L29)



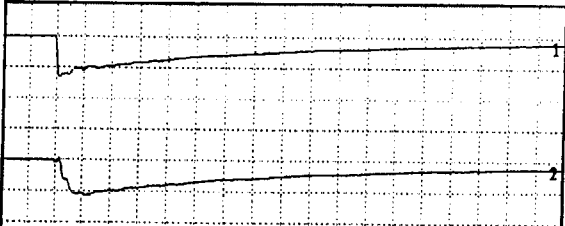
国家变压器质量监督检验中心
时基 (\CH1\CH2): \1. \1. 微秒/格

雷电截波 (Chopped Lightning Impulse Voltage)
T1=1.15us Tc=4.14us K=25% Up=84.0kV
备注: a相 (B02205-L30)



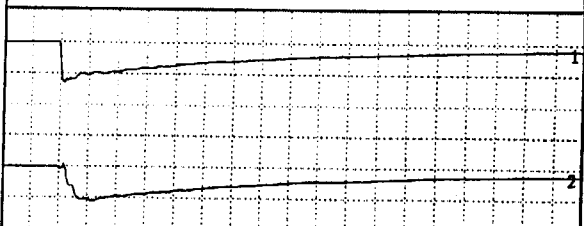
国家变压器质量监督检验中心
时基 (\CH1\CH2): \1. \1. 微秒/格

雷电全波 (Lightning Impulse Voltage)
T1=1.17us T2=51.2us Up=77.1kV
备注: a相 (B02205-L31)



国家变压器质量监督检验中心
时基 (\CH1\CH2): \10. \10. 微秒/格

雷电全波 (Lightning Impulse Voltage)
T1=1.19us T2=51.3us Up=75.8kV
备注: a相 (B02205-L32)



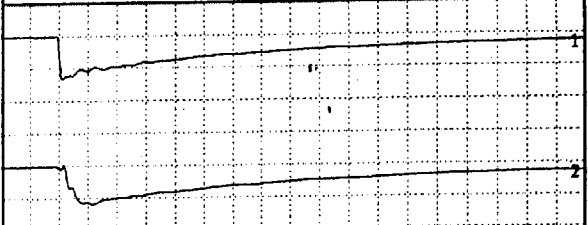
国家变压器质量监督检验中心
时基 (\CH1\CH2): \10. \10. 微秒/格

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

雷电全波 (Lightning Impulse Voltage)

T1=1.17us T2=51.2us Up=39.1kV

备注: b相 (B02205-L33)



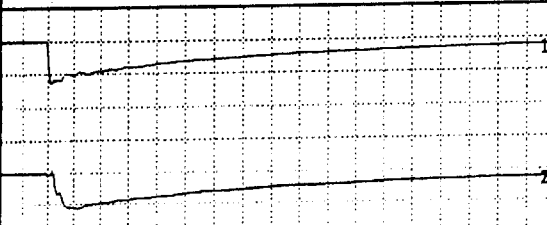
国家变压器质量监督检验中心

时基 (\CH1\CH2): \10. \10. 微秒/格

雷电全波 (Lightning Impulse Voltage)

T1=1.17us T2=51.1us Up=75.4kV

备注: b相 (B02205-L34)



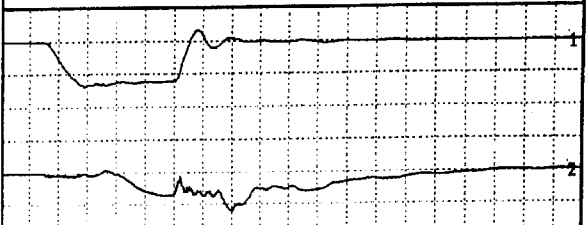
国家变压器质量监督检验中心

时基 (\CH1\CH2): \10. \10. 微秒/格

雷电截波 (Chopped Lightning Impulse Voltage)

T1=1.17us Tc=4.58us K=26% Up=43.2kV

备注: b相 (B02205-L35)



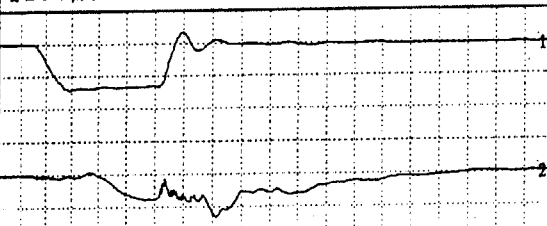
国家变压器质量监督检验中心

时基 (\CH1\CH2): \1. \1. 微秒/格

雷电截波 (Chopped Lightning Impulse Voltage)

T1=1.17us Tc=4.73us K=27% Up=84.0kV

备注: b相 (B02205-L36)



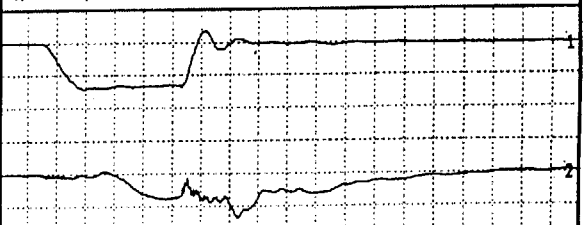
国家变压器质量监督检验中心

时基 (\CH1\CH2): \1. \1. 微秒/格

雷电截波 (Chopped Lightning Impulse Voltage)

T1=1.17us Tc=4.88us K=28% Up=84.0kV

备注: b相 (B02205-L37)



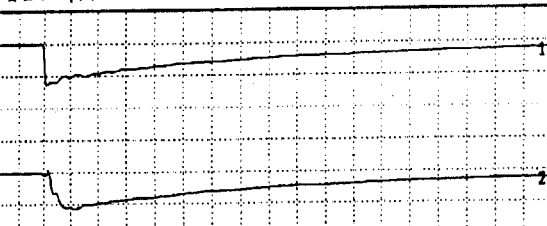
国家变压器质量监督检验中心

时基 (\CH1\CH2): \1. \1. 微秒/格

雷电全波 (Lightning Impulse Voltage)

T1=1.17us T2=51.1us Up=75.4kV

备注: b相 (B02205-L38)



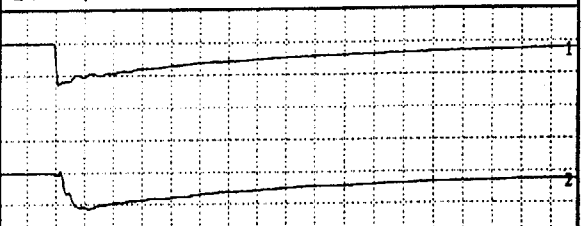
国家变压器质量监督检验中心

时基 (\CH1\CH2): \10. \10. 微秒/格

雷电全波 (Lightning Impulse Voltage)

T1=1.17us T2=51.0us Up=75.5kV

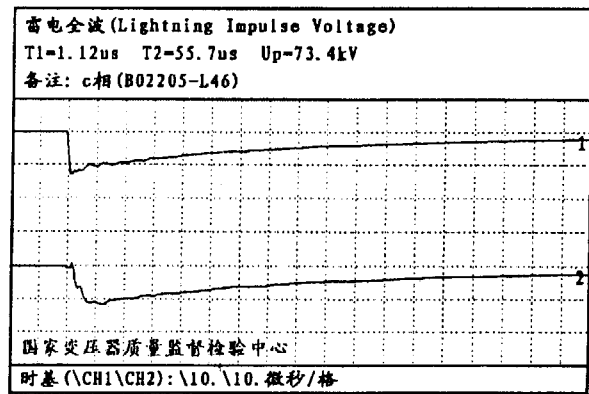
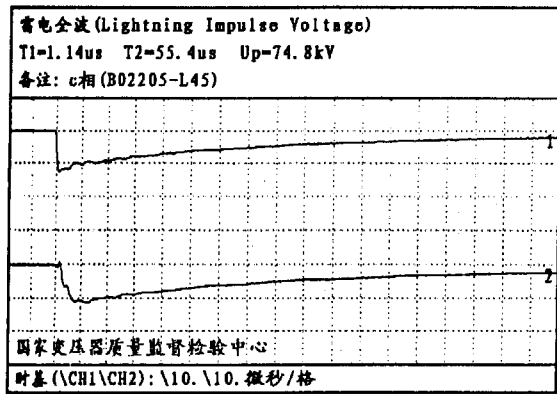
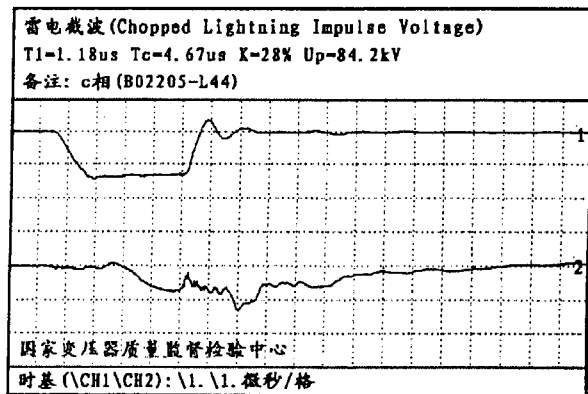
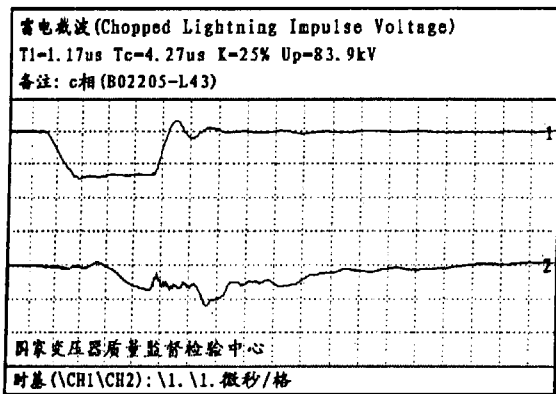
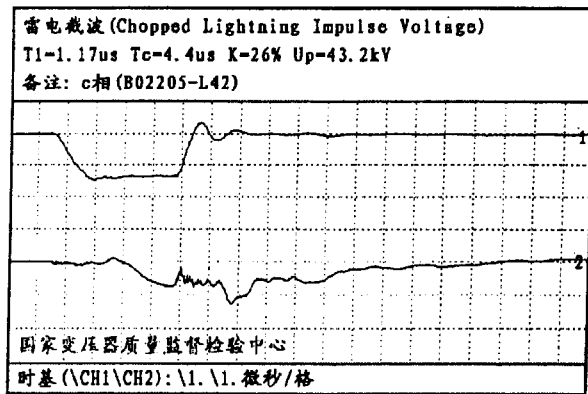
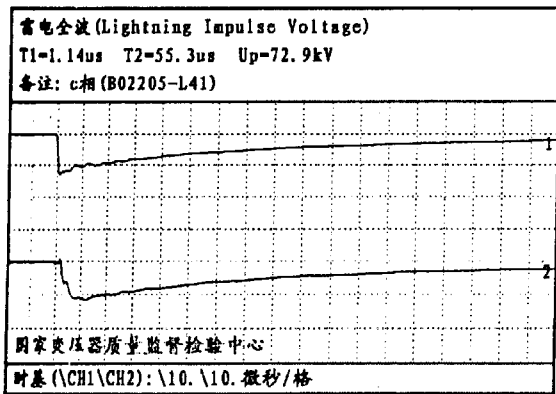
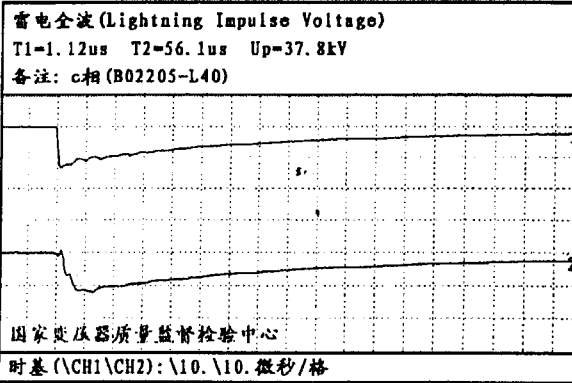
备注: b相 (B02205-L39)



国家变压器质量监督检验中心

时基 (\CH1\CH2): \10. \10. 微秒/格

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



3.13 Sound level measurement (Special test) Test date: May 10,2002

Explanation of measurement position:

Transformer is energized under rated voltage, There are 24 measurement points, the measurement point interval is 0.92m, the hight of tank is 2.9m, the hight of measurement points is 0.97m and 1.93m.

Environmental conditions

Area of the surface of the test room Sv (m ²)	Mean sound absorption coefficient α	Sound Absorption A (m ²)	d (m)	Area of effective surface S (m ²)	Environmental correction factor K (dB)
2300	0.15	345	0.3	79.75	2.8

d--Distance between specified contour and principal radiating surface.

Test results (dB)

Conditions of cooler	Mean values of transformer sound level $\overline{L_{PA}}$	Mean values of background sound level	Sound level difference between transformer and background	Corrected value of background sound level (X)
ONAN	65.5	45.4	20.1	0

A-weighted surface sound level

$$\overline{L_{PA}} = L_{PA} - K - X$$

62.7

A-weighted sound power level

$$L_{WA} = L_{PA} + 10 \log (S/S_0)$$

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3.14 Zero sequence impedance measurement for three phase transformers (Special test)

Test date: May 10, 2002

Connection group	Applied voltage terminal	Open circuit terminal	Short circuit terminal	Tap position	Applied current (A)	Measured voltage (V)	Losses (W)	Impedance (Ω)
YNd11	A.B.C-O	a.b.c	/	9	80.0	1080	5880	40.5

3.15 No load current harmonic measurement (Special test)

Test date: May 10, 2002

No	CH - A THD= 0.5072 %			CH - B THD= 0.4507 %			CH - C THD= 0.5601 %		
	Un (V)	Un / U1	PHASE	Un (V)	Un / U1	PHASE	Un (V)	Un / U1	PHASE
01	6004.3	100.00%	356.0	5911.9	100.00%	117.0	6083.6	100.00%	237.0
02	1.9125	0.0318%	261.5	0.7159	0.0121%	327.4	2.0408	0.0335%	177.0
03	25.899	0.4313%	346.7	18.718	0.3166%	025.3	28.943	0.4757%	007.0
04	0.4716	0.0078%	327.4	0.5447	0.0092%	073.4	0.5996	0.0098%	168.1
05	3.5233	0.0586%	170.5	11.000	0.1860%	012.4	7.4751	0.1228%	200.6
06	0.6495	0.0108%	354.0	0.6534	0.0110%	241.9	0.2341	0.0038%	351.5
07	2.2932	0.0381%	093.5	1.4045	0.0237%	333.7	2.3070	0.0379%	256.7
08	0.1027	0.0017%	097.0	0.5120	0.0086%	039.1	0.5998	0.0098%	205.3
09	2.7855	0.0463%	089.3	1.6567	0.0280%	239.4	0.8685	0.0142%	173.0
10	0.4610	0.0076%	203.5	0.2802	0.0047%	100.9	1.2023	0.0197%	353.0
11	10.980	0.1828%	148.9	11.608	0.1963%	031.1	12.137	0.1995%	270.0
12	0.5923	0.0098%	197.6	0.5699	0.0096%	355.5	0.2870	0.0047%	128.0
13	10.049	0.1673%	137.3	5.4784	0.1603%	255.0	10.009	0.1645%	015.0
14	0.3351	0.0055%	243.7	0.2100	0.0035%	236.5	0.3173	0.0052%	010.9
15	0.4374	0.0072%	192.4	0.3310	0.0055%	107.6	0.2152	0.0035%	150.4
16	0.4651	0.0077%	286.1	0.3286	0.0055%	047.3	0.4631	0.0076%	153.4
17	1.4667	0.0244%	158.4	1.4676	0.0248%	005.5	0.8353	0.0137%	240.4
18	0.1466	0.0024%	034.4	0.3605	0.0060%	228.3	0.0629	0.0010%	227.3
19	1.4451	0.0240%	277.0	2.2194	0.0375%	030.6	2.5643	0.0421%	162.9

No	CH - A THD= 28.866 %			CH - B THD= 27.275 %			CH - C THD= 20.866 %		
	In (A)	In / I1	PHASE	In (A)	In / I1	PHASE	In (A)	In / I1	PHASE
01	1.0340	100.00%	355.5	0.9981	100.00%	083.0	1.4722	100.00%	218.5
02	0.0236	0.2856%	257.6	0.0304	0.0544%	315.0	0.0476	0.2332%	112.5
03	0.2117	20.481%	022.1	0.2185	21.892%	234.7	0.1217	8.2702%	126.2
04	0.0124	0.2078%	121.1	0.0233	0.3396%	055.6	0.0301	0.0491%	253.4
05	0.1796	17.372%	079.1	0.1251	12.533%	006.0	0.2459	16.707%	229.3
06	0.0156	0.5104%	093.5	0.0260	0.6088%	265.5	0.0122	0.8330%	076.7
07	0.0974	9.4210%	105.0	0.0842	8.4376%	202.5	0.1184	8.0451%	330.4
08	0.0064	0.6232%	052.0	0.0059	0.5971%	100.9	0.0102	0.6947%	259.1
09	0.0209	2.0295%	166.7	0.0144	1.4435%	345.5	0.0082	0.5596%	356.0
10	0.0038	0.3698%	314.1	0.0064	0.6459%	203.5	0.0066	0.4542%	049.3
11	0.0257	2.4856%	240.4	0.0284	2.8537%	125.8	0.0312	2.1226%	357.5
12	0.0027	0.2680%	268.5	0.0040	0.4021%	054.2	0.0021	0.1469%	219.6
13	0.0174	1.6842%	233.3	0.0160	1.6112%	334.7	0.0193	1.3140%	099.9
14	0.0009	0.0903%	230.4	0.0014	0.1403%	243.9	0.0014	0.1013%	043.2
15	0.0017	0.1705%	265.0	0.0014	0.1430%	094.5	0.0014	0.0988%	249.9
16	0.0005	0.0491%	041.2	0.0002	0.0216%	182.5	0.0013	0.0911%	229.3
17	0.0019	0.1928%	029.6	0.0025	0.2530%	270.0	0.0037	0.2525%	166.1
18	0.0003	0.0303%	040.2	0.0017	0.1799%	200.6	0.0003	0.0256%	059.9
19	0.0067	0.6487%	052.0	0.0092	0.9280%	140.4	0.0101	0.6906%	275.0

3.16 Partial discharge measurement (Special test) Test date: May 11,2002

Applied voltage		Time (min)	Partial discharge measurement (pC)		
Multiple	Value (kV)		A	B	C
1.5Um/√3	109.1	5	94	97	96
Um	126	5s	95	99	95
1.5Um/√3	109.1	5	98	98	95
1.5Um/√3		10	96	94	98
1.5Um/√3		15	95	95	94
1.5Um/√3		20	97	94	96
1.5Um/√3		25	98	97	98
1.5Um/√3		30	97	98	96

3.17 Short-circuit withstand test (Special test) Test date: May 15, 2002

3.17.1 Calculated short-circuit current

Calculated short-circuit current (Reference temperature 75°C)

Tap position	Peak value (A)	Symmetrical value (A)	Multiple (K√2)
1	3221	1263	2.550
9	3692	1448	2.550
17	4274	1676	2.550

3.17.2 Measurement of short-circuit current

Perform single-phase test, Voltage is applied between one terminal and neutral terminal, Test waveshapes are no distortion, Test oscillograms are shown in Page 29-31.

Tap position	Applied current terminal	Peak value (A)		Symmetrical value (A)		Duration (S)
		(A)	%	(A)	%	
1	AO	2461	76.4	1168	92.5	0.20
	AO	3175	98.6	1168	92.5	0.19
	AO	2859	88.8	1168	92.5	0.20
9	BO	2809	76.1	1474	101.8	0.21
	BO	3711	100.5	1474	101.8	0.21
	BO	2821	76.4	1474	101.8	0.21
17	CO	3488	81.6	1607	95.9	0.21
	CO	4272	100.0	1607	95.9	0.21
	CO	3730	87.3	160	95.9	0.21

Note: The percentage of peak value and symmetrical value is the ratio of applied current to calculated current

3.17.3 Measured values of short-circuit reactance before and after S.C.T.

Reactance value before and after S.C.T.

Tap position	Reactance measured before test (Ω)			Reactance measured after test (Ω)		
	A	B	C	A	B	C
1	50.96	/	/	50.88	/	/
9	/	39.51	/	/	39.45	/
17	/	/	30.94	/	/	30.92

Deviation of short-circuit reactance before and after S.C.T.

Tap position	Deviation(%)			The maximum deviation (%)
	A	B	C	
1	-0.157	/	/	0.16
9	/	-0.152	/	
17	/	/	-0.065	

3.17.4 The out of tank 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 32 and Page 33 .

3.17.5 Repeating routine tests after short-circuit withstand tests

3.17.5.1 Measurement of insulation resistances

Test date: May 16, 2002

Humidity: 58%

Oil temperature: 25.0°C

Measurement position	R_{60} (G Ω)	R_{15} (G Ω)	R_{60}/R_{15}	$\tan \delta$
H.V. —L.V.&E	5.82	3.90	1.49	0.0024
L.V.—HIV.&E	3.76	2.19	1.72	0.0030
H.V.&L.V.—E	5.18	3.39	1.53	0.0032

3.17.5.2 Measurement of voltage ratio and check of connection group

Test date: May 16, 2002

H.V.		L.V.		Ratio	Measured deviation (%)			Conne- tion group
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AB/ab	BC/bc	CA/ca	
1	121.002	/	10.5	11.52	0.05	0.12	0.11	YNd11
2	119.626			11.39	0.10	0.17	0.17	
3	118.251			11.26	0.04	0.11	0.11	
4	116.876			11.13	0.09	0.16	0.16	
5	115.500			11.00	0.02	0.09	0.09	
6	114.124			10.87	0.08	0.15	0.15	
7	112.749			10.74	0.01	0.07	0.07	
8	111.373			10.61	0.05	0.13	0.13	
9	110.000			10.48	0.00	0.06	0.06	
10	108.622			10.35	0.05	0.12	0.11	
11	107.247			10.21	-0.02	0.05	0.04	
12	105.872			10.08	0.04	0.11	0.10	
13	104.499			9.95	-0.04	0.03	0.03	
14	103.125			9.82	0.03	0.10	0.09	
15	101.750			9.69	-0.05	0.02	0.01	
16	100.375			9.56	0.04	0.08	0.08	
17	99.000			9.43	-0.07	0.00	-0.01	

3.17.5.3 Measurement of winding resistances Test date: May 16, 2002

Oil temperature: 25.0°C

Winding	Tap position	Measured values (Ω)			Unbalancedness (%)
		A~O a~b	B~O b~c	C~O c~a	
H.V.	1	0.4609	0.4615	0.4630	0.45
	2	0.4526	0.4534	0.4546	0.44
	3	0.4437	0.4445	0.4453	0.36
	4	0.4355	0.4364	0.4375	0.46
	5	0.4266	0.4274	0.4283	0.40
	6	0.4185	0.4193	0.4200	0.36
	7	0.4095	0.4102	0.4108	0.32
	8	0.4011	0.4021	0.4026	0.37
	9	0.3903	0.3907	0.3899	0.20
	10	0.4012	0.4028	0.4052	0.99
	11	0.4102	0.4117	0.4132	0.73
	12	0.4185	0.4200	0.4224	0.93
	13	0.4271	0.4290	0.4307	0.84
	14	0.4353	0.4370	0.4396	0.98
	15	0.4446	0.4463	0.4481	0.78
	16	0.4523	0.4550	0.4554	0.68
	17	0.4612	0.4628	0.4634	0.56
L.V.	/	0.006680	0.006687	0.006705	0.37

3.17.5.4 Separate-source voltage withstand test Test date: May 16, 2002

Position	Applied voltage (kV)	Duration (s)	Results
H.V. neutral—L.V.&E	80.75	60	Passed
L.V.—H.V.&E	29.75	60	

3.17.5.5 Induced overvoltage withstand test Test date: May 16, 2002

Tap position	Applied voltage (kV)	Induced voltage (kV)	Induced multiple	Frequency (Hz)	Duration (s)	Results
	L.V.	H.V.				
9	17.85	170	1.7	150	40	Passed

3.17.5.6 Measurement of no-load loss and current Test date: May 16,2002

R.M.S. value voltage (kV)		No-load current		No-load loss (kW)	
Reading of mean value voltmeter	Reading of R.M.S. value voltmeter	(A)	(%)	Measured value	Corrected value
10.5	10.5	1.29	0.06	20.32	20.32

Note: The reading tolerance between R.M.S value voltmeter and mean value voltmeter is less than 3%.

3.17.5.7 Measurement of short-circuit impedance and load loss Test date: May 16,2002

Oil temperature: 25.0°C

Winding	Tap Position	Applied current I		Measured voltage (kV)	Short-circuit impedance (Each phase)		Load loss (kW)	Total loss (kW)
		(A)	I/Ir (%)		H.V. impedance (Ω)	(%)	Corrected value	Corrected value
					t=75°C I=Ir	t=75°C I=Ir	t=75°C I=Ir	t=75°C I=Ir
H.V. L.V.	1	191.1	100.0	17.70	53.4	14.6	155.63	175.95
	9	210.0	100.0	15.40	42.4	14.0	158.53	178.85
	17	233.1	100.0	13.26	32.8	13.4	174.24	194.56

3.17.5.8 Test on transformer oil Test date: May 16, 2002

tan δ (90°C)	Breakdown voltage (kV)	Water dissolved in oil (10 ⁻⁶)
0.0009	54.76	9.30

Gas chromatography

H ₂	CO	CO ₂	CH ₄	C ₂ H ₆	C ₂ H ₄	C ₂ H ₂	Hydro carbons
0.00	9.58	200.8	0.99	0.00	0.83	0.00	1.82

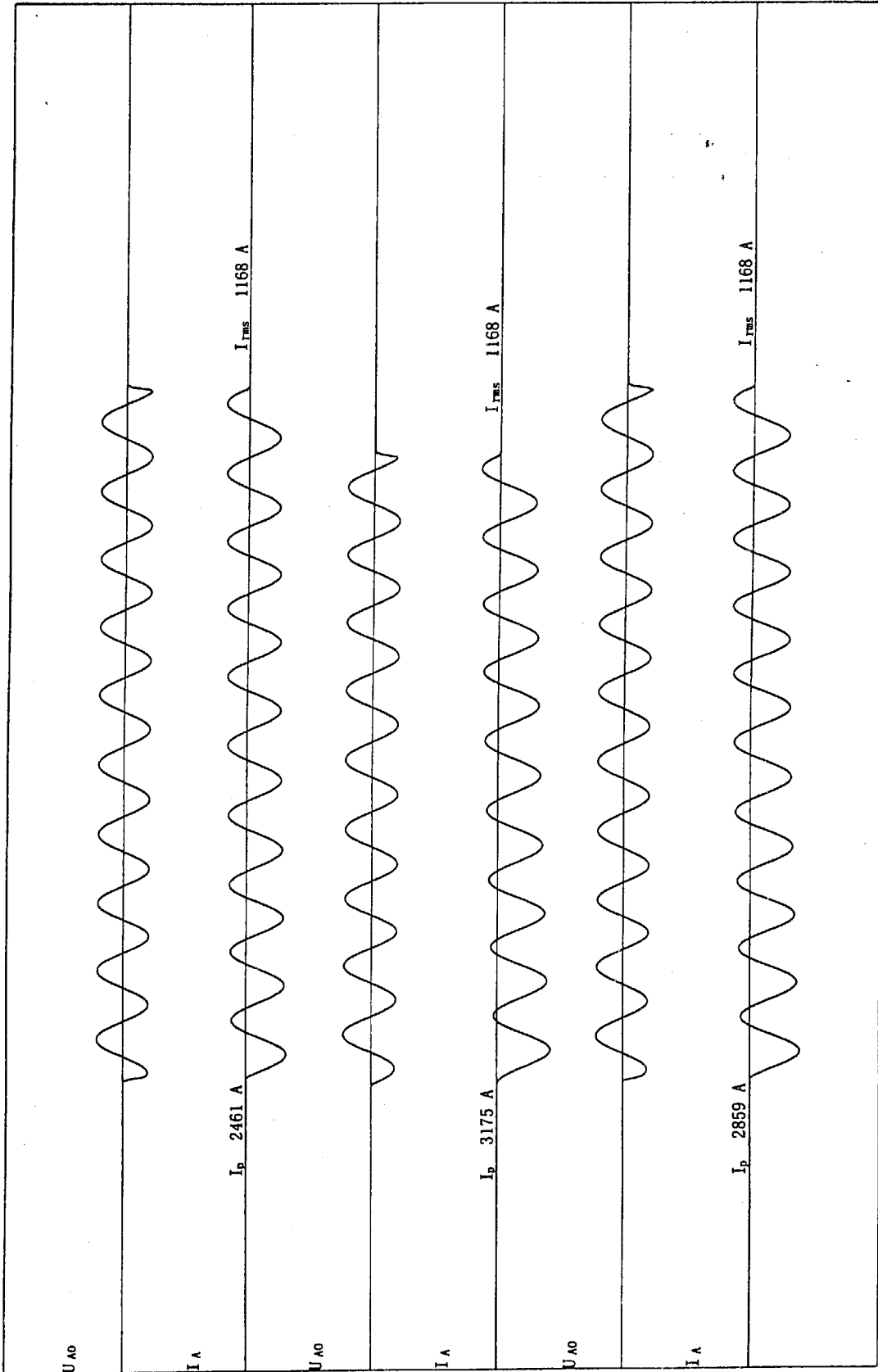
3.17.5.9 Test on on-load tap-changers Test date: May 16, 2002

Operation test:

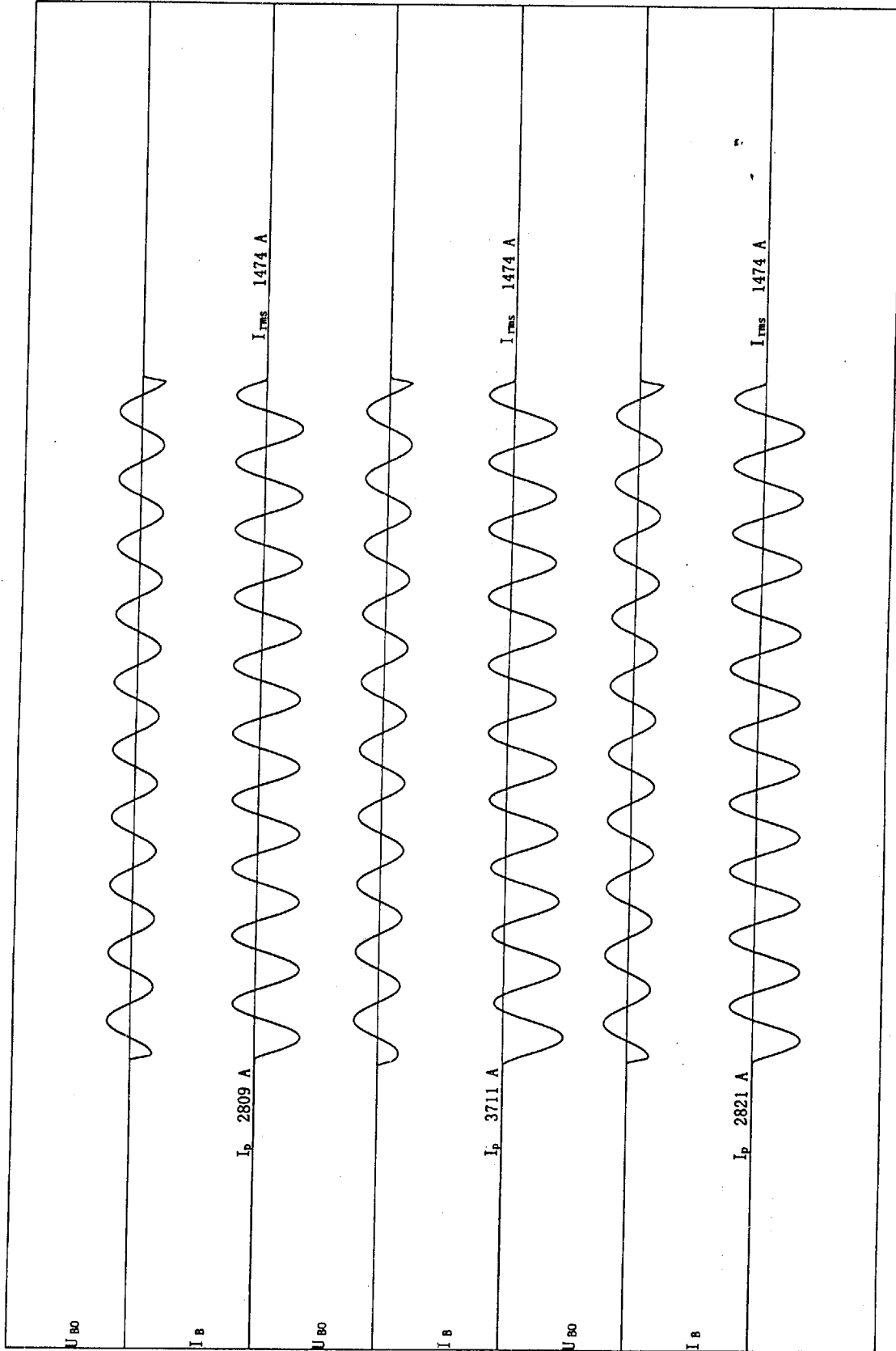
- a. 8 complete operating cycles with the transformer not energized;
- b. 1 complete operate cycle with the transformer is not energized, with 85% of the rated operation voltage;
- c. 1 complete operating cycle with the transformer is energized at rated voltage and rated frequency at no-load;
- d. 10 tap-change operations with ±2 steps on either side of the principal ta under on load test of transformer.

Auxiliary circuits dielectric test:

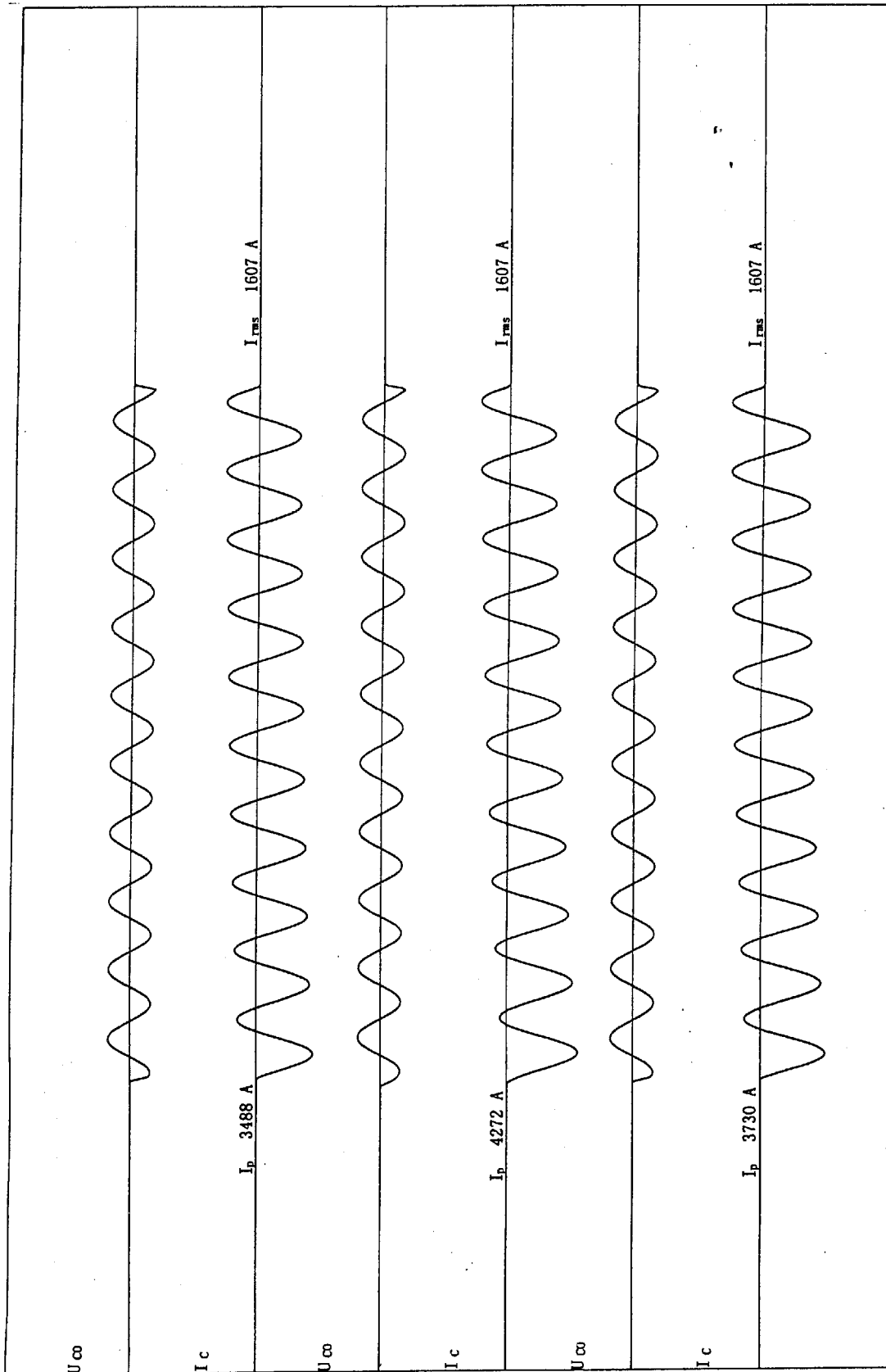
2kV (R.M.S.) 1 min separate-source voltage withstand test, passed.



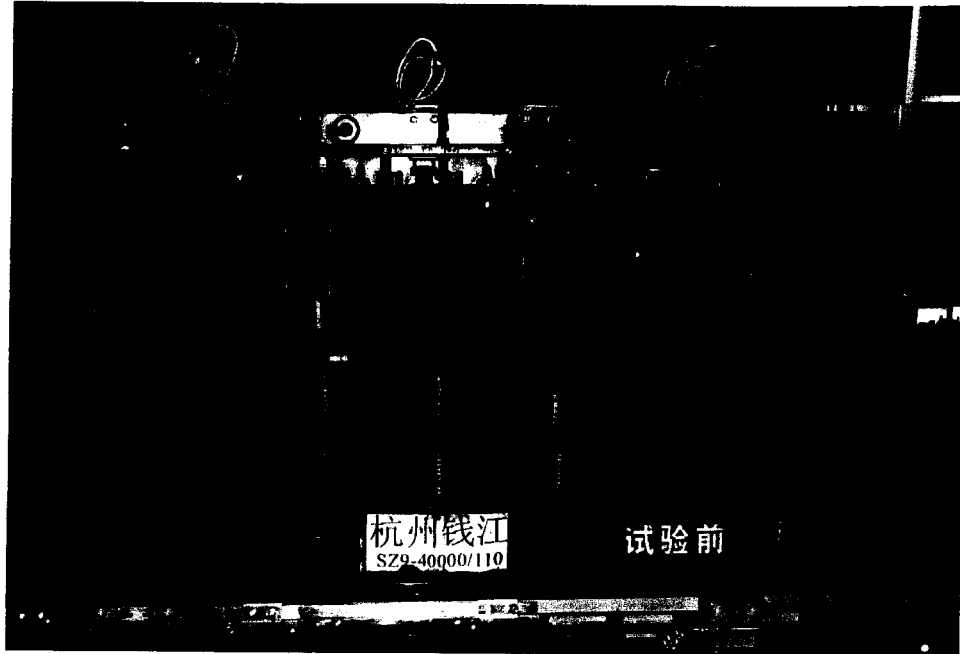
B02205-S01



B02205-502



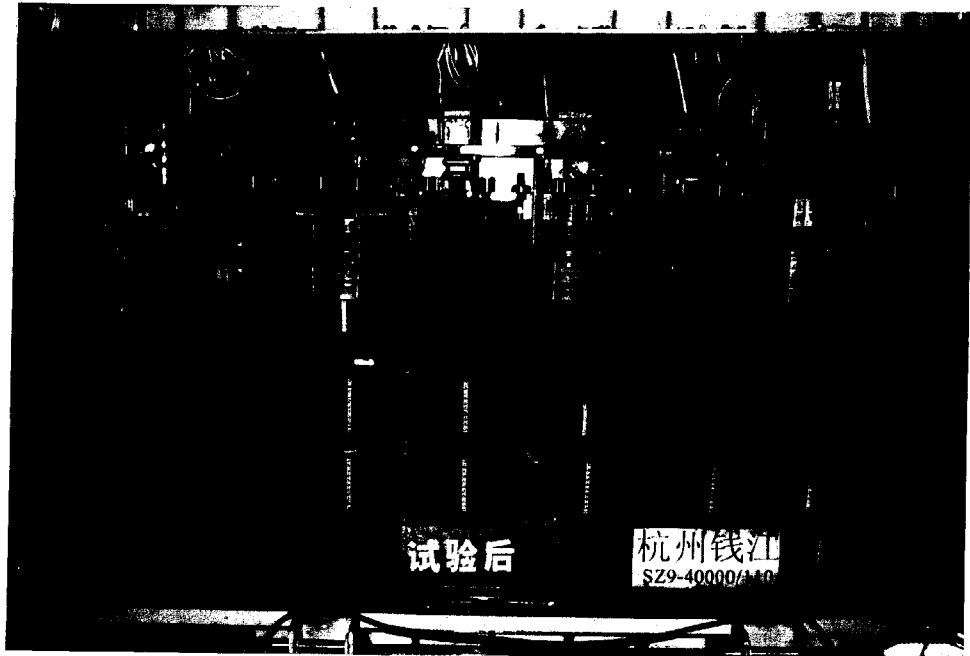
High voltage side before S.C.T.:



Low voltage side before S.C.T.:



High voltage side after S.C.T.:



Low voltage side after S.C.T.:

