

# Report.

Report number 08-66575A  
Project number 70855023  
Apparatus Power Transformer 180 MVA  
Client STI.CTQC  
Test location STI.CTQC, Shenyang, P.R. China  
Manufacturer Hangzhou Qiantang River Electric  
Group Co., Ltd.  
(Hangzhou Qiandian Power  
Transmission and Transformation  
Equipment Co., Ltd.)

Arnhem, 21 August 2008

**INSPECTION REPORT**

Report number 70855023-TDT 08-66575A

Client STI.CTQC  
China Transformer Quality Supervision Testing Center.  
Hushitai county, Xinchengzi district,  
Shenyang 110122  
China

Reference Trust testing

Concerning Routine, type and special tests  
Date Between 19 June and 28 June 2008  
Place Shenyang, China  
Object Power Transformer 180 MVA  
Manufacturer Hangzhou Qiantang River Electric Group Co., Ltd.  
(Hangzhou Qiandian Power Transmission and  
Transformation Equipment Co., Ltd.)

**REQUIREMENTS**

Requirements as specified in the standards IEC 60076-1, IEC 60076-3, IEC 60076-5.

**TEST PROGRAMME**

The programme was specified by the client.  
For the programme we refer to page 3.

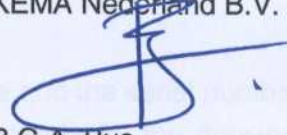
**SUMMARY AND CONCLUSION**

The results obtained relate only to the work ordered and to the material tested.  
On the points examined, the requirements specified for the material tested were met.  
The short circuit test was carried out by the single-phase method between phase and neutral. According to the IEC 60076-5 this is an agreement between purchaser and manufacturer.

Author G.J. Veldscholten

This B-report consists of:  
98 pages incl. 9 annexes ( 87 pages)

KEMA Nederland B.V.



P.G.A. Bus  
KEMA T&D Testing Services  
Managing Director

Arnhem, 21 August 2008



**MATERIAL DATA**

Manufacturer	Hangzhou Qiantang River Electric Group Co., Ltd (Hangzhou Qiandian Power Transmission and Transformation Equipment Co., Ltd.)
Type	SFPSZ11-180000/220
Serial number	085008001
Rated power	180/180/90 MVA
Rated voltage	220/121,00/10,5 kV
Rated current	472,38/858,87/4948,72 A
Rated frequency	50 Hz
Number of phases	3
Tapping range	+10%, -10%
Number of steps/ tapping step	17 / 2.5%
Vector group	Yyn0d11
Cooling method	ODAF
Temperature class of insulation	A
Insulation levels	h.v. terminal : LI/LIC/ AC – 950/1050/395 kV h.v. neutral : LI/AC – 400/200 kV m.v. terminal : LI/LIC/ AC – 480/530/200 kV m.v. neutral : LI/AC – 250/95 kV l.v. terminal : LI/LIC/AC – 75/85/35 kV
Short-circuit impedance calculated To 180 MVA.	h.v.-m.v. : 14,0 % at 75°C h.v.-l.v. : 24,0 % at 75°C m.v.-l.v. : 9,0 % at 75°C
Total assembled mass	206000 kg

**TEST OBJECT IDENTIFICATION**

The test object was identified by checking the rating plate and the serial number.

During the unloading operation the test object was checked with the drawings enclosed in the STI.CTQC report, nr. CTQC/B-08.404.

The STI.CTQC test report regarding tests, oscillogrammes, curves, lists of test equipments, test circuits and manufacturer drawings are enclosed in this report as annex I.

## TEST PROGRAMME

		kind of test <sup>1)</sup>	standard/ specification	clause
0	INSPECTION OF THE TEST SET-UP			
1	ROUTINE-, SPECIAL- AND TYPE TESTS BEFORE SHORT-CIRCUIT TEST			
2	SHORT-CIRCUIT TEST	S	IEC 60076-5	
3	REPEAT OF ROUTINE TESTS, SPECIAL- AND TYPE TESTS			
3.1	Measurement of insulation resistances, absorption ratio and tan $\delta$ and capacitance.	S	IEC 60076-1	10.1
3.2	Measurement of winding resistance	R	IEC 60076-1	10.2
3.3	Measurement of voltage ratio and check of voltage vector relationship	R	IEC 60076-1	10.3
3.4	Separate source AC withstand voltage test	R	IEC 60076-3	5,11
3.5	Measurement of load loss and short-circuit impedance	R	IEC 60076-1	10.4
3.6	Measurement of no-load loss and current	R	IEC 60076-1	10.5
3.7	Lightning impulse test (including chopped on the tail)	R, S	IEC60076-3	13, 14
3.8	Switching impulse withstand test	R	IEC60076-3	15
3.9	Short-duration AC withstand voltage test	S	IEC 60076-3	5,12
3.10	Long-duration AC withstand voltage test and currents.	R	IEC 60076-3	5,12
3.11	Tests on transformer oil			
3.12	Inspection of the active part	S	IEC 60076-5	4.2

<sup>1)</sup> R = routine test T = type test S = special test



**PERSONS ATTENDING THE TEST**

Mr Chen Kui	STI.CTQC
Mr Tian Wenge	STI.CTQC
Mr Wang Maosong	STI.CTQC

**THE INSPECTION WAS CARRIED OUT BY**

Mr G.J. Veldscholten	KEMA Nederland B.V.
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**PURPOSE OF THE TEST**

Purpose of the test was to verify whether the material, regarding the routine-, type- and special tests in accordance with the test programme, complies with the specified requirements.

**SHORT-CIRCUIT TEST**

The short-circuit test was carried out in accordance with IEC 60076-5. The transformer is of category 3. Calculations of the short-circuit current were made with a short-circuit rating of 1000 MVA and a system voltage of 220 kV. The short-circuit test was carried out in two parts. First part was between the h.v. and m.v. windings in the extreme- and rated tap positions. Second part was between the h.v. and m.v. windings in the extreme- and rated tap positions.

## **DESCRIPTION AND RESULTS OF THE TESTS PERFORMED**

### **0 INSPECTION OF THE TEST SET-UP**

The tests were carried out in the laboratory of STI, who is therefore jointly responsible for the correctness of the results obtained. The measuring devices and the test set-up were checked by us and were where necessary calibrated.

#### **Results**

The inspection did not give rise to remarks.

### **1 ROUTINE-, TYPE- AND SPECIAL TESTS BEFORE SHORT-CIRCUIT TEST**

The routine test before the short circuit test has been performed by the manufacturer without attendance of KEMA.

The laboratory did the ratio-, resistance-, insulation resistance-, and short circuit impedances measurements before the short-circuit test, also without attendance of KEMA.

For comparison reason the test results of the manufacturer have been put in the records and the annexes of this report.

### **2 SHORT-CIRCUIT TEST**

The short-circuit test was carried out in accordance with IEC 60076-5. The transformer is of category 3.

Calculations of the short-circuit current were made with a short-circuit rating of 18000 MVA and a system voltage of 220 kV.

The short-circuit test was carried out in two parts. First part was between the h.v. and l.v. windings in the extreme- and rated tap positions. Second part was between the h.v. and m.v. windings, in the extreme- and rated tap positions.

The test was performed according to the single-phase method. The power supply was not sufficient for the method described in the IEC. The purchaser and the manufacturer agreed upon the use of single-phase power supply between the line terminal and the neutral.

The non-tested h.v. terminals were connected together.

The secondary phase windings were shorted.

The primary, and tank currents were measured.

After each test the reactance of the windings were measured at the primary side.

The measured and calculated values of currents and reactance are represented in the STI.CTQC report, see annex I, pages 15 up to 18 and 40 up to 45.

### **Results**

During the test no visible damage could be detected.

The reactance deviations were within the maximum tolerance.

The currents and peak currents were within the tolerances.

## **3 REPEAT OF ROUTINE TEST**

### **3.1 Measurement of insulation resistance absorption ratio and $\tan \delta$**

The measurement was carried out in accordance with IEC 60076-1, clause 10.1.3.

Measured was the insulation resistance between the mutual windings and between the winding and earth with a d.c. voltage of 5 kV. The absorption ratio was calculated for the megger values after 15 and 60 and 600 seconds. After this test the  $\tan \delta$  was measured between the mutual windings and between the winding and tank. The measured values are represented in annex A.

### **Results**

The measured values do not give rise to remarks.

### **3.2 Measurement of winding resistance**

The measurement was carried out in accordance with IEC 60076-1 clause 10.2.



The d.c. resistance of the windings was determined with equipment, measuring voltages and currents and calculating the measured resistance. The resistances of the h.v. winding were measured in all positions of the tap-changer. The results of the measurements of the h.v. and m.v. and l.v. windings are represented in annex B.

**Results**

The measured values do not give rise to remarks.

**3.3 Measurement of voltage ratio and check of voltage vector relationship**

The measurement was carried out in accordance with IEC 60076-1, clause 10.3. The voltage ratio was measured using a bridge circuit at low voltage. The measurements took place for all tapping positions between h.v. and m.v. windings, between h.v. and l.v. windings in tap position 9 and between m.v. and l.v. windings. The connection symbol was checked together with the determination of the voltage ratio. Balance of the bridge can be attained only if the voltages connected to the bridge from the primary and secondary side have the same phase and sense. The measured values in comparison with the specified ones are represented in annex C.

**Results**

The deviations with respect to the rated values are within the specified tolerances.

**3.4 Separate source AC withstand voltage test**

The tests were carried in accordance with IEC 60076-3 clause 11. The h.v. winding was tested with 200 kV, 50 Hz for 1 minute. The m.v. winding was tested with 95 kV, 50 Hz for 1 minute. The l.v. winding was tested with 35 kV, 50 Hz for 1 minute.

**Results**

Values of the applied voltages are higher than the IEC standard. No collapse of the test voltages occurred.

### 3.5 Measurement of load loss and short-circuit impedance

The measurement was carried out in accordance with IEC 60076-1 clause 10.4.

The load loss and the short-circuit impedance were measured with a three phase supply and three combinations were measured.

Between h.v. and m.v. windings in tapping positions 1, 9, 17 with the m.v. winding short-circuited.

Between the h.v. and l.v. windings in tapping 1, 9, 17 with the l.v. winding short-circuited.

Between the m.v. and the l.v. windings with the l.v. winding short-circuited.

The measuring results were recalculated to 75 °C and are represented in annex D.

#### Results

The measured values were within the specified tolerance.

### 3.6 Measurement of no-load loss and current

The measurement was carried out in accordance with IEC 60076-1, clause 10.5.

The no-load loss and no-load currents were measured with supply at the l.v. side with rated voltage.

The results in comparison with the specified values are represented in annex E.

#### Results

The measured values were within the specified tolerance.

### 3.7 Lightning impulse test (inclusive chopped on the tail)

The lightning impulse test was carried out in accordance with IEC 60076-3, clauses 5 and 13. The test voltages were:

For the h.v. winding 950 kV and 1050 kV for the chopped impulse.

For the m.v. winding 480 kV and 530 kV for the chopped impulse.

For the l.v. winding 75 kV and 85 kV for the chopped impulse.

The windings were each tested with a sequence consisting of one reduced full wave, one full wave, one reduced chopped wave, two chopped waves and two full waves all of negative polarity.



The neutrals were tested without chopped waves and were 400 kV for the h.v. winding and 250 kV for the m.v. winding.

The front-, chop- and half times for the first impulses per phase are presented in annex F. The results are represented in the STI.CTQC report, see annex I, pages 28 up to 39.

### **Results**

The values of the voltages are higher than the IEC standard.  
The transformer passed the test successfully.

### **3.8 Switching impulse voltage test**

For the h.v. terminals the test voltage specified was 750 kV for the full wave. The tests were carried out in tap positions 1 for each of the phases A, B and C.

The wave shape was within the requirements of the standard.

The front-, chop- and half times for the first impulses per phase are presented in annex F.

The result is presented in annex A and the records are presented in annex I, pages 24 up to 27.

### **Result**

The results do not give rise to remarks.

### **3.9 Short-duration induced AC withstand voltage test**

This test was carried out in accordance with IEC 60076-3, clauses 5 and 12.

Two tests were performed and in both tests the partial discharge level was measured.

In the phase to earth test the rated withstand voltage was induced between one h.v./m.v. terminal and earth. The single-phase source was applied between two phases of the l.v. winding.

In the phase-to-phase test the rated withstand voltage was induced between the h.v./m.v. terminals. The three-phase source was applied to the three l.v. terminals.

The tapping position of the transformer was tap number 1.

The voltage levels were:

h.v. winding  $U_m = 252$  kV,  $U_1 = 395$  kV.

m.v. winding  $U_m = 126$  kV,  $U_1 = 200$  kV.

These levels are higher than the IEC levels as noted in table 2.



The rated withstand voltage levels, their durations and their PD levels are represented in annex G.

#### **Results**

The values of the voltages are higher than the IEC standard.  
The partial discharge levels were within the acceptance levels.

### **3.10 Long-duration AC withstand voltage test**

This tests with non-uniformly insulated h.v. windings was carried out according IEC 60076-3, clause 12.4 and carried out as three single phase tests.

The voltage source was applied to two terminals of the l.v. winding. The neutral points of the h.v. and m.v. winding were earthed. The tapping position was 1.

The rated withstand voltages, their durations and their PD levels, are given in annex H.

#### **Results**

The measured values are within the acceptance levels.

### **3.11 Test on transformer oil**

The transformer oil was checked upon breakdown voltage and  $\tan \delta$  at 90 °C and water dissolved in oil. Further a gas chromatography was carried out.

#### **Results**

Breakdown voltage was 66,2 kV, while requirement was higher than 40 kV.

$\tan \delta$  was 0.0009 while requirement was less than 0.01.

Water content was 11,7 mg/l, while requirement is less than 20 mg/l.

No gas development could be detected.

### **3.12 Inspection of the active part**

The transformer was untanked and the active part was inspected.

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

The drawings and photos made before and after short-circuit test can be found in the STI.CTQC report, see annex I.

**Results**

The transformer complies with IEC 60076-5, sub-clause 4.2.7.

Insulation resistance, capacitance and power factor before SOT at 37 °C and 50% humidity					
Combination	R15 (GΩ)	R60 (GΩ)	R000 (GΩ)	CV (pF)	Tan δ
H.V. - M.V., L.V. - tank	14,17	16,97	29,7	15800	0,23
M.V. - H.V., L.V. - tank	14,65	15,78	36,5	21040	0,24
L.V. - H.V., M.V. - tank	9,18	14,48	35,0	20910	0,25
H.V./M.V. - L.V. - tank	15,75	17,9		17748	0,20
M.V., M.V., L.V. - tank	10,43	16,25		26800	0,28
Insulation resistance, capacitance and power factor after SCT at 37 °C and 52% humidity					
Combination	R15 (GΩ)	R60 (GΩ)	R000 (GΩ)	CV (pF)	Tan δ
H.V. - M.V., L.V. - tank	6,63	0,10	18,3	16700	0,19
M.V. - H.V., L.V. - tank	4,14	4,02	6,61	21160	0,21
L.V. - H.V., M.V. - tank	4,25	6,60	9,92	26520	0,21
H.V./M.V. - L.V. - tank	0,80	0,99		1809	0,21
M.V., M.V., L.V. - tank	0,21	0,80		2725	0,24

**ANNEX A INSULATION RESISTANCES, ABSORPTION RATIO AND TAN δ**

Transformer number: 085008001

<b>Insulation resistance, capacitance and power factor before SCT at 37 °C and 50% humidity</b>					
Combination	R15 (GΩ)	R60 (GΩ)	R600 (GΩ)	CN (pF)	Tan δ (%)
h.v. – m.v., l.v., tank	14,17	15,87	29,7	15800	0,23
m.v. – h.v., l.v., tank	14,65	15,79	39,8	21040	0,24
l.v. – h.v., m.v., tank	9,19	14,48	35,0	26310	0,25
h.v./ m.v. – l.v., tank	15,75	17,8		17740	0,28
h.v., m.v., l.v. – tank	10,48	16,29		26800	0,28
<b>Insulation resistance, capacitance and power factor after SCT at 29 °C and 52% humidity</b>					
Combination	R15 (GΩ)	R60 (GΩ)	R600 (GΩ)	CN (pF)	Tan δ
h.v. – m.v., l.v., tank	6,63	9,10	18,2	15700	0,18
m.v. – h.v., l.v., tank	4,14	4,62	6,61	21160	0,21
l.v. – h.v., m.v., tank	4,23	5,60	9,82	26520	0,24
h.v./ m.v. – l.v., tank	3,30	3,93		18030	0,21
h.v., m.v., l.v. – tank	2,21	2,68		27290	0,24



**ANNEX B WINDING RESISTANCE MEASUREMENT**

Transformer number: 085008001

Winding	Tap position	Measured values before/ after short circuit test		
		T-ambient before : 37.0 °C/ T-ambient after: 29,0 °C		
		A-0	B-0	C-0
h.v. (Ω)	1	0,3725/ 0,3559	0,3746/ 0,3575	0,3738/ 0,3570
	2	0,3669/ 0,3503	0,3688/ 0,3520	0,3682/ 0,3517
	3	0,3611/ 0,3448	0,3631/ 0,3464	0,3624/ 0,3461
	4	0,3559/ 0,3394	0,3576/ 0,3412	0,3569/ 3409
	5	0,3498/ 0,3339	0,3517/ 0,3356	0,3511/ 0,3352
	6	0,3443/ 0,3287	0,3461/ 0,3303	0,3456/ 0,3301
	7	0,3387/ 0,3232	0,3404/ 0,3249	0,3394/ 0,3244
	8	0,3331/ 0,3180	0,3349/ 0,3196	0,3342/ 0,3193
	9	0,3262/ 0,3116	0,3274/ 0,3128	0,3267/ 0,3124
	10	0,3336/ 0,3185	0,3353/ 0,3197	0,3349/ 0,3191
	11	0,3394/ 0,3241	0,3407/ 0,3250	0,3402/ 0,3246
	12	0,3453/ 0,3294	0,3462/ 0,3304	0,3460/ 0,3301
	13	0,3505/ 0,3348	0,3518/ 0,3358	0,3516/ 0,3353
	14	0,3561/ 0,3401	0,3574/ 0,3413	0,3575/ 0,3409
	15	0,3616/ 0,3455	0,3632/ 0,3467	0,3633/ 0,3463
	16	0,3672/ 0,3510	0,3688/ 0,3521	0,3689/ 0,3518
	17	0,3728/ 0,3565	0,3746/ 0,3576	0,3744/ 0,3572
m.v. (mΩ)		Am-0m	Bm-0m	Cm-0m
	/	84,24/ 80,58	84,19/ 80,55	84,34/ 80,67
l.v. (mΩ)	/	a-b	b-c	c-a
	/	1,9454/ 1,86	1,9414/ 1,862	1,9578/ 1,872

**ANNEX C MEASUREMENT OF VOLTAGE RATIO**

Transformer number: 085008001

Measurement of voltage ratio					
Tap position	h.v. line/ m.v. line kV/kV	Calculated Ratio	Measured value before/ after SCT		
			AB/AmBm	BC/BmCm	CA/CmAm
1/17	242,00/121,00	2,000	-0,01/ -0,09	-0,07/ -0,10	0,05/ -0,09
2/17	239,25/121,00	1,977	0,01/ -0,08	-0,06/ -0,08	0,07/ -0,07
3/17	236,50/121,00	1,955	0,01/ -0,06	-0,03/ -0,06	0,07/ -0,07
4/17	233,75/121,00	1,932	0,04/ -0,03	-0,02/ -0,04	0,10/ -0,05
5/17	231,00/121,00	1,909	0,04/ -0,02	-0,01/ 0,03	0,10/ -0,02
6/17	228,25/121,00	1,886	0,06/ -0,01	0,01/ -0,01	0,12/ 0,00
7/17	225,50/121,00	1,864	0,08/ 0,00	0,01/ 0,00	0,14/ 0,01
8/17	222,75/121,00	1,841	0,09/ 0,02	0,04/ 0,01	0,15/ 0,02
9/17	220,00/121,00	1,818	0,12/ 0,04	0,06/ 0,04	0,17/ 0,05
10/17	217,25/121,00	1,795	0,14/ 0,06	0,07/ 0,05	0,18/ 0,06
11/17	214,50/121,00	1,773	0,16/ 0,09	0,10/ 0,07	0,21/ 0,07
12/17	211,75/121,00	1,750	0,18/ 0,12	0,12/ 0,11	0,23/ 0,10
13/17	209,00/121,00	1,727	0,20/ 0,13	0,14/ 0,12	0,25/ 0,12
14/17	206,25/121,00	1,705	0,22/ 0,15	0,16/ 0,15	0,27/ 0,14
15/17	203,50/121,00	1,682	0,25/ 0,18	0,19/ 0,18	0,29/ 0,18
16/17	200,75/121,00	1,659	0,27/ 0,20	0,22/ 0,20	0,32/ 0,20
17/17	198,00/121,00	1,636	0,29/ 0,22	0,23/ 0,22	0,35/ 0,22
Tap position	m.v. line / l.v. line (kV/ kV)		AmBm/ab	BmCm/bm	CmAm/ca
-	121,00/10,50	11,524	0,17/ 0,13	0,13/ 0,13	0,19/ 0,13
Tap position	h.v. line/ l.v. line (kV/kV)		AB/ab	BC/bc	CA/ca
9/17	220,00/10,50	20,952	0,28/ 0,20	0,19/ 0,19	0,19/ 0,13



**ANNEX D RESISTANCES, JOULE-LOSS, SHORT-CIRCUIT LOSS AND IMPEDANCES H.V/M.V.**

Transformer number: 085008001

<b>Resistances, Joule-loss, short-circuit loss and impedances h.v/m.v.</b>						
Tap position	1		9		17	
Ratio in tap (kV )	242/121		220/121		198/121	
Rated currents in tap (A).	429,4/858,9		472,4/858,9		524,9/858,9	
	<b>Before SCT</b>			<b>After SCT</b>		
Tap changer position	1	9	17	1	9	17
Average resistance at 75 °C h.v.	0,8517	0,7448	0,8524	0,8411	0,7361	0,8418
Average resistance at 75 °C l.v.	0,192			0,190		
Joule-losses at 75 °C (kW)	448,1	461,8	564,7	441,9	455,6	557,2
Joule-losses at T-measure (kW)	392,4	392,4	494,6	375,8	387,4	473,9
Short-circuit losses measured at 36,5 °C BSCT/ 28,0 °C ASCT	479,3	482,4	572,2	457,0	456,6	540,1
Eddy-current losses at T-measure	86,9	77,9	77,6	81,2	69,3	66,8
Eddy-current losses at T-75 °C	76,1	68,2	68,0	69,5	59,2	56,9
Short-circuit losses at 75 °C	524,2	530,0	632,7	511,3	514,8	614,1
Guaranteed losses (kW)	-	550	-	-	550	-
Tolerance	-	0%	-	-	0%	-
Short-circuit impedances (%)	14,20	13,6	13,57	14,18	13,60	13,56
Guaranteed values (%)	-	14,0	-	-	14,0	-
Tolerance	-	± 7,5%	-	-	± 7,5%	-

<b>Resistances, Joule-loss, short-circuit loss and impedances h.v./ l.v.</b>						
Tap position	1		9		17	
Ratio in tap (kV )	242/10,5		220/10,5		198/10,5	
Rated currents in tap (A).	429,4/4948,7		472,4/4948,7		524,9/4948,7	
	Before SCT			After SCT		
Tap changer position	1	9	17	1	9	17
Average resistance at 75 °C h.v.	0,8517	0,7448	0,8524	0,8411	0,7361	0,8418
Average resistance at 75 °C l.v.	2,22 mΩ			2,20 mΩ		
Joule-losses at 75 °C (kW)	140,5	143,9	169,6	138,6	141,9	167,2
Joule-losses at T-measure (kW)	123,0	126,0	148,6	117,8	120,8	142,3
Short-circuit losses measured at 18.0 °C BSCT/ 15.5 °C ASCT	172,1	172,3	193,9	167,1	166,5	186,5
Eddy-current losses at T-measure	49,1	46,3	45,3	49,3	45,8	44,3
Eddy-current losses at T-75 °C	43,0	40,5	39,7	42,0	39,1	37,8
Short-circuit losses at 75 °C	183,5	184,4	209,3	180,6	181,0	205,0
Guaranteed losses (kW)	-	550	-	-	550	-
Tolerance	-	0%	-	-	0%	-
Short-circuit impedances (%)	25,00	24,48	24,51	25,04	24,47	24,45
Guaranteed values (%)	-	24.0			24.0	
Tolerance	-	± 7,5%			± 7,5%	

<b>Short-circuit impedance m.v./ l.v.</b>		
	Before SCT	After SCT
Short-circuit impedances (%)	8,94	8,96
Guaranteed values (%)	9,0	9,0
Tolerance	±10,0%	±10,0%



**ANNEX E MEASUREMENT OF NO-LOAD LOSS AND CURRENT**

Transformer number: 085008001

<b>No-load loss and no-load current before short circuit test</b>						
U/ Un (%)	RMS voltage (kV)	Average voltage (kV)	Average current (A)	Average current (%)	Measured loss (kW)	Corrected loss (kW)
100	10,50	10,75	6,71	0,07*	102,2	102,3*
<b>No-load loss and no-load current after short circuit test</b>						
U/ Un (%)	RMS voltage (kV)	Average voltage (kV)	Average current (A)	Average current (%)	Measured loss (kW)	Corrected loss (kW)
100	10,50	10,63	6,61	0,07	99,91	98,67

\*Maximum loss and maximum current at rated voltage: 110 kW, 0.2%.

**Switching impulse test**

Winding	Terminal	U <sub>pk</sub> (kVp)	Tap position	Wave shape (us)	Priority
J12	A	743	1	100/200 > 1000	-
	B	747	1	200/200 > 1000	-
	C	753	1	100/270 > 1000	-

**ANNEX F SWITCHING IMPULSE VOLTAGE TEST**

Transformer number: 085008001

**Lightning impulse test**

Winding	Terminal	BIL/ Chopped (kVp)	Tap position	Wave shape (µs) Front/ tail/ chopped	Polarity
h.v.	A	942,0/ 1045,6	9	1,45/ 47,9/ 3,31	-
	B	942,5/ 1044,8	17	1,42/ 44,6/ 3,60	-
	C	922,9/ 1039,2	1	1,40/ 51,2/ 4,16	-
m.v.	Am	489,1/ 526,7	-	1,48/ 41,5/ 3,56	-
	Bm	482,4/ 529,6	-	1,48/ 42,5/ 3,89	-
	Cm	485,0/ 535,5	-	1,50/ 41,4/ 3,11	-
l.v.	a	76,2/ 84,7	-	1,15/ 44,2/ 3,40	-
	b	75,2/ 84,4	-	1,13/ 45,1/ 3,46	-
	c	75,1/ 85,0	-	1,12/ 44,9/ 3,82	-
h.v. neutral	O	400,9/ -	1	6,05/ 47,4/ -	-
m.v. neutral	Om	251,7/ -	-	2,57/ 56,7/ -	-

**Switching impulse test**

Winding	Terminal	BIL (kVp)	Tap position	Wave shape (µs) Front/ T > 90%/ T to 0	Polarity
h.v.	A	743	1	191/ 287/ > 1000	-
	B	747,9	1	201/ 290/ > 1000	-
	C	753,3	1	195/ 274/ > 1000	-



**ANNEX G      SHORT DURATION AC WITHSTAND VOLTAGE TEST  
AFTER SCT**

Transformer number: 085008001

Phase to earth test, tap position 1, frequency 150 Hz						
Induced voltage		Time	Partial discharge levels (pC) – BST/ AST			
x Um	Voltage h.v / m.v.		A/ Am	B/ Bm	C/Cm	Limits
1.1 Um/ $\sqrt{3}$	160/ 80kV	5 min.	-	-	-	-
1.5Um/ $\sqrt{3}$	218/ 109 kV	5 min.	-	-	-	-
U1	395/ 200 kV	40 s	-	-	-	-
1.5 Um/ $\sqrt{3}$	218/ 109 kV	5 min.	<30/<40	<30/<50	<30/<50	500
1.1 Um/ $\sqrt{3}$	160/ 80kV	5 min.	<30/<40	<30/<50	<30/<40	100

Phase to phase test, tap position 1, frequency 150 Hz						
Induced voltage		Time	Partial discharge levels (pC) – BST/ AST			
x Um	Voltage		A/Am	B/Bm	C/Cm	Limits
1.1 Um	277,2/ 138,6 kV	5 min.	-	-	-	-
1.3 Um	327,6/ 163,8 kV	5 min.	-	-	-	-
U1	395/ 200kV	40 s	-	-	-	-
1.3 Um	327,6/ 163,8 kV	5 min.	<50/<60	<50/<60	<50/<60	300
1.1 Um	277,2/ 138,6 kV	5 min.	<40/<50	<40/<50	<40/<50	100

Background level was less than 25 pC before and after test.

Um is 252 kV (IEC=245 kV) for h.v and 126 kV (IEC=123 kV) for m.v.

**ANNEX H LONG DURATION AC WITHSTAND VOLTAGE TEST**

Transformer number: 085008001

<b>After short circuit test</b>						
Phase to earth test, tap position 1, frequency 100 Hz						
x.U <sub>m</sub>	Voltage h.v. / m.v.	Duration	Patial discharge levels (pC)			Limits
			A/ A <sub>m</sub>	B/ B <sub>m</sub>	C/ C <sub>m</sub>	
1.1 U <sub>m</sub> /√3	160/ 80kV	5 min	-	-	-	-
1.5 U <sub>m</sub> /√3	218/ 109 kV	5 min	-	-	-	-
1.7 U <sub>m</sub> /√3	247/ 124 kV	40 s	-	-	-	-
1.5 U <sub>m</sub> /√3	218/ 109 kV	5 min.	<20/<60	<30/<50	<40/<50	500
		10 min.	<20/<60	<30/<50	<40/<50	
		15 min.	<20/<60	<30/<50	<40/<50	
		20 min.	<20/<60	<30/<40	<40/<50	
		25 min.	<20/<60	<30/<40	<40/<50	
		30 min.	<20/<60	<30/<40	<40/<50	
1.1 U <sub>m</sub> /√3	160/ 80 kV	5 min	<20/<50	<30/<40	<30/<50	100

Background level before and after the test was 16 pC. U<sub>m</sub> is 252 kV (IEC=245 kV) for h.v. and 126 kV (IEC=123 kV) for m.v.





# CTQC



TESTING  
No. L0681



(2006)国认监认字(080)号



2006000394Z



机检电(2004)07号

## TEST REPORT

No:CTQC/B-08.404

Apparatus: Power transformer

Manufacturer: HANGZHOU QIANTANG RIVER  
ELECTRIC GROUP CO., LTD.  
(HANGZHOU QIANDIAN POWER  
TRANSMISSION AND TRANSFORMATION  
EQUIPMENT CO., LTD.)

Kind of testing: Trust testing

CHINA NATIONAL TRANSFORMER QUALITY  
SUPERVISION TESTING CENTER





### Test Report

No: CTQC/B-08.404

Total 47 Page 1

Test object name	Power transformer	Test object type	SFPSZ11-180000/220
		Brand	/
Entrusted by	HANGZHOU QIANTANG RIVER ELECTRIC GROUP CO., LTD. (HANGZHOU QIANTANG POWER TRANSMISSION AND TRANSFORMATION EQUIPMENT CO., LTD.)	Kind of testing	Trust testing
Manufacturer	HANGZHOU QIANTANG RIVER ELECTRIC GROUP CO., LTD. (HANGZHOU QIANTANG POWER TRANSMISSION AND TRANSFORMATION EQUIPMENT CO., LTD.)	Sampling date	May 17,2008
Address	Qiantang River Electric Science & Technology Industrial Zone, Xiaoshan District, Hangzhou, China	Serial No	0850080001
Standards	IEC60076-1:2000 IEC60076-3:2000 IEC60076-5:2000 Technical contract	Test items	Routine test Short-duration AC withstand voltage test Short-circuit withstand test Lightning impulse test.
Results	The test results of routine test, short-duration AC withstand voltage test, short-circuit withstand test, lightning impulse test of SFPSZ11-180000/220 are in accordance with standards and technical contract requirements. The sample passed the above tests.		
	Signing and issuing date: July 21, 2008 Period of validity 5 years		
KEMA T&D TESTING SERVICES INSPECTORS: Mr. G. J. Veldscholten			

Approved by:  Checked by:  Compiled by: 

- 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(except for copying all the testing report).



Test results

No	Test items	Specified values	Measured values		Conclusions
		Standards (Technical contract)	Before S.C.T.	After S.C.T.	
1	Measurement of insulation resistance and tan δ (Routine test)	Providing insulation resistance, Providing absorption ratio(R <sub>60</sub> /R <sub>15</sub> ) and tan δ	See 4.1	See 4.13.3.1	/
2	Measurement of voltage ratio and check of phase displacement (Routine test)	The tolerances of voltage ratio : ±0.5%  Connection symbol: YNyn0d11	H.V.~L.V.: 0.19%~0.28% H.V.~M.V.: 0.06%~0.17% M.V.~L.V.: 0.13%~0.19% YNyn0d11	H.V.~L.V.: 0.19%~0.20% H.V.~M.V.: 0.04%~0.05% M.V.~L.V.: 0.13% YNyn0d11	Passed
3	Measurement of winding resistance (Routine test)	Providing winding resistance ( Ω )	See 4.3	See 4.13.3.3	/
4	Separate-source AC withstand voltage test (Routine test)	H.V. neutral: 200kV; 60s M.V. neutral: 95kV; 60s L.V.: 35kV; 60s	200kV; 60s 95kV; 60s 35kV; 60s	200kV; 60s 95kV; 60s 35kV; 60s	Passed
5	Long-duration AC withstand voltage test (Routine test)	Phase to earth test			Passed
		U <sub>1</sub> =1.7U <sub>m</sub> /√3 (kV) Duration (s): 120 (f <sub>n</sub> /f)	247 60	247 40	
		U <sub>2</sub> =1.5U <sub>m</sub> /√3 (kV) Duration(min): 30 PD≤500pC	H.V. M.V. 218 109 30 30 <40 <40	H.V. M.V. 218 109 30 30 <40 <60	
		1.1U <sub>m</sub> /√3 (kV) Duration(min): 5 PD≤100pC	H.V. M.V. 160 80 5 5 <30 <30	H.V. M.V. 160 80 5 5 <30 <50	
		Frequency (Hz): >50	100	150	





No	Test items	Specified values	Measured values				Conclu- sions
		Standards (Technical contract)	Before S.C.T.		After S.C.T.		
6	Short-duration AC withstand voltage test (Routine test, Special test)	A phase-to-earth test with single-phase supply					
			H.V.	M.V.	H.V.	M.V.	
		$U_1$ (kV): 395	395	200	395	200	
		Duration (s): 120 ( $f_n/f$ )	60	60	40	40	
			H.V.	M.V.	H.V.	M.V.	
		$U_2=1.5U_m/\sqrt{3}$ (kV)	218	110.3	218	109	
		Duration(min): 5	5	5	5	5	
		PD $\leq$ 500pC	<50	<40	<30	<50	
			H.V.	M.V.	H.V.	M.V.	
		$1.1U_m/\sqrt{3}$ (kV)	160	80.9	160	80	
		Duration(min): 5	5	5	5	5	
		PD $\leq$ 100pC	<40	<40	<30	<50	
Frequency (Hz): >50	100		150				
A phase-to-phase test with three-phase supply						Passed	
	H.V.	M.V.	H.V.	M.V.			
$U_1$ (kV): 395	395	200	395	200			
Duration (s): 120 ( $f_n/f$ )	60	60	40	40			
	H.V.	M.V.	H.V.	M.V.			
$U_2=1.3U_m$ (kV)	328	164	327.6	163.8			
Duration(min): 5	5	5	5	5			
PD $\leq$ 300pC	<50	<35	<50	<60			
	H.V.	M.V.	H.V.	M.V.			
$1.1U_m$ (kV)	277	138	277.2	138.6			
Duration(min): 5	5	5	5	5			
PD $\leq$ (70) pC	<20	<35	<40	<50			
Frequency (Hz): >50	100		150				
7	Measurement of no-load loss and current (Routine test)	$I_0\%$ : 0.15 +30% $P_0$ (kW): (110.00)	0.07 102.20		0.07 98.67	Passed	
8	Measurement of short-circuit impedance and load loss (Routine test)	t: 75°C Z%: H.V. ~L.V.: (24 +7.5%) H.V. ~M.V.: (14 +7.5%) M.V.~L.V.: (9 +10%) H.V. ~M.V.: $P_k$ (kW): ( $\leq$ 550.00) $P_{total}$ (kW): ( $\leq$ 660.00)	24.48 13.60 8.94 530.00 632.20		24.47 13.60 8.96 514.80 613.47	Passed	





<b>Test Report</b>	<b>China National Transformer Quality Supervision Testing Center</b>	No: CTQC/B-08.404 Total 47 Page 4
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No	Test items	Specified values		Measured values		Conclusions																																																
		Standards (Technical contract)		Before S.C.T.	After S.C.T.																																																	
9	Test on transformer oil (routine test)	Breakdown voltage (kV): $\geq 40$ tan $\delta$ (90°C): $\leq 0.01$ Water dissolved in oil (mg/L): $\leq 20$ Providing gas chromatography		63.8 0.00042  5.1 Providing gas chromatography	66.20 0.0009  11.70 Providing gas chromatography	Passed																																																
10	Leakage test (Routine test)	Applied pressure (kPa): 50 Duration (h): 72 No leakage and damage		50 72 No leakage and damage		Passed																																																
11	Test on on-load tap-changers (Routine test)	According to standard		Comply with standard	Comply with standard	Passed																																																
12	Switching impulse wave (Routine test)	Switching impulse wave (kV): 750 $\pm 3\%$		Replace by short-duration AC withstand voltage test	742.5~753.3	Passed																																																
13	Short-circuit withstand test (Special test)	Three times each phase Duration (s): $0.25 \pm 10\%$ Test waveshapes have no distortion Deviation of reactance before and after S.C.T. $\leq 2\%$  The untanking inspection shows no apparent defects Successfully repeat routine test		3 0.24 No distortion  H.V.-M.V.: 0.30% H.V.-L.V.: 0.35% No apparent defects  Passed		Passed																																																
14	Lightning impulse test (Routine test, type test)	<table style="width: 100%; border-collapse: collapse;"> <tr> <td></td> <td style="text-align: center;">Full wave</td> <td style="text-align: center;">Chopped wave</td> <td></td> </tr> <tr> <td>H.V. (kV):</td> <td style="text-align: center;">950</td> <td style="text-align: center;">1050 <math>\pm 3\%</math></td> <td style="text-align: center;"><math>\pm 3\%</math></td> </tr> <tr> <td>O (kV):</td> <td style="text-align: center;">400</td> <td style="text-align: center;">/</td> <td style="text-align: center;"><math>\pm 3\%</math></td> </tr> <tr> <td>M.V. (kV):</td> <td style="text-align: center;">480</td> <td style="text-align: center;">530 <math>\pm 3\%</math></td> <td style="text-align: center;"><math>\pm 3\%</math></td> </tr> <tr> <td>O (kV):</td> <td style="text-align: center;">250</td> <td style="text-align: center;">/</td> <td style="text-align: center;"><math>\pm 3\%</math></td> </tr> <tr> <td>L.V. (kV):</td> <td style="text-align: center;">75</td> <td style="text-align: center;">85 <math>\pm 3\%</math></td> <td style="text-align: center;"><math>\pm 3\%</math></td> </tr> </table>			Full wave	Chopped wave		H.V. (kV):	950	1050 $\pm 3\%$	$\pm 3\%$	O (kV):	400	/	$\pm 3\%$	M.V. (kV):	480	530 $\pm 3\%$	$\pm 3\%$	O (kV):	250	/	$\pm 3\%$	L.V. (kV):	75	85 $\pm 3\%$	$\pm 3\%$	<table style="width: 100%; border-collapse: collapse;"> <tr> <td></td> <td style="text-align: center;">Full wave</td> <td style="text-align: center;">Chopped wave</td> <td></td> </tr> <tr> <td>H.V. (kV):</td> <td style="text-align: center;">922.9~955.8</td> <td style="text-align: center;">1039.2~1052.4</td> <td></td> </tr> <tr> <td>O (kV):</td> <td style="text-align: center;">400.2~400.9</td> <td style="text-align: center;">/</td> <td></td> </tr> <tr> <td>M.V. (kV):</td> <td style="text-align: center;">474.7~489.1</td> <td style="text-align: center;">526.7~535.5</td> <td></td> </tr> <tr> <td>O (kV):</td> <td style="text-align: center;">248.0~252.1</td> <td style="text-align: center;">/</td> <td></td> </tr> <tr> <td>L.V. (kV):</td> <td style="text-align: center;">74.4~76.2</td> <td style="text-align: center;">84.4~85.0</td> <td></td> </tr> </table>			Full wave	Chopped wave		H.V. (kV):	922.9~955.8	1039.2~1052.4		O (kV):	400.2~400.9	/		M.V. (kV):	474.7~489.1	526.7~535.5		O (kV):	248.0~252.1	/		L.V. (kV):	74.4~76.2	84.4~85.0		Passed
	Full wave	Chopped wave																																																				
H.V. (kV):	950	1050 $\pm 3\%$	$\pm 3\%$																																																			
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O (kV):	250	/	$\pm 3\%$																																																			
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O (kV):	248.0~252.1	/																																																				
L.V. (kV):	74.4~76.2	84.4~85.0																																																				

Annex 1: Rating plate and outline photo (1 page totally)

Annex 2: Test circuits (7 pages totally)

Annex 3: Transformer drawings (12 pages totally)

- № 1 Name plate 8QB.868.5008
- № 2 Outline dimensions 1QB.710.5008
- № 3 Transportation drawing 1QB.710.5008YS
- № 4 Connection diagram 6QB.076.5008
- № 5 H.V. lead 5QB.516.5008.1
- № 6 M.V.&L.V. lead 5QB.516.5008.2
- № 7 Core assemble 5QB.640.5008
- № 8 Active body insulation 5QB.700.5008
- № 9 H.V. winding 6QB.600.5008.1
- № 10 M.V. winding 6QB.600.5008.2
- № 11 L.V. winding 6QB.600.5008.3
- № 12 H.V. tap winding 6QB.600.5008.4

Annex 4: List of instruments and meters used (6 pages totally)





<b>Test Report</b>	<b>China National Transformer Quality Supervision Testing Center</b>	No: CTQC/B-08.404 Total 47 Page 5
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### 1. Test object parameters

Rated power: 180000 kVA

Rated voltage: 220/121/10.5 kV

Rated current: 472.4/858.9/4948.7 A

Rated frequency: 50 Hz

Number of phases: 3

Tap range: (220±8×1.25%) /121/ 10.5 kV

Connection symbol: YNyn0d11

Cooling method: ODAF

Temperature class of insulation: A

Insulation level: h.v. line terminal	SI/LI/AC	750/950/395 kV
h.v. neutral	LI/AC	400/200 kV
m.v line terminal	LI/AC	480/200 kV
m.v. neutral	LI/AC	250/95 kV
l.v. line terminal	LI/AC	75/35kV

### 2. Sample condition description

- (1) Sample exterior construction and major dimensions( length, width, height) are in compliance with drawing. Measured values: length is 9810mm, width is 5857mm, height is 7661mm.
- (2) The form, performance data , specifications of sample rating plate are in compliance with drawing.
- (3) The mark of the phase sequence on high voltage and low voltage side of the sample is clear and right.
- (4)The surface of the sample has no collision and damage.

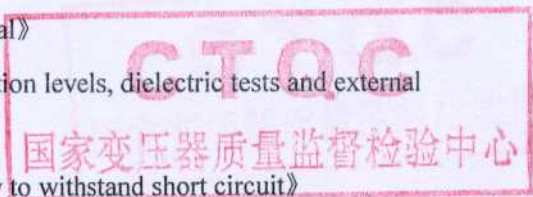
### 3. Standards

IEC60076-1:2000 《Power transformers Part1: General》

IEC60076-3:2000 《Power transformers Part3: Insulation levels, dielectric tests and external clearances in air》

IEC60076-5:2000 《Power transformers Part5: Ability to withstand short circuit》

Technical contract



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4. Test items and conclusions:

4.1 Measurement of insulation resistance and  $\tan \delta$  (Routine test)

Test date: May 23, 2008

Humidity: 50%; Oil temperature: 37.0°C

Measurement position	Insulation resistance (GΩ)			R <sub>60</sub> /R <sub>15</sub>	R <sub>600</sub> /R <sub>60</sub>	tan δ
	R <sub>600</sub>	R <sub>60</sub>	R <sub>15</sub>			
H.V.—M.V.、L.V.&E	29.7	15.87	14.17	1.11	1.87	0.0023
M.V.—H.V.、L.V.&E	39.8	15.79	14.65	1.07	2.52	0.0024
L.V.—H.V.、M.V.&E	35.0	14.48	9.19	1.57	2.42	0.0025
H.V.、M.V.—L.V.、E	27.8	17.80	15.75	1.12	1.56	0.0028
H.V.、M.V.、L.V.—E	26.1	16.29	10.48	1.55	1.60	0.0028
Core—E	>2.5			/	/	/
Clamp—E	>2.5			/	/	/





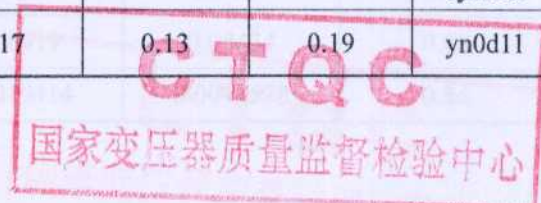
4.2 Measurement of voltage ratio and check of phase displacement (Routine test)  
Test date: May 23, 2008

H.V.		L.V.		Ratio	Measured deviation (%)			Conne- tion symbol
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AB/ ab	BC/ bc	CA/ ca	
1	242.000	/	10.5	23.048	0.15	0.05	0.11	YNd11
2	239.250			22.786	0.16	0.07	0.13	
3	236.500			22.524	0.18	0.09	0.15	
4	233.750			22.262	0.20	0.11	0.15	
5	231.000			22.000	0.21	0.12	0.18	
6	228.250			21.738	0.23	0.14	0.19	
7	225.500			21.476	0.24	0.15	0.21	
8	222.750			21.214	0.26	0.18	0.22	
9a, 9b, 9c	220.000			20.952	0.28	0.19	0.24	
10	217.250			20.690	0.30	0.21	0.26	
11	214.500			20.429	0.32	0.23	0.27	
12	211.750			20.167	0.34	0.24	0.30	
13	209.000			19.905	0.35	0.27	0.32	
14	206.250			19.643	0.38	0.30	0.34	
15	203.500			19.381	0.39	0.32	0.37	
16	200.750			19.119	0.43	0.34	0.38	
17	198.000			18.857	0.45	0.37	0.41	



<b>Test Report</b>	<b>China National Transformer Quality Supervision Testing Center</b>	No: CTQC/B-08.404 Total 47 Page 8
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H.V.		M.V.		Ratio	Measured deviation (%)			Conne- tion symbol
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AB/ AmBm	BC/ BmCm	CA/ CmAm	
1	242.000			2.000	-0.01	-0.07	0.05	YNyn0
2	239.250			1.977	0.01	-0.06	0.07	
3	236.500			1.955	0.01	-0.03	0.07	
4	233.750			1.932	0.04	-0.02	0.10	
5	231.000			1.909	0.04	-0.01	0.10	
6	228.250			1.886	0.06	0.01	0.12	
7	225.500			1.864	0.08	0.01	0.14	
8	222.750			1.841	0.09	0.04	0.15	
9a, 9b, 9c	220.000	/	121	1.818	0.12	0.06	0.17	
10	217.250			1.795	0.14	0.07	0.18	
11	214.500			1.773	0.16	0.10	0.21	
12	211.750			1.750	0.18	0.12	0.23	
13	209.000			1.727	0.20	0.14	0.25	
14	206.250			1.705	0.22	0.16	0.27	
15	203.500			1.682	0.25	0.19	0.29	
16	200.750			1.659	0.27	0.22	0.32	
17	198.000			1.636	0.29	0.23	0.35	
M.V.		L.V.		Ratio	Measured deviation (%)			Conne- tion symbol
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AmBm/ab	BmCm/ bc	CmAm/ca	
/	121	/	10.5	11.524	0.17	0.13	0.19	yn0d11



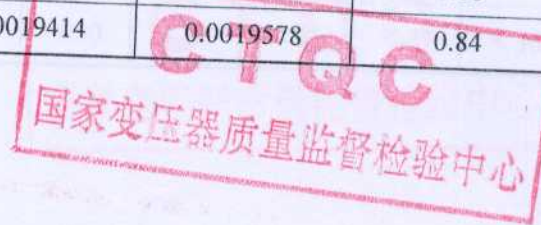


#### 4.3 Measurement of winding resistance (Routine test)

Test date: May 23, 2008

Oil temperature: 37.0°C

Winding	Tap position	Measured values (Ω)			Unbalancedness (%)
		A~O Am~Om a~b	B~O Bm~Om b~c	C~O Cm~Om c~a	
H.V.	1	0.3725	0.3746	0.3738	0.56
	2	0.3669	0.3688	0.3682	0.52
	3	0.3611	0.3631	0.3624	0.55
	4	0.3559	0.3576	0.3569	0.48
	5	0.3498	0.3517	0.3511	0.54
	6	0.3443	0.3461	0.3456	0.52
	7	0.3387	0.3404	0.3398	0.50
	8	0.3331	0.3349	0.3342	0.54
	9a, 9b, 9c	0.3262	0.3274	0.3267	0.37
	10	0.3336	0.3353	0.3349	0.51
	11	0.3394	0.3407	0.3402	0.38
	12	0.3453	0.3462	0.3460	0.26
	13	0.3505	0.3518	0.3516	0.37
	14	0.3561	0.3574	0.3575	0.39
	15	0.3616	0.3632	0.3633	0.47
	16	0.3672	0.3688	0.3689	0.46
	17	0.3728	0.3746	0.3744	0.48
M.V.	/	0.08424	0.08419	0.08434	0.18
L.V.	/	0.0019454	0.0019414	0.0019578	0.84





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4.4 Separate-source AC withstand voltage test (Routine test)      Test date: May 24, 2008

Test circuit is given in Annex2-a

Humidity: 50%; Ambient temperature: 37.0°C; Oil temperature: 37.0°C

Position	Applied voltage (kV)	Duration (s)	Results
H.V.neutral—M.V.、L.V.&E	200	60	Passed
M.V.neutral—H.V.、L.V.&E	95	60	
L.V.—H.V. M.V.&E	35	60	

4.5 Long-duration AC withstand voltage test (ACLD) (Routine test)      Test date: May 25, 2008

Phase to earth test ,Tap position 1, Frequency 100Hz.

Induced voltage			Duration	Partial discharge levels (pC)					
Multiple	H.V.	M.V.		A	B	C	Am	Bm	Cm
$1.1U_m/\sqrt{3}$	160	80	5 min	/	/	/	/	/	/
$U_2=1.5U_m/\sqrt{3}$	218	109	5 min	/	/	/	/	/	/
$U_1=1.7U_m/\sqrt{3}$	247	124	60s	/	/	/	/	/	/
$U_2=1.5U_m/\sqrt{3}$	218	109	5 min	<30	<30	<40	<20	<25	<40
			10 min	<30	<30	<40	<20	<25	<40
			15 min	<30	<30	<40	<20	<25	<40
			20 min	<30	<30	<40	<20	<25	<40
			25 min	<30	<30	<40	<20	<25	<40
30 min	<30	<30	<40	<20	<25	<40			
$1.1U_m/\sqrt{3}$	160	80	5 min	<20	<30	<40	<20	<25	<30

Note: H.V.  $U_m=252kV$ ;      M.V.  $U_m=126kV$ ;  
 Background noise level is 10pC before and after test.

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4.6 Short-duration AC withstand voltage test

4.6.1 Short-duration AC withstand voltage test (Routine test before S.C.T.)

Test date: May 25, 2008      Test circuit is given in Annex2-b

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

Tap position 2. Frequency 100Hz.

Induced voltage			Duration	Partial discharge levels (pC)					
Multiple	Phase-to-earth (kV)			A	B	C	Am	Bm	Cm
	H.V.	M.V.							
$1.1U_m/\sqrt{3}$	160	80.9	5 min	/	/	/	/	/	/
$U_2=1.5U_m/\sqrt{3}$	218	110.3	5 min	/	/	/	/	/	/
$U_1$	395	200	60s	/	/	/	/	/	/
$U_2=1.5U_m/\sqrt{3}$	218	110.3	5 min	<30	<30	<50	<25	<30	<40
$1.1U_m/\sqrt{3}$	160	80.9	5 min	<30	<20	<40	<25	<20	<40

Note: H.V.  $U_m=252kV$ ; M.V.  $U_m=126kV$   
Background noise level is 10pC before and after test.

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

Tap position 1, Frequency 100Hz.

Induced voltage			Duration	Partial discharge levels (pC)					
Multiple	Phase-to- phase (kV)			A	B	C	Am	Bm	Cm
	H.V.	M.V.							
$1.1U_m$	277	138	5 min	/	/	/	/	/	/
$U_2=1.3U_m$	328	164	5 min	/	/	/	/	/	/
$U_1$	395	200	60s	/	/	/	/	/	/
$U_2=1.3U_m$	328	164	5 min	<20	<50	<25	<30	<30	<35
$1.1U_m$	277	138	5 min	<20	<10	<20	<20	<30	<35

Note: H.V.  $U_m=252kV$ ; M.V.  $U_m=126kV$   
Background noise level is 10pC before and after test.



Pz      [Signature]



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4.6.2 Short-duration AC withstand voltage test(Special test after S.C.T.) Test date: June 26,2008

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

Tap position 1. Frequency 150Hz.

Multiple	Induced voltage		Duration	Partial discharge levels (pC)					
	Phase-to-earth (kV)			A	B	C	Am	Bm	Cm
	H.V.	M.V.							
$1.1U_m/\sqrt{3}$	160	80	5 min	/	/	/	/	/	/
$U_2=1.5U_m/\sqrt{3}$	218	109	5 min	/	/	/	/	/	/
$U_1$	395	200	40s	/	/	/	/	/	/
$U_2=1.5U_m/\sqrt{3}$	218	109	5 min	<30	<30	<30	<40	<50	<50
$1.1U_m/\sqrt{3}$	160	80	5 min	<30	<30	<30	<40	<50	<40

Note: H.V.  $U_m=252kV$ ; M.V.  $U_m=126kV$   
 Background noise level is <25pC before and after test.  
 Start voltage:133kV Extinction voltage:133kV.

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

Tap position 1, Frequency 150Hz.

Multiple	Induced voltage		Duration	Partial discharge levels (pC)					
	Phase-to-phase (kV)			A	B	C	Am	Bm	Cm
	H.V.	M.V.							
$1.1U_m$	277.2	138.6	5 min	/	/	/	/	/	/
$U_2=1.3U_m$	327.6	163.8	5 min	/	/	/	/	/	/
$U_1$	395	200	40s	/	/	/	/	/	/
$U_2=1.3U_m$	327.6	163.8	5 min	<50	<50	<50	<60	<60	<60
$1.1U_m$	277.2	138.6	5 min	<40	<40	<40	<50	<50	<50

Note: H.V.  $U_m=252kV$ ; M.V.  $U_m=126kV$   
 Background noise level is <30pC before and after test.  
 Start voltage:160kV Extinction voltage:160kV.





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4.7 Measurement of no-load loss and current (Routine test)      Test date: May 25, 2008  
Test circuit is given in Annex2-c

RMS voltage (kV)		No-load current		No-load loss (kW)	
Reading of mean value voltmeter	Reading of RMS voltmeter	(A)	(%)	Measured value	Corrected value
10.500	10.749	6.71	0.07	104.68	102.20

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

4.8 Measurement of short-circuit impedance and load loss (Routine test)      Test date: May 23, 2008  
Test circuit is given in Annex2-d

Oil temperature: 36.5°C

Winding	Tap Position (H.V.)	Applied current I		Measured voltage (kV)	Short-circuit impedance (Each phase)		Load loss (kW)	Total loss (kW)
		(A)	I/Ir (%)		H.V. (M.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	113.45	52.8	15.984	81.30	25.00	183.50	285.70
	9b	125.19	53.0	14.271	65.80	24.48	184.40	286.60
	17	141.27	53.8	13.062	53.40	24.51	209.30	311.50
H.V.   M.V.	1	222.77	51.9	17.820	46.20	14.20	524.20	626.40
	9b	250.63	53.1	15.868	36.60	13.60	530.00	632.20
	17	272.00	51.8	13.919	29.60	13.57	632.70	734.90
M.V.   L.V.	/	246.0	57.3	3.100	7.3	8.94	150.10	252.30



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## 4.9 Test on transformer oil (Routine test) Test date: May 21,2008

tan $\delta$ (90°C)	Breakdown voltage (kV)	Water dissolved in oil (mg/L)
0.00042	63.8	5.1

Gas chromatography (before all the tests) Test date: May 21,2008  $\mu$  L/L

H <sub>2</sub>	CO	CO <sub>2</sub>	CH <sub>4</sub>	C <sub>2</sub> H <sub>6</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>	Hydro cardons
3	8	97	0.2	0.1	0	0	0.3

## 4.10 Leakage test (Routine test) Test date: June 02, 2008

Test method	Applied pressure (kPa)	Duration (h)	Residual pressure (kPa)	Result
Atmospheric pressure	50	72	50	No leakage and damage

## 4.11 Test on on-load tap-changers (Routine test) Test date: May 23, 2008

## 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  $\pm 2$  steps on either side of the principal tap at rated current.

## Auxiliary circuits dielectric test:

2kV (RMS) 1 min separate-source voltage withstand test, passed.

## 4.12 Switching impulse test (Routine test)

Replace by short-duration AC withstand voltage test.

See 4.6





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4.13 Short-circuit withstand test (Special test)      Test date: June 20, 2008

4.13.1 H.V. — M.V.

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

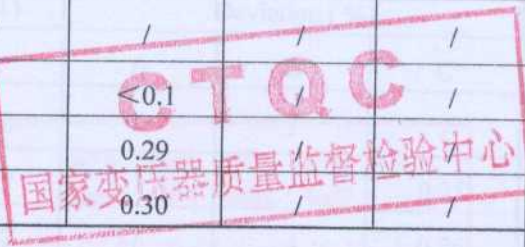
Tap position	Peak value (A)	Symmetrical value (A)	Multiple ( $K\sqrt{2}$ )
1	7688	2858	2.69
9b	8704	3236	2.69
17	9537	3545	2.69

4.13.1.2 Measurement of short-circuit current

Test circuit is given in Annex2-e

Perform single-phase test, Voltage is applied between one line terminal and neutral point, supply power on H.V. winding, M.V. is short-circuit, L.V. is open circuit, test waveshapes have no distortion, Test oscillograms are shown in Page 40-42. The percentage of peak value and symmetrical value is the ratio of applied current to calculated current.

Tap position	Apply current terminal	Degree	Current measured					
			Peak value (A)		Symmetrical value (A)		Duration (s)	Wave serial No
			(A)	(%)	(A)	(%)		
1	AO	No1	7553	98.2	2704	94.6	0.24	B08404-S04-1
		No2	7370	95.9	2704	94.6	0.24	B08404-S04-2
		No3	7349	95.6	2704	94.6	0.24	B08404-S04-3
		Degree	Single-phase reactance value (Ω)			Deviation (%)		
			A	B	C	A	B	C
		before test	45.79	/	/	/	/	/
		No1	45.78	/	/	<0.1	/	/
		No2	45.93	/	/	0.29	/	/
		No3	45.93	/	/	0.30	/	/



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9b	BO	Degree	Current measured					Duration (s)	Wave serial No
			Peak value (A)		Symmetrical value (A)				
			(A)	(%)	(A)	(%)			
			No 1	8431	96.9	3083	95.3	0.24	B08404-S05-1
			No 2	8482	97.4	3083	95.3	0.24	B08404-S05-2
			No 3	8534	98.0	3083	95.3	0.24	B08404-S05-3
			Degree	Reactance measured					
				Single-phase reactance value (Ω)			Deviation (%)		
				A	B	C	A	B	C
				before test	/	36.35	/	/	/
	No 1	/		36.45	/	/	0.28	/	
	No 2	/		36.38	/	/	<0.1	/	
	No 3	/		36.38	/	/	<0.1	/	
17	CO	Degree	Current measured					Duration (s)	Wave serial No
			Peak value (A)		Symmetrical value (A)				
			(A)	(%)	(A)	(%)			
			No 1	9440	99.0	3504	98.8	0.24	B08404-S06-1
			No 2	9440	99.0	3504	98.8	0.24	B08404-S06-2
			No 3	9471	99.3	3504	98.8	0.24	B08404-S06-3
			Degree	Reactance measured					
				Single-phase reactance value (Ω)			Deviation (%)		
				A	B	C	A	B	C
				before test	/	/	29.20	/	/
	No 1	/		/	29.27	/	/	0.25	
	No 2	/		/	29.27	/	/	0.26	
	No 3	/		/	29.23	/	/	0.10	
The maximum deviation of short-circuit reactance is 0.30%.									



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4.13.2 H.V. —L.V.

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

Tap position	Peak value (A)	Symmetrical value (A)	Multiple ( $K\sqrt{2}$ )
1	4240	1663	2.55
9b	4728	1854	2.55
17	5199	2039	2.55

4.13.2.2 Measurement of short-circuit current

Test circuit is given in Annex2-f

Perform single-phase test, Voltage is applied between one line terminal and neutral point, supply power on H.V. winding, L.V. is short-circuit, M.V. is open circuit, test waveshapes have no distortion, Test oscillograms are shown in Page 43-45. The percentage of peak value and symmetrical value is the ratio of applied current to calculated current.

Tap position	Apply current terminal	Degree	Current measured					
			Peak value (A)		Symmetrical value (A)		Duration (s)	Wave serial No
			(A)	(%)	(A)	(%)		
1	AO	No 1	4395	103.7	1600	96.2	0.24	B08404-S01-1
		No 2	4439	104.7	1600	96.2	0.24	B08404-S01-2
		No 3	4125	97.3	1600	96.2	0.24	B08404-S01-3
		Degree	Reactance measured					
		Single-phase reactance value ( $\Omega$ )			Deviation (%)			
		A	B	C	A	B	C	
		before test	80.20	/	/	/	/	/
		No 1	80.29	/	/	0.12	/	/
		No 2	80.27	/	/	0.10	/	/
		No 3	80.43	/	/	0.29	/	/



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Tap position	Apply current terminal	Degree	Current measured						
			Peak value (A)		Symmetrical value (A)		Duration (s)	Wave serial No	
			(A)	(%)	(A)	(%)			
9b	BO	No1	4725	99.9	1764	95.1	0.24	B08404-S02-1	
		No2	4735	100.1	1764	95.1	0.24	B08404-S02-2	
		No3	4745	100.4	1764	95.1	0.24	B08404-S02-3	
		Degree	Reactance measured						
			Single-phase reactance value (Ω)			Deviation (%)			
		before test	A	B	C	A	B	C	
			/	64.88	/	/	/	/	/
		No1	/	65.09	/	/	0.32	/	/
		No2	/	65.02	/	/	0.21	/	/
		No3	/	65.10	/	/	0.35	/	/

Tap position	Apply current terminal	Degree	Current measured						
			Peak value (A)		Symmetrical value (A)		Duration (s)	Wave serial No	
			(A)	(%)	(A)	(%)			
17	CO	No1	5165	99.3	1927	94.5	0.24	B08404-S03-1	
		No2	5095	98.0	1927	94.5	0.24	B08404-S03-2	
		No3	5155	99.2	1927	94.5	0.24	B08404-S03-3	
		Degree	Reactance measured						
			Single-phase reactance value (Ω)			Deviation (%)			
		before test	A	B	C	A	B	C	
			/	/	52.68	/	/	/	/
		No1	/	/	52.75	/	0.13	/	/
		No2	/	/	52.81	/	0.25	/	/
		No3	/	/	52.87	/	0.35	/	/

The maximum deviation of short-circuit reactance is 0.35%.

**4.13.2.3 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 46~47.



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4.13.3 Repeated routine tests after short-circuit withstand test

4.13.3.1 Measurement of insulation resistance and  $\tan\delta$  Test date: June 21,2008

Humidity: 52%; Oil temperature: 29.0°C

Measurement position	Insulation resistance (GΩ)			R <sub>60</sub> /R <sub>15</sub>	R <sub>600</sub> /R <sub>60</sub>	tan δ
	R <sub>600</sub>	R <sub>60</sub>	R <sub>15</sub>			
H.V.—M.V.、L.V.&E	18.20	9.10	6.63	1.37	2.0	0.0018
M.V.—H.V.、L.V.&E	6.61	4.62	4.14	1.12	1.43	0.0021
L.V.—H.V.、M.V.&E	9.82	5.60	4.23	1.32	1.75	0.0024
H.V.、M.V.—L.V.、E	/	3.93	3.30	1.19	/	0.0021
H.V.、M.V.、L.V.—E	/	2.68	2.21	1.21	/	0.0024
Core—E	41.5			/	/	/
Clamp—E	3.28			/	/	/



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4.13.3.2 Measurement of voltage ratio and check of phase displacement Test date: June 21, 2008

H.V.		M.V.		Ratio	Measured deviation (%)			Connec- tion symbol
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AB/ AmBm	BC/ BmCm	CA/ CmAm	
1	242.000	/	121	2.000	-0.09	-0.10	-0.09	YNyn0
2	239.250			1.977	-0.08	-0.08	-0.07	
3	236.500			1.955	-0.06	-0.06	-0.07	
4	233.750			1.932	-0.03	-0.04	-0.05	
5	231.000			1.909	-0.02	-0.03	-0.02	
6	228.250			1.886	-0.01	-0.01	0.00	
7	225.500			1.864	0.00	0.00	0.01	
8	222.750			1.841	0.02	0.01	0.02	
9a, 9b, 9c	220.000			1.818	0.04	0.04	0.05	
10	217.250			1.795	0.06	0.05	0.06	
11	214.500			1.773	0.09	0.07	0.07	
12	211.750			1.750	0.12	0.11	0.10	
13	209.000			1.727	0.13	0.12	0.12	
14	206.250			1.705	0.15	0.15	0.14	
15	203.500			1.682	0.18	0.18	0.18	
16	200.750			1.659	0.20	0.20	0.20	
17	198.000			1.636	0.22	0.22	0.22	
H.V.		L.V.		Ratio	Measured deviation (%)			Connec- tion symbol
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AB/ab	BC/ bc	CA/ca	
9b	220.000	/	10.5	20.95	0.20	0.19	0.19	YNd11
M.V.		L.V.		Ratio	Measured deviation (%)			Connec- tion symbol
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AmBm/ab	BmCm/ bc	CmAm/ca	
/	121	/	10.5	11.52	0.13	0.13	0.13	yn0d11

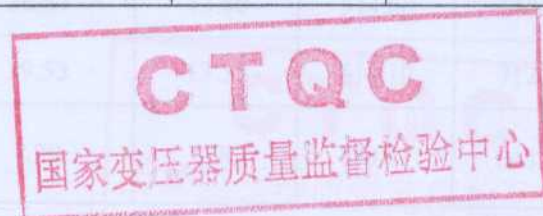
国家变压器质量监督检验中心

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4.13.3.3 Measurement of winding resistance				Test date: June 21, 2008		Oil temperature: 29.0°C
Winding	Tap position	Measured values (Ω)			Unbalancedness (%)	
		A~O Am~Om a~b	B~O Bm~Om b~c	C~O Cm~Om c~a		
H.V.	1	0.3559	0.3575	0.3570	0.45	
	2	0.3503	0.3520	0.3517	0.48	
	3	0.3448	0.3464	0.3461	0.46	
	4	0.3394	0.3412	0.3409	0.53	
	5	0.3339	0.3356	0.3352	0.51	
	6	0.3287	0.3303	0.3301	0.49	
	7	0.3232	0.3249	0.3244	0.52	
	8	0.3180	0.3196	0.3193	0.50	
	9a, 9b, 9c	0.3116	0.3128	0.3124	0.38	
	10	0.3185	0.3197	0.3191	0.38	
	11	0.3241	0.3250	0.3246	0.28	
	12	0.3294	0.3304	0.3301	0.30	
	13	0.3348	0.3358	0.3353	0.30	
	14	0.3401	0.3413	0.3409	0.35	
	15	0.3455	0.3467	0.3463	0.35	
	16	0.3510	0.3521	0.3518	0.31	
	17	0.3565	0.3576	0.3572	0.31	
M.V.	/	0.08058	0.08055	0.08067	0.15	
L.V.	/	0.001860	0.001862	0.001872	0.64	



*[Handwritten signatures]*

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4.13.3.4 Separate-source AC withstand voltage test      Test date: June 25, 2008  
 Humidity: 51%; Ambient temperature: 23.0°C; Oil temperature: 23.0°C; Atmospheric pressure: 102.0kPa

Position	Applied voltage (kV)	Duration (s)	Results
H.V.neutral—M.V.、L.V.&E	200	60	Passed
M.V.neutral—H.V.、L.V.&E	95	60	
L.V.—H.V. M.V &E	35	60	

4.13.3.5 Measurement of no-load loss and current      Test date: June 25,2008

RMS voltage (kV)		No-load current		No-load loss (kW)	
Reading of mean value voltmeter	Reading of RMS voltmeter	(A)	(%)	Measured value	Corrected value
10.50	10.63	6.61	0.07	99.91	98.67

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

4.13.3.6 Measurement of short-circuit impedance and load loss      Test date: June 25,2008

Winding	Tap Position (H.V.)	Applied current I		Measured voltage (kV)	Short-circuit impedance (Each phase)		Load loss (kW)	Total loss (kW)
		(A)	I/Ir (%)		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	113.2	52.7	15.98	81.47	25.04	180.57	279.24
	9b	125.2	53.0	14.27	65.80	24.47	181.03	279.70
	17	142.0	54.1	13.10	53.25	24.45	205.05	303.72
H.V.   M.V.	1	222.7	51.8	17.80	46.14	14.18	511.32	609.99
	9b	253.0	53.6	16.03	36.57	13.60	514.80	613.47
	17	270.9	51.6	13.85	29.53	13.56	614.10	712.77
M.V.   L.V.	/	225.0	52.4	2.84	7.29	8.96	150.01	248.68



R      JG



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4.13.3.7 Long-duration AC withstand voltage test (ACLD)      Test date: June 26,2008  
Phase to earth test ,Tap position 1, Frequency 100Hz.

Induced voltage			Duration	Partial discharge levels (pC)					
Multiple	H.V.	M.V.		A	B	C	Am	Bm	Cm
$1.1U_m/\sqrt{3}$	160	80	5 min	/	/	/	/	/	/
$U_2=1.5U_m/\sqrt{3}$	218	109	5 min	/	/	/	/	/	/
$U_1=1.7U_m/\sqrt{3}$	247	124	60s	/	/	/	/	/	/
$U_2=1.5U_m/\sqrt{3}$	218	109	5 min	<20	<30	<40	<60	<50	<50
			10 min	<20	<30	<40	<60	<50	<50
			15 min	<20	<30	<40	<60	<50	<50
			20 min	<20	<30	<40	<60	<40	<50
			25 min	<20	<30	<40	<60	<40	<50
			30 min	<20	<30	<40	<60	<40	<50
$1.1U_m/\sqrt{3}$	160	80	5 min	<20	<30	<30	<50	<40	<50

Note: H.V.  $U_m=252kV$ ; M.V.  $U_m=126kV$ ;  
Background noise level is 10pC before and after test.  
Start voltage:160kV      Extinction voltage:83kV.

4.13.3.8 Test on transformer oil      Test date: June 24,2008

tan $\delta$ (90°C)	Breakdown voltage (kV)	Water dissolved in oil (mg/L)
0.0009	66.20	11.70

Gas chromatography (After all the tests)

							$\mu$ L/L
H <sub>2</sub>	CO	CO <sub>2</sub>	CH <sub>4</sub>	C <sub>2</sub> H <sub>6</sub>	C <sub>2</sub> H <sub>4</sub>	C <sub>2</sub> H <sub>2</sub>	Hydro cardons
0	14.03	93.60	0.68	0	0	0	0.68

4.13.3.9 Test on on-load tap-changers      Test date: June 23, 2008

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  $\pm 2$  steps on either side of the principal tap at rated current.

Auxiliary circuits dielectric test:

2kV (RMS) 1 min separate-source voltage withstand test, passed.



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4.13.3.10 Switching impulse test Test date: June 23, 2008

Humidity: 61%; Ambient temperature: 14.5°C; Atmospheric pressure: 99.6kPa

Test items and voltage:

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

Test sequence:

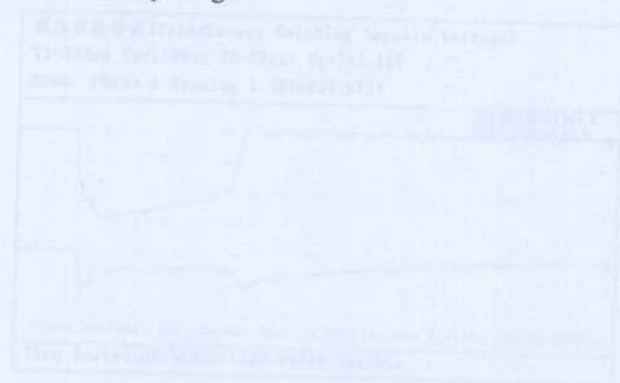
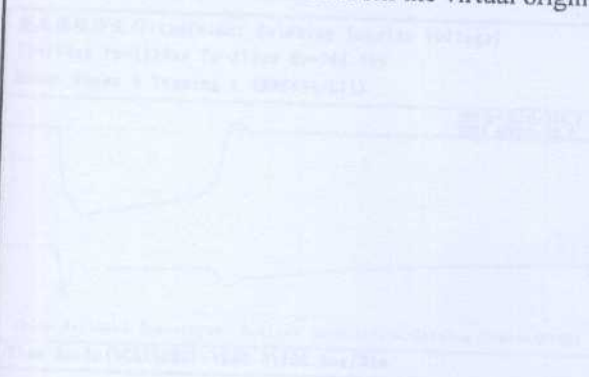
One reduced negative polarity switching impulse;

Three rated negative polarity switching impulse.

Test records:

T1:Front time; Td:Time above 90% Upk;

Tz:A total duration from the virtual origin to the first zero passage.





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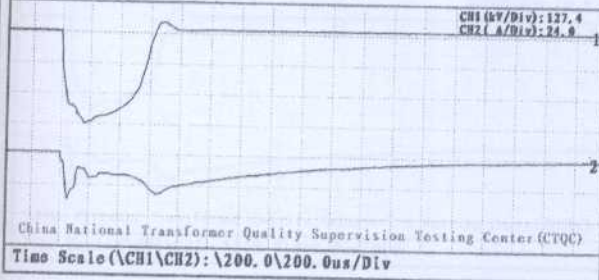
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Tested terminal: A Test polarity: Negative CH1.Voltage records CH2. Neutral current records

变压器操作波 (Transformer Switching Impulse Voltage)

T1=188us Tz=623us Td=202us Up=386.5kV

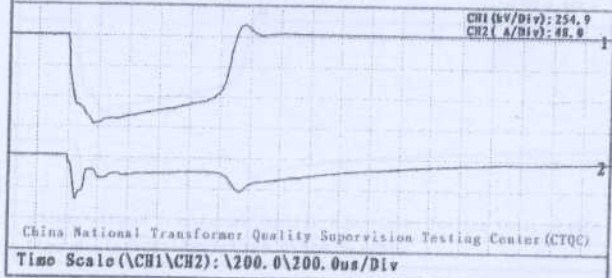
Memo: Phase A Tapping 1 (B08404-L09)



变压器操作波 (Transformer Switching Impulse Voltage)

T1=191us Tz=1101us Td=287us Up=743.0kV

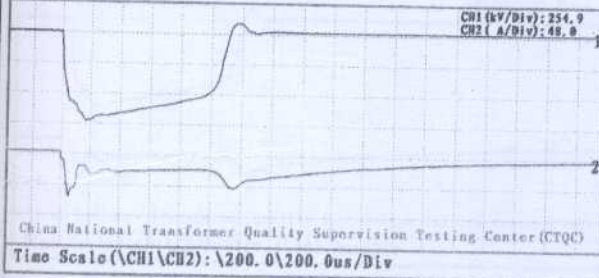
Memo: Phase A Tapping 1 (B08404-L10)



变压器操作波 (Transformer Switching Impulse Voltage)

T1=194us Tz=1118us Td=273us Up=748.5kV

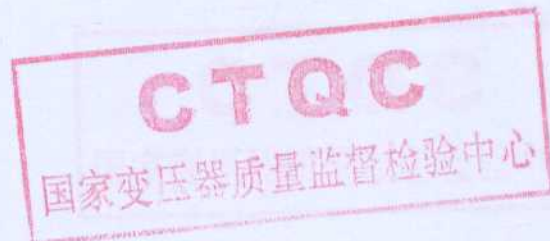
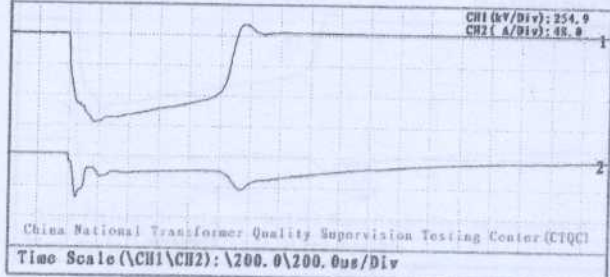
Memo: Phase A Tapping 1 (B08404-L11)



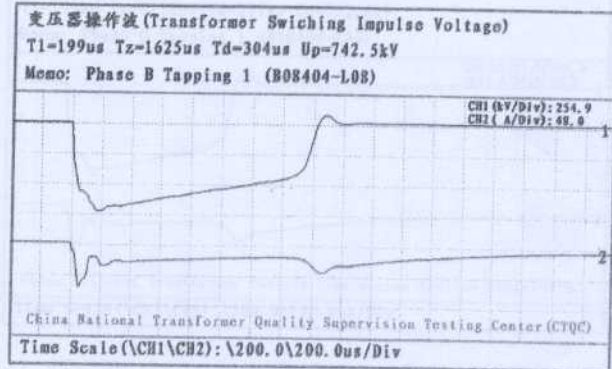
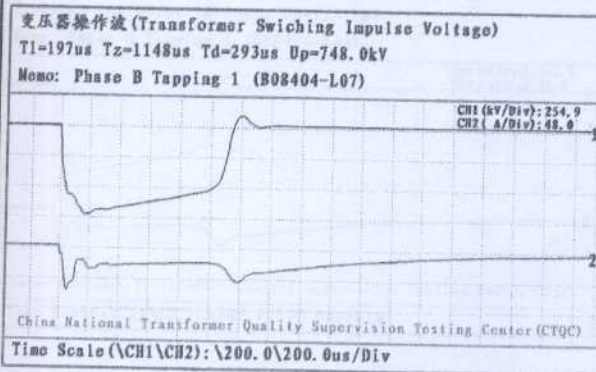
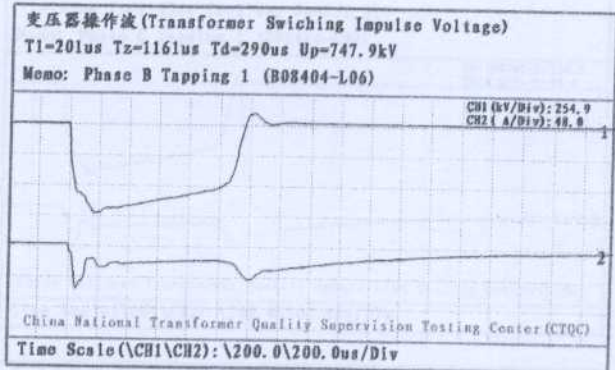
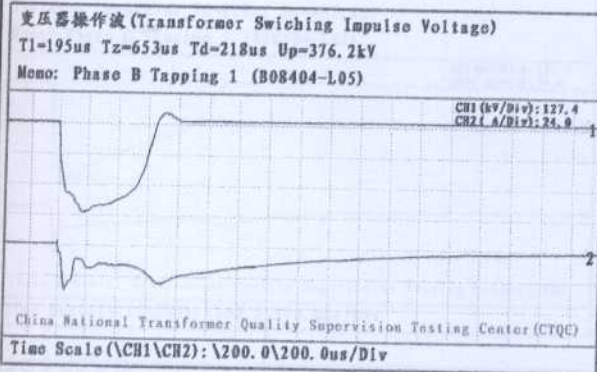
变压器操作波 (Transformer Switching Impulse Voltage)

T1=193us Tz=1109us Td=296us Up=745.1kV

Memo: Phase A Tapping 1 (B08404-L12)

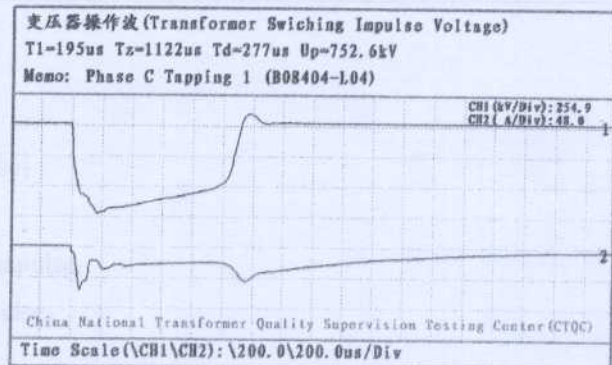
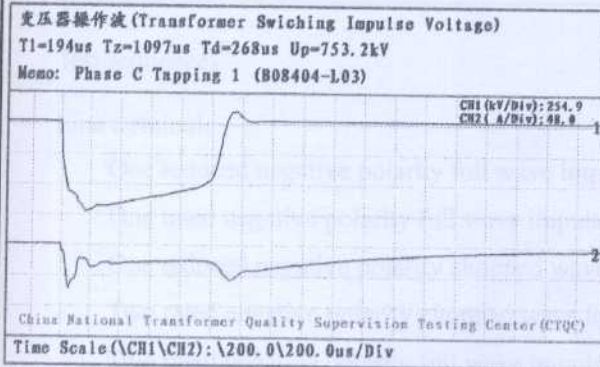
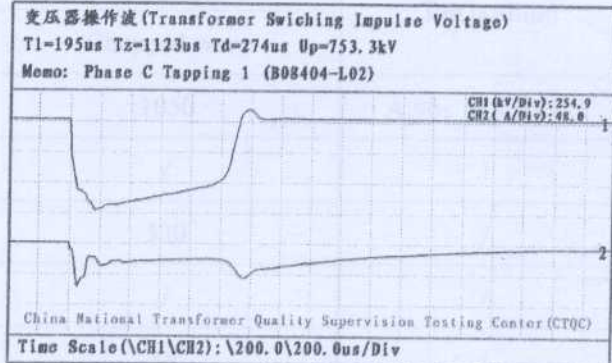
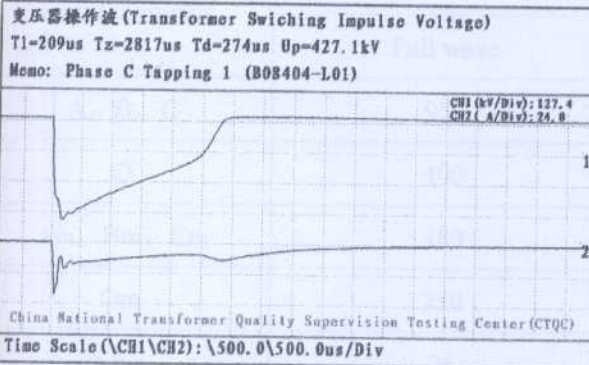


Tested terminal: B Test polarity: Negative CH1.Voltage records CH2. Neutral current records





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



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4.14 Lightning impulse test (Routine test, type test) Test date: June 23,2008

Test circuit is given in Annex2-g

Humidity: 53.7%; Ambient temperature: 25.0°C; Atmospheric press: 99.5kPa

Test items and voltage:

Tested terminals	Rated withstand voltage (kV)		Tap position
	Full wave	Chopped wave	
A, B, C	950	1050	A:9b; B:17; C:1
O	400	/	1
Am, Bm, Cm	480	530	/
Om	250	/	/
a,b,c	75	85	/

Test sequence:

Line terminal:

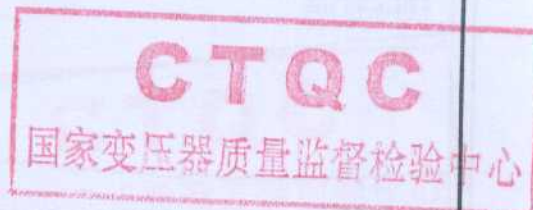
- One reduced negative polarity full wave impulse;
- One rated negative polarity full wave impulse;
- One reduced negative polarity chopped wave impulse;
- Two rated negative polarity chopped wave impulse;
- Two rated negative polarity full wave impulse.

Neutral:

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

T1:Front time; T2:Time to half value; Tc:Time to chopping;

k:Factor of over crossing; Up:Peak voltage.





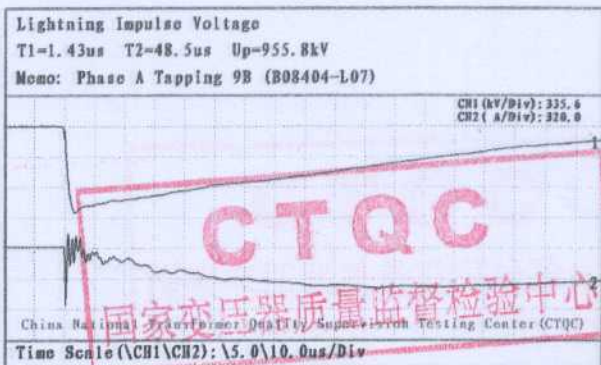
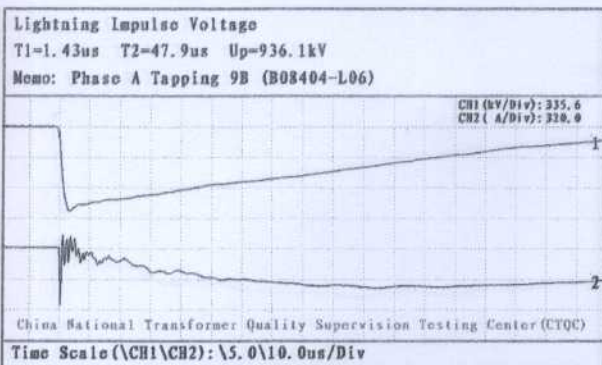
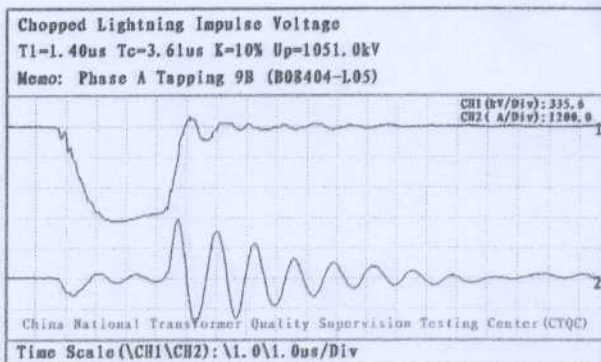
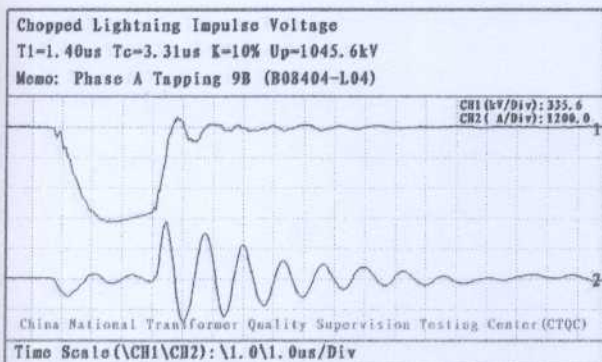
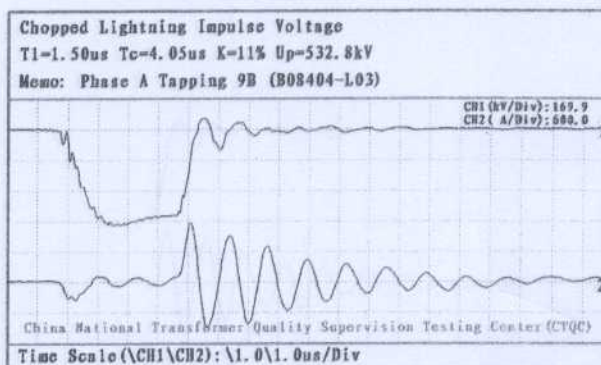
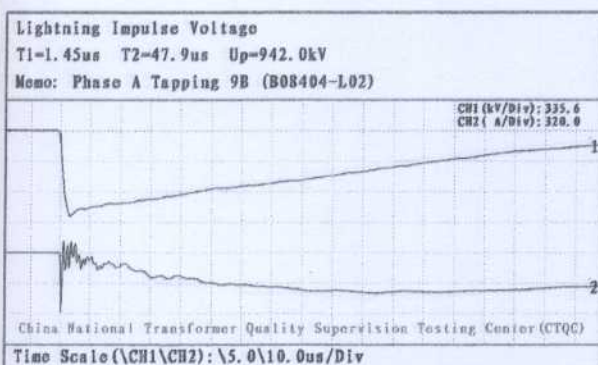
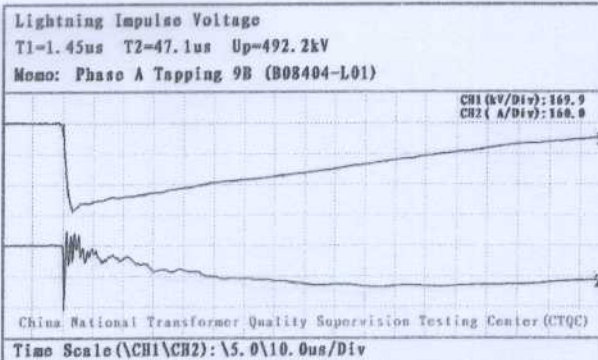
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Tested terminal: A  
Test polarity: Negative  
CH1. Voltage records  
CH2. Neutral current records





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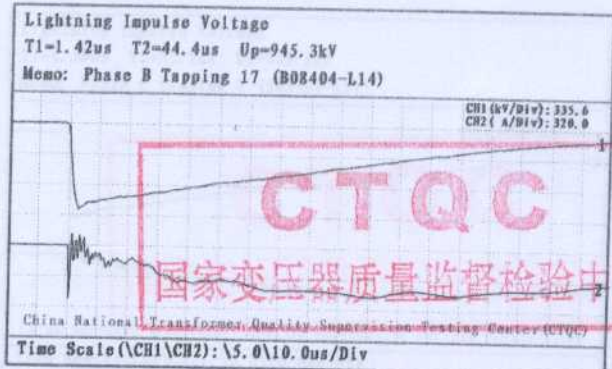
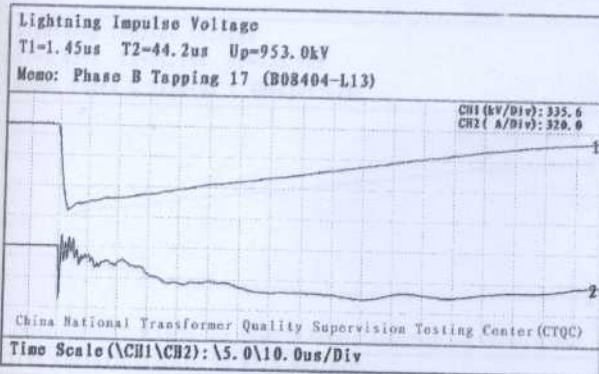
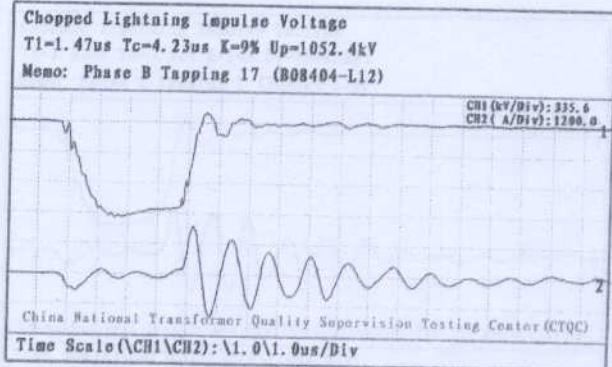
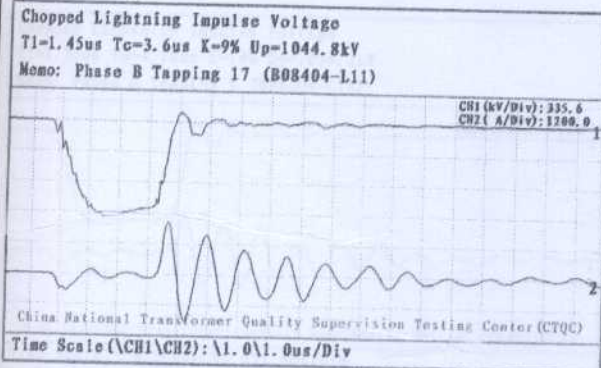
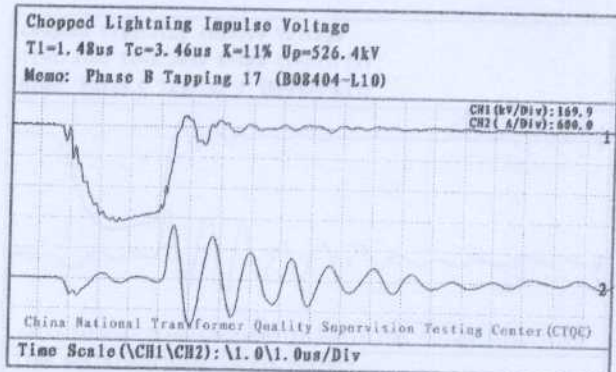
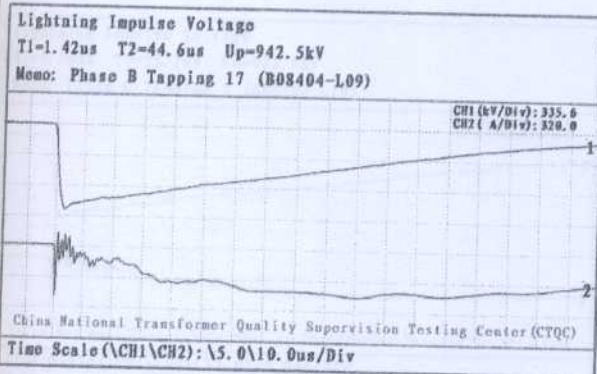
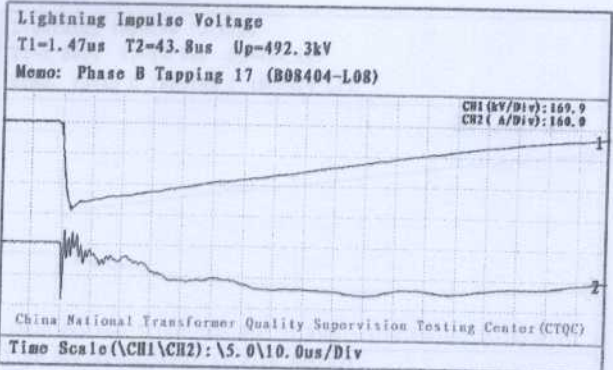
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Tested terminal: B

Test polarity: Negative

CH1. Voltage records

CH2. Neutral current records



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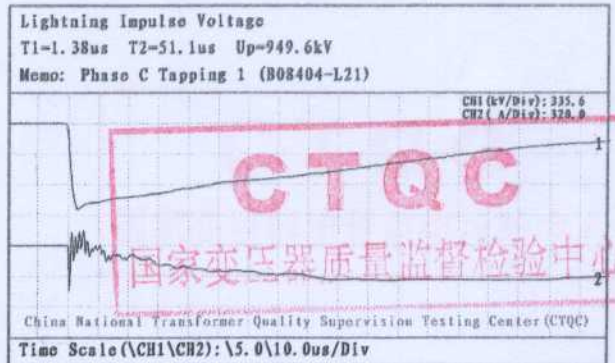
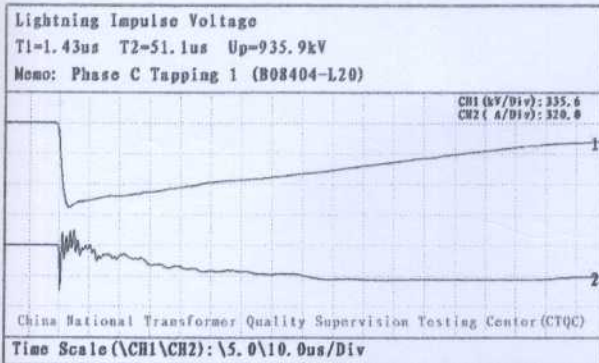
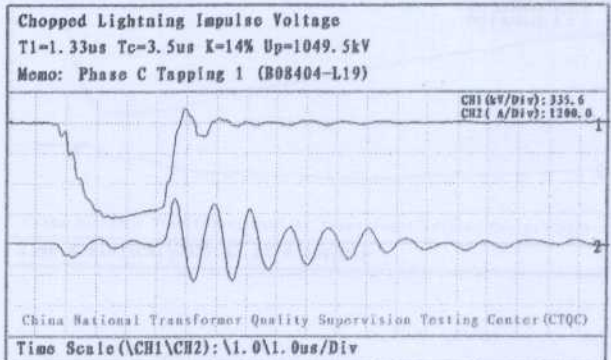
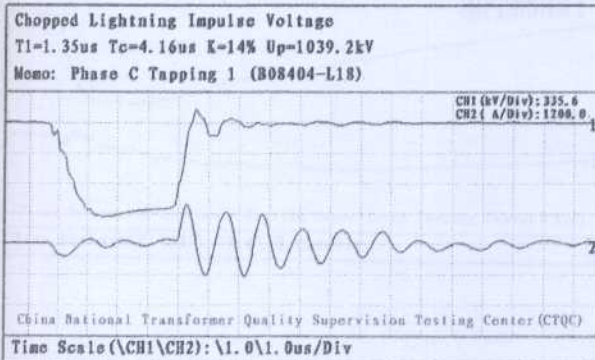
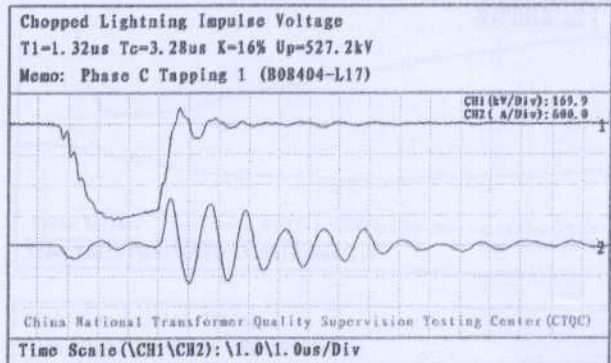
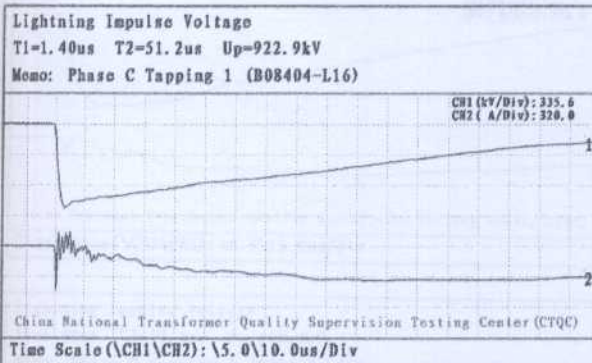
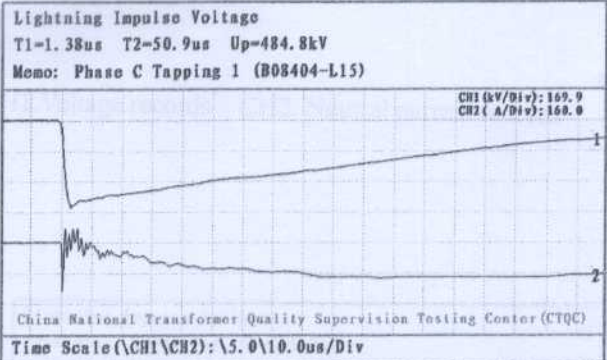
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Tested terminal: C  
Test polarity: Negative  
CH1. Voltage records  
CH2. Neutral current records



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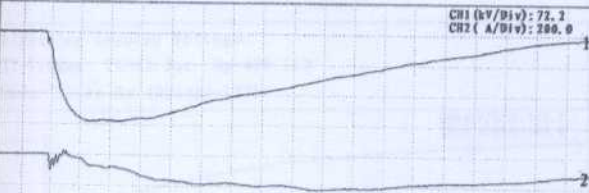
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Tested terminal: O Test polarity: Negative CH1.Voltage records CH2. Neutral current records

### Lightning Impulse Voltage

T1=6.00us T2=47.1us Up=212.3kV

Memo: Phase 0 Tapping 1 (B08404-L22)



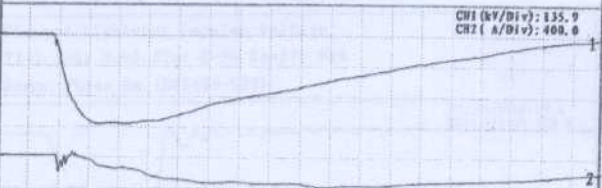
China National Transformer Quality Supervision Testing Center (CTQC)

Time Scale (\CH1\CH2): \5.0\10.0us/Div

### Lightning Impulse Voltage

T1=6.05us T2=47.4us Up=400.9kV

Memo: Phase 0 Tapping 1 (B08404-L23)



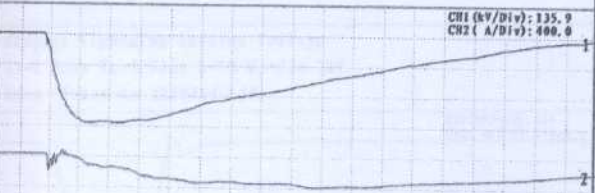
China National Transformer Quality Supervision Testing Center (CTQC)

Time Scale (\CH1\CH2): \5.0\10.0us/Div

### Lightning Impulse Voltage

T1=6.05us T2=47.6us Up=400.4kV

Memo: Phase 0 Tapping 1 (B08404-L24)



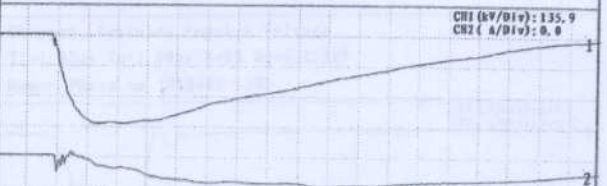
China National Transformer Quality Supervision Testing Center (CTQC)

Time Scale (\CH1\CH2): \5.0\10.0us/Div

### Lightning Impulse Voltage

T1=6.02us T2=47.5us Up=400.2kV

Memo: Phase 0 Tapping 1 (B08404-L25)



China National Transformer Quality Supervision Testing Center (CTQC)

Time Scale (\CH1\CH2): \5.0\10.0us/Div

# CTQC

国家变压器质量监督检验中心

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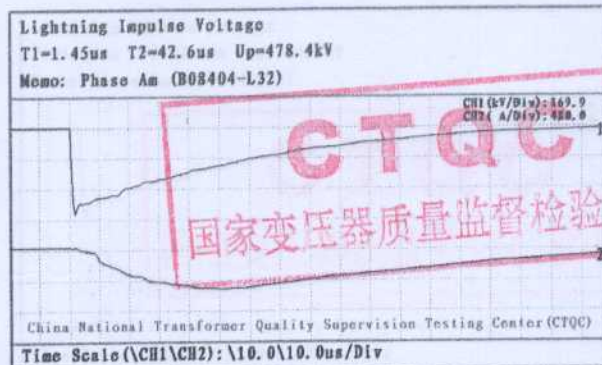
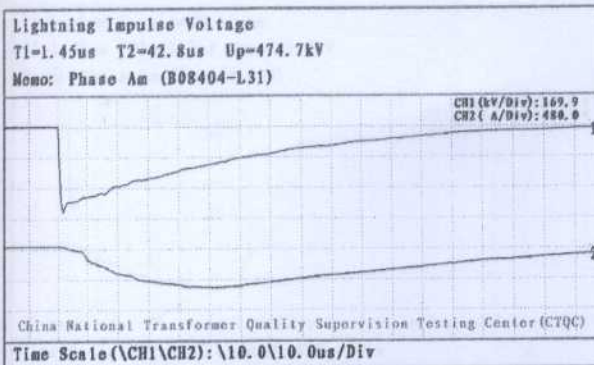
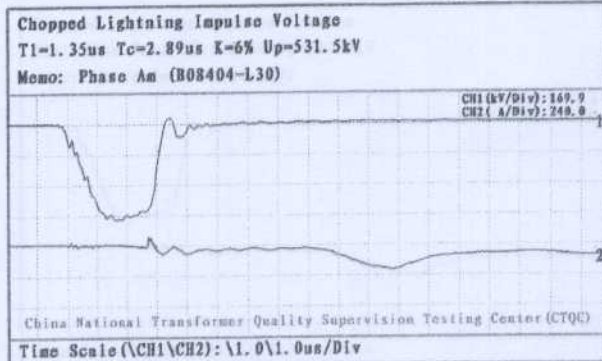
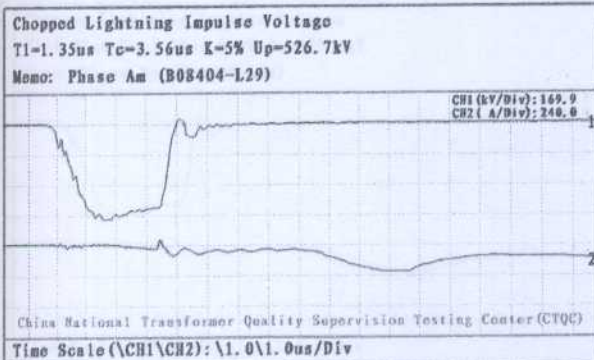
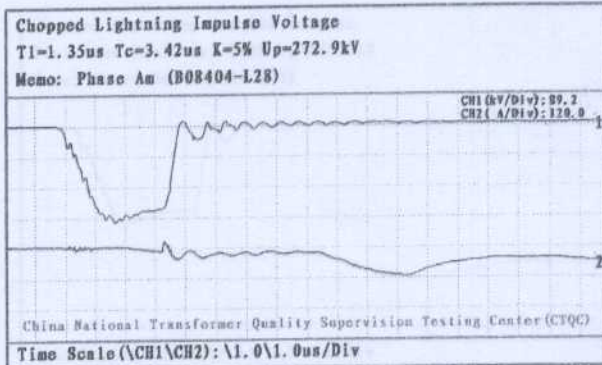
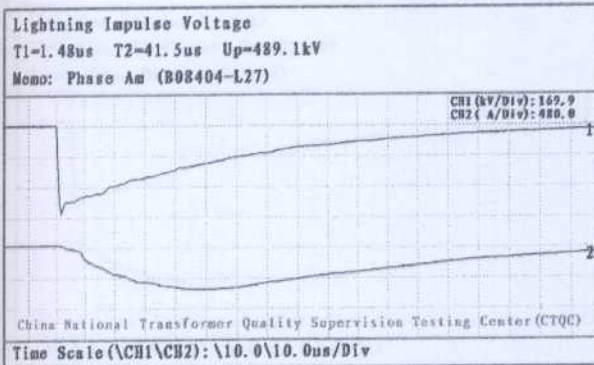
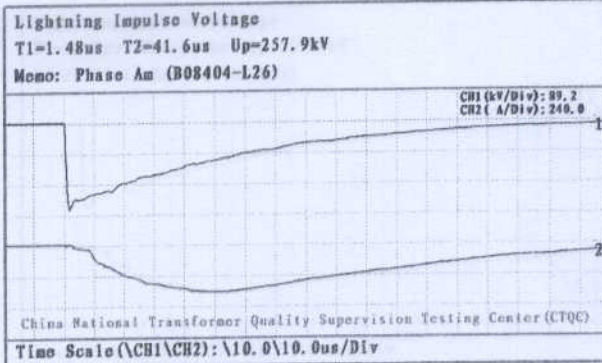
## Test Report

China National Transformer Quality  
Supervision Testing Center

No: CTQC/B-08.404

Total 47 Page 33

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



**CTQC**  
国家变压器质量监督检验中心

Address: Hushitai Country Xinchengzi District Shenyang  
E-mail: ctqc@vip.sina.com http://www.ctn.cn

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Postal code: 110122

(024)89702527  
Fax: (024)89707949



## Test Report

China National Transformer Quality  
Supervision Testing Center

No: CTQC/B-08.404

Total 47 Page 34

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

Lightning Impulse Voltage  
T1=1.52us T2=41.7us Up=255.0kV  
Memo: Phase Bm (B08404-L33)

CH1 (kV/Div): 89.2  
CH2 (A/Div): 248.0

China National Transformer Quality Supervision Testing Center (CTQC)

Time Scale (\CH1\CH2): \10.0\10.0us/Div

Lightning Impulse Voltage  
T1=1.48us T2=42.5us Up=482.4kV  
Memo: Phase Bm (B08404-L34)

CH1 (kV/Div): 169.9  
CH2 (A/Div): 488.0

China National Transformer Quality Supervision Testing Center (CTQC)

Time Scale (\CH1\CH2): \10.0\10.0us/Div

Chopped Lightning Impulse Voltage  
T1=1.42us Tc=3.93us K=4% Up=276.7kV  
Memo: Phase Bm (B08404-L35)

CH1 (kV/Div): 89.2  
CH2 (A/Div): 128.0

China National Transformer Quality Supervision Testing Center (CTQC)

Time Scale (\CH1\CH2): \1.0\1.0us/Div

Chopped Lightning Impulse Voltage  
T1=1.42us Tc=3.89us K=4% Up=529.6kV  
Memo: Phase Bm (B08404-L36)

CH1 (kV/Div): 169.9  
CH2 (A/Div): 248.0

China National Transformer Quality Supervision Testing Center (CTQC)

Time Scale (\CH1\CH2): \1.0\1.0us/Div

Chopped Lightning Impulse Voltage  
T1=1.38us Tc=3.22us K=5% Up=527.8kV  
Memo: Phase Bm (B08404-L37)

CH1 (kV/Div): 169.9  
CH2 (A/Div): 248.0

China National Transformer Quality Supervision Testing Center (CTQC)

Time Scale (\CH1\CH2): \1.0\1.0us/Div

Lightning Impulse Voltage  
T1=1.50us T2=42.2us Up=481.6kV  
Memo: Phase Bm (B08404-L38)

CH1 (kV/Div): 169.9  
CH2 (A/Div): 488.0

China National Transformer Quality Supervision Testing Center (CTQC)

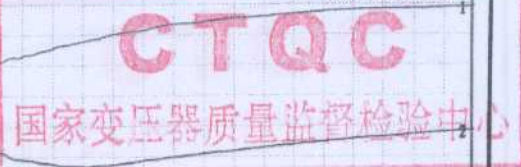
Time Scale (\CH1\CH2): \10.0\10.0us/Div

Lightning Impulse Voltage  
T1=1.50us T2=42.2us Up=484.5kV  
Memo: Phase Bm (B08404-L39)

CH1 (kV/Div): 169.9  
CH2 (A/Div): 488.0

China National Transformer Quality Supervision Testing Center (CTQC)

Time Scale (\CH1\CH2): \10.0\10.0us/Div





## Test Report

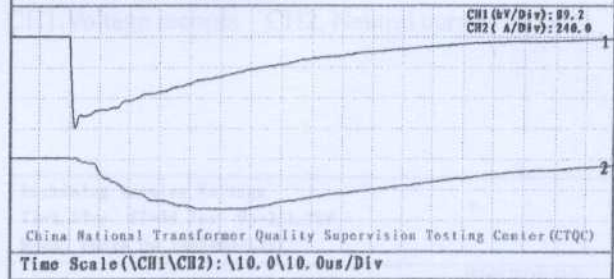
China National Transformer Quality  
Supervision Testing Center

No: CTQC/B-08.404

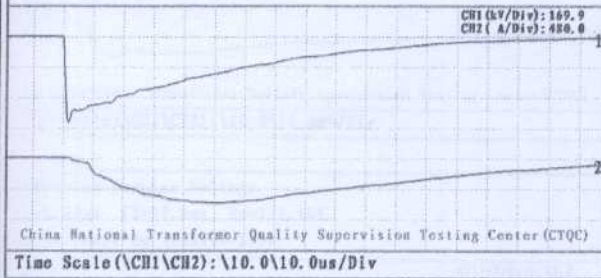
Total 47 Page 35

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

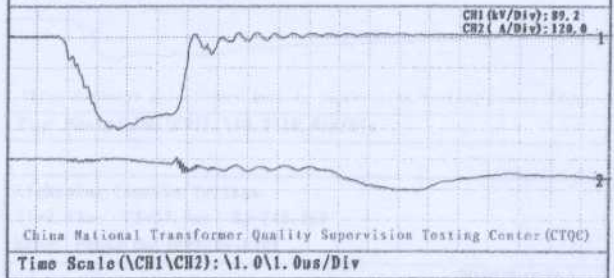
Lightning Impulse Voltage  
T1=1.50us T2=41.5us Up=271.9kV  
Memo: Phase Cm (B08404-L40)



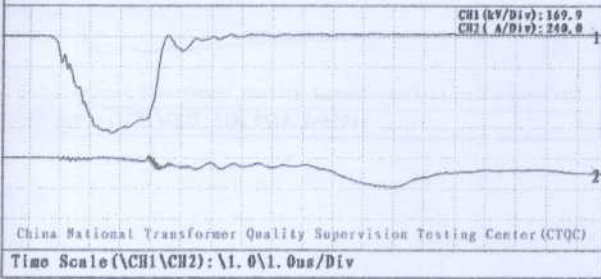
Lightning Impulse Voltage  
T1=1.50us T2=41.4us Up=485.0kV  
Memo: Phase Cm (B08404-L41)



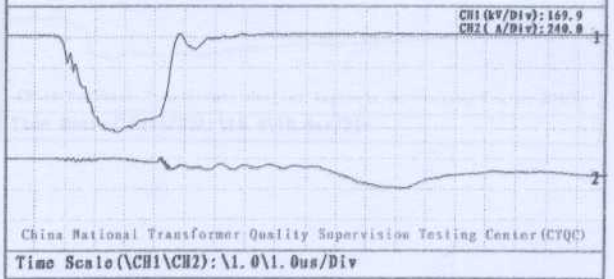
Chopped Lightning Impulse Voltage  
T1=1.43us Tc=3.91us K=4% Up=268.0kV  
Memo: Phase Cm (B08404-L42)



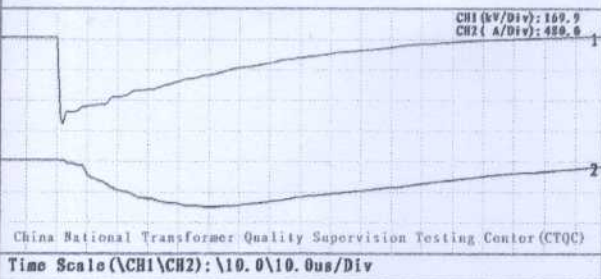
Chopped Lightning Impulse Voltage  
T1=1.42us Tc=3.11us K=3% Up=535.5kV  
Memo: Phase Cm (B08404-L43)



Chopped Lightning Impulse Voltage  
T1=1.42us Tc=3.36us K=2% Up=533.8kV  
Memo: Phase Cm (B08404-L44)



Lightning Impulse Voltage  
T1=1.50us T2=41.7us Up=483.4kV  
Memo: Phase Cm (B08404-L45)



Lightning Impulse Voltage  
T1=1.50us T2=41.3us Up=481.7kV  
Memo: Phase Cm (B08404-L46)



*[Handwritten signatures]*

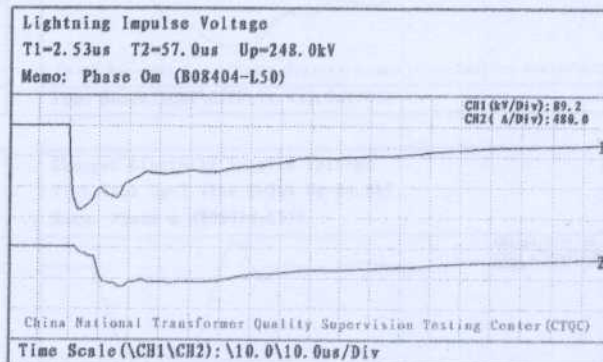
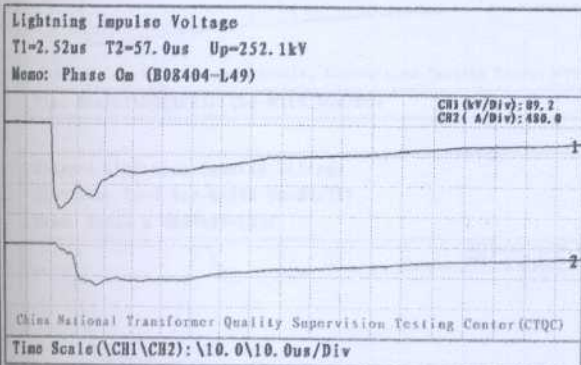
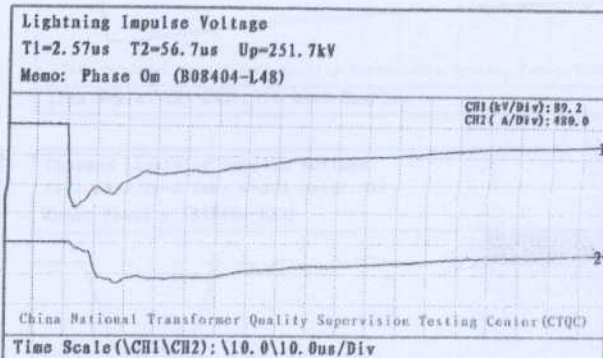
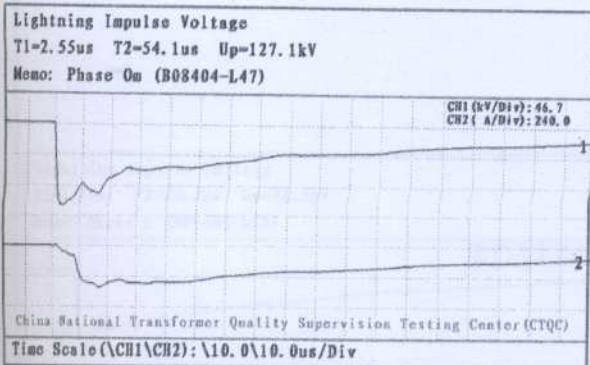
## Test Report

China National Transformer Quality  
Supervision Testing Center

No: CTQC/B-08.404

Total 47 Page 36

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





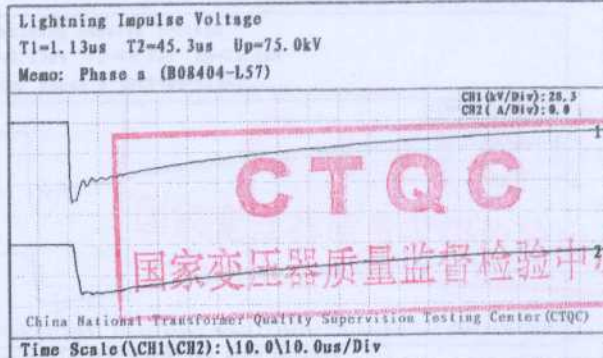
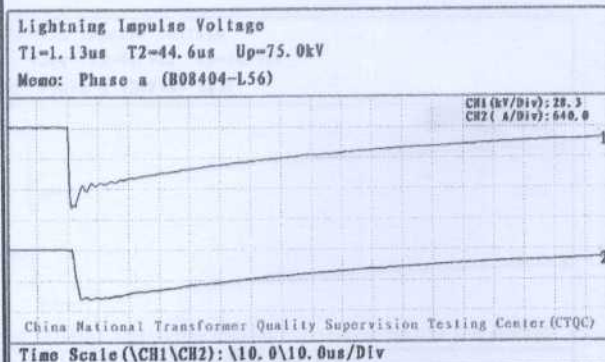
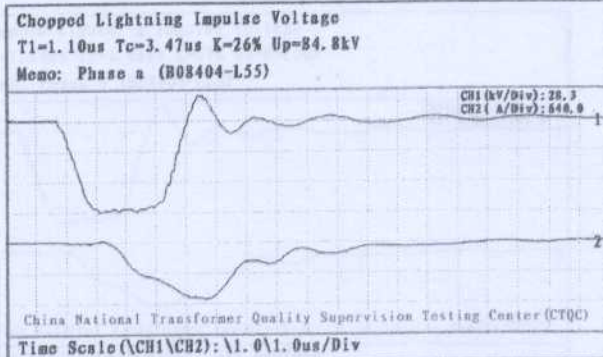
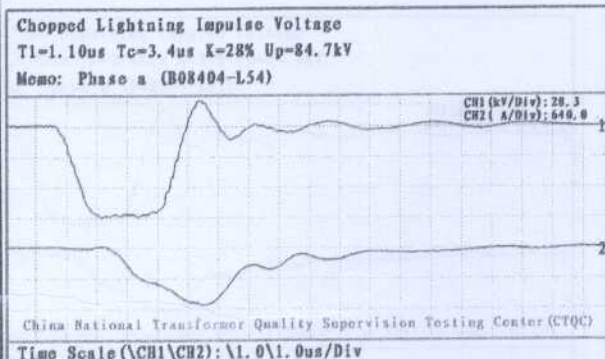
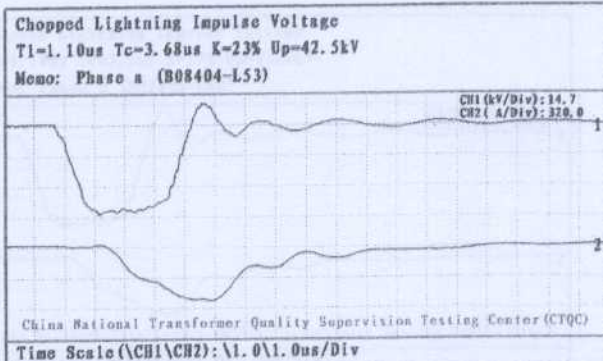
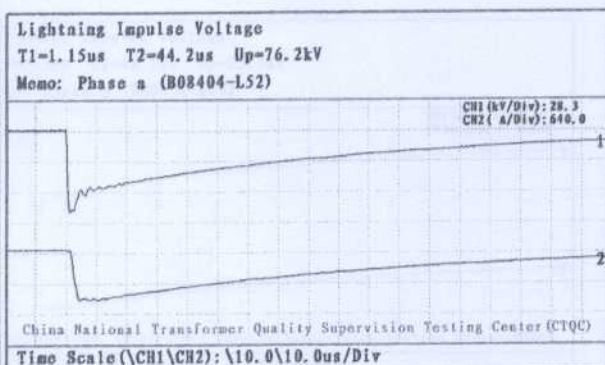
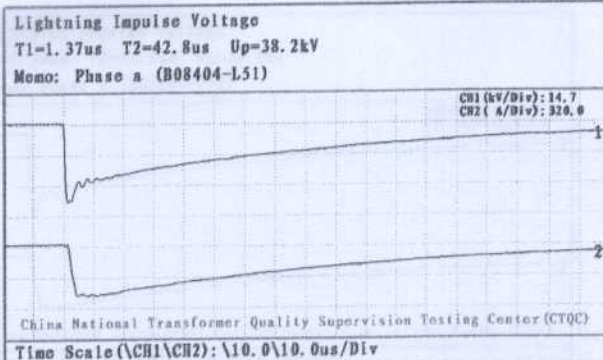
## Test Report

China National Transformer Quality  
Supervision Testing Center

No: CTQC/B-08.404

Total 47 Page 37

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



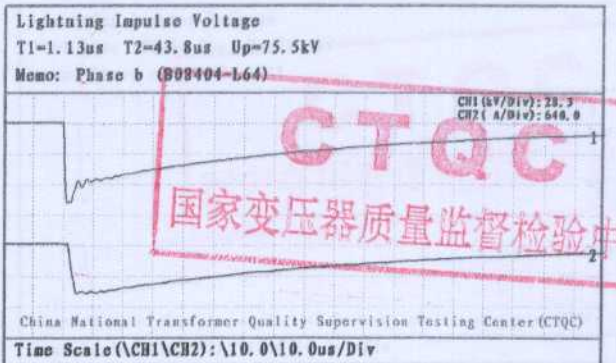
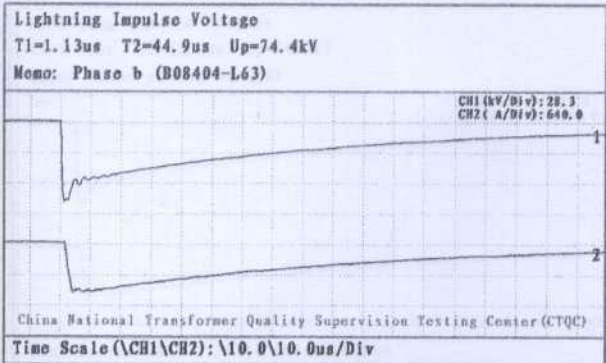
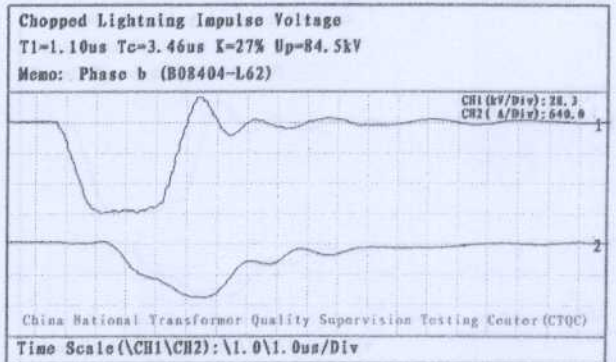
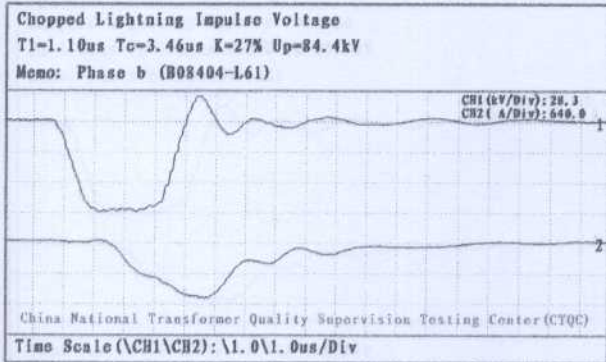
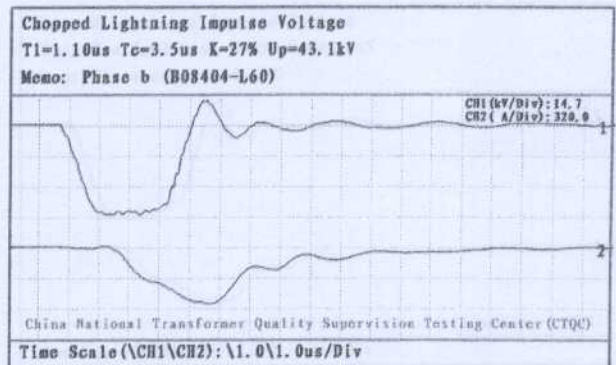
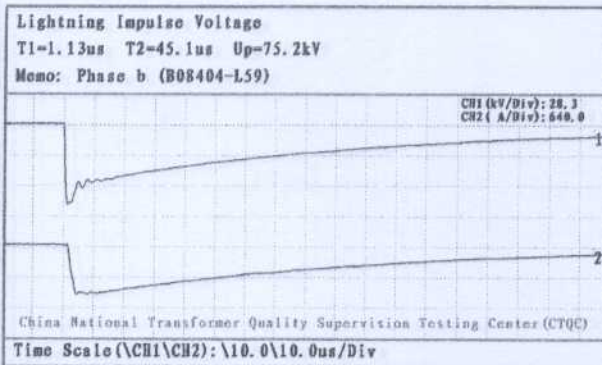
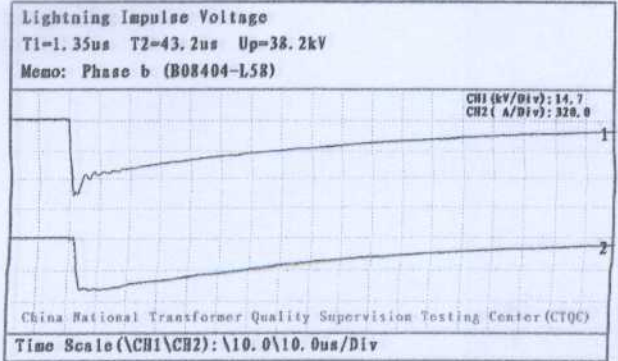
Address: Hushitai Country Xinchengzi District Shenyang  
E-mail: [ctqc@vip.sina.com](mailto:ctqc@vip.sina.com) <http://www.ctn.cn>

Phone: (024) 89874449  
Postal code: 110122

(024) 89702527  
Fax: (024) 89707949



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





## Test Report

China National Transformer Quality  
Supervision Testing Center

No: GTQC/B-08.404

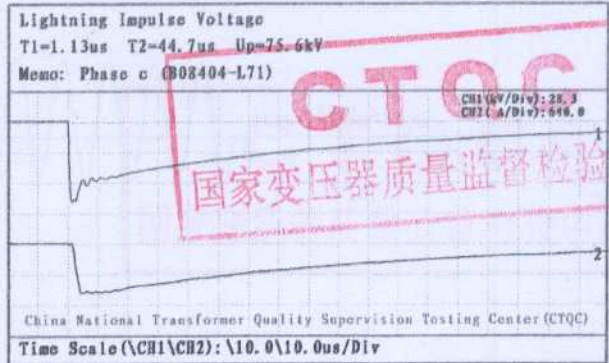
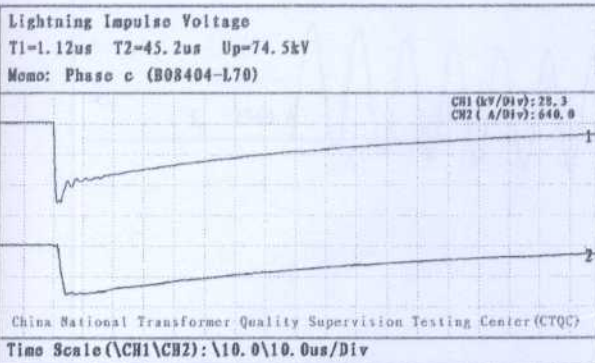
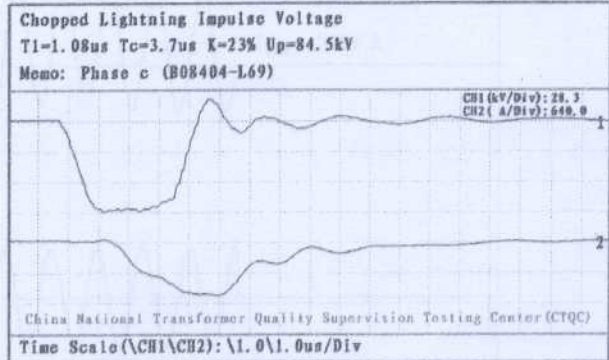
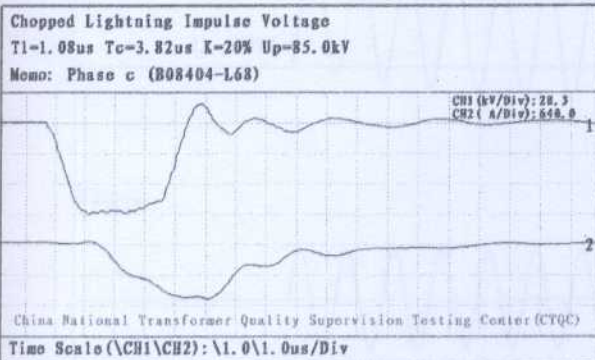
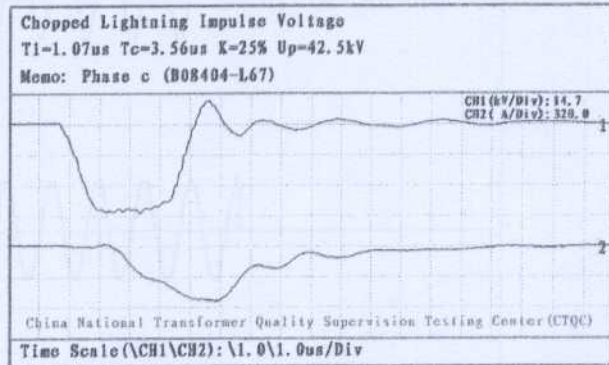
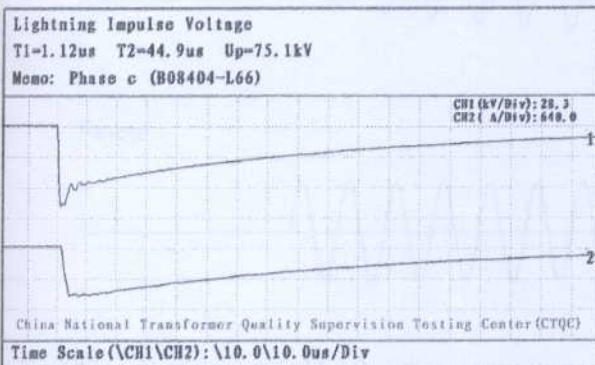
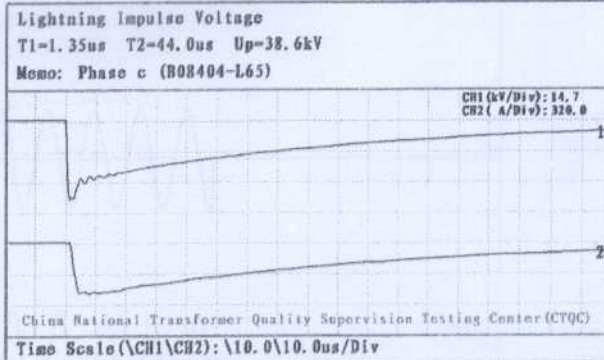
Total 47 Page 39

Tested terminal: c

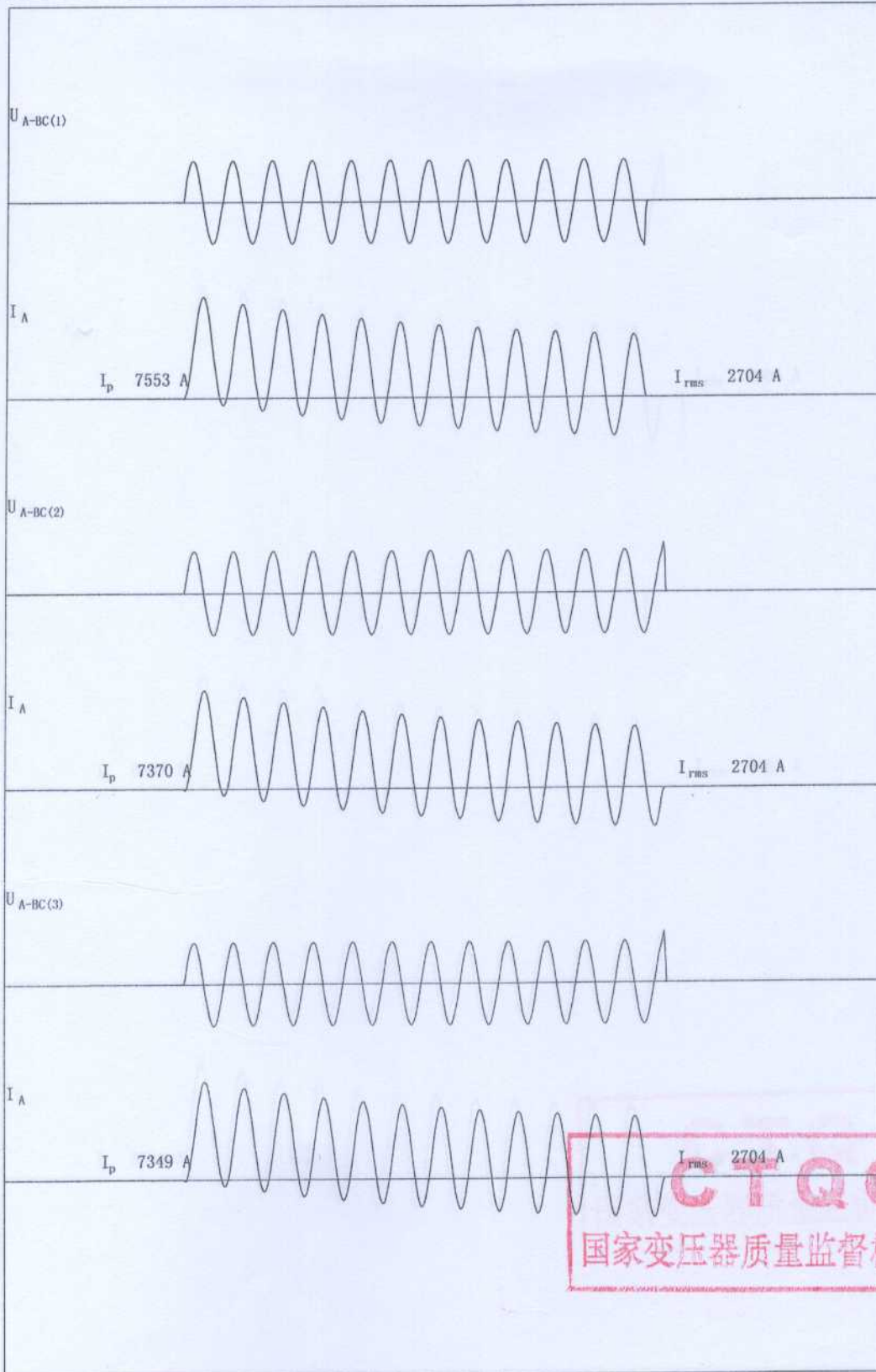
Test polarity: Negative

CH1. Voltage records

CH2. Neutral current records



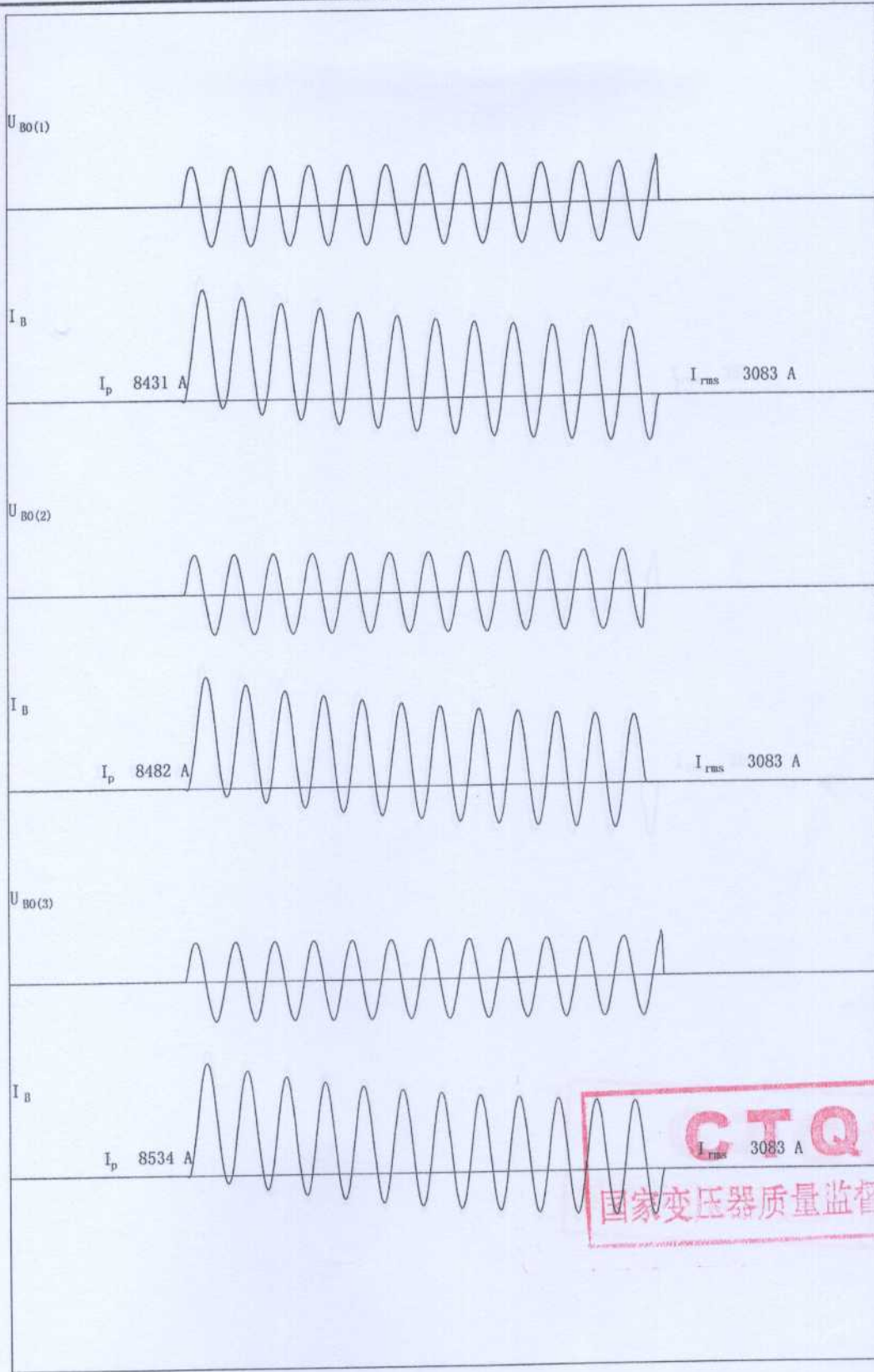
<b>Test Report</b>	<b>China National Transformer Quality Supervision Testing Center</b>	No: CTQC/B-08.404 Total 47 Page 40
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B08404-S04



<b>Test Report</b>	<b>China National Transformer Quality Supervision Testing Center</b>	No: CTQC/B-08.404 Total 47 Page 41
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CTQC  
 国家变压器质量监督检验中心

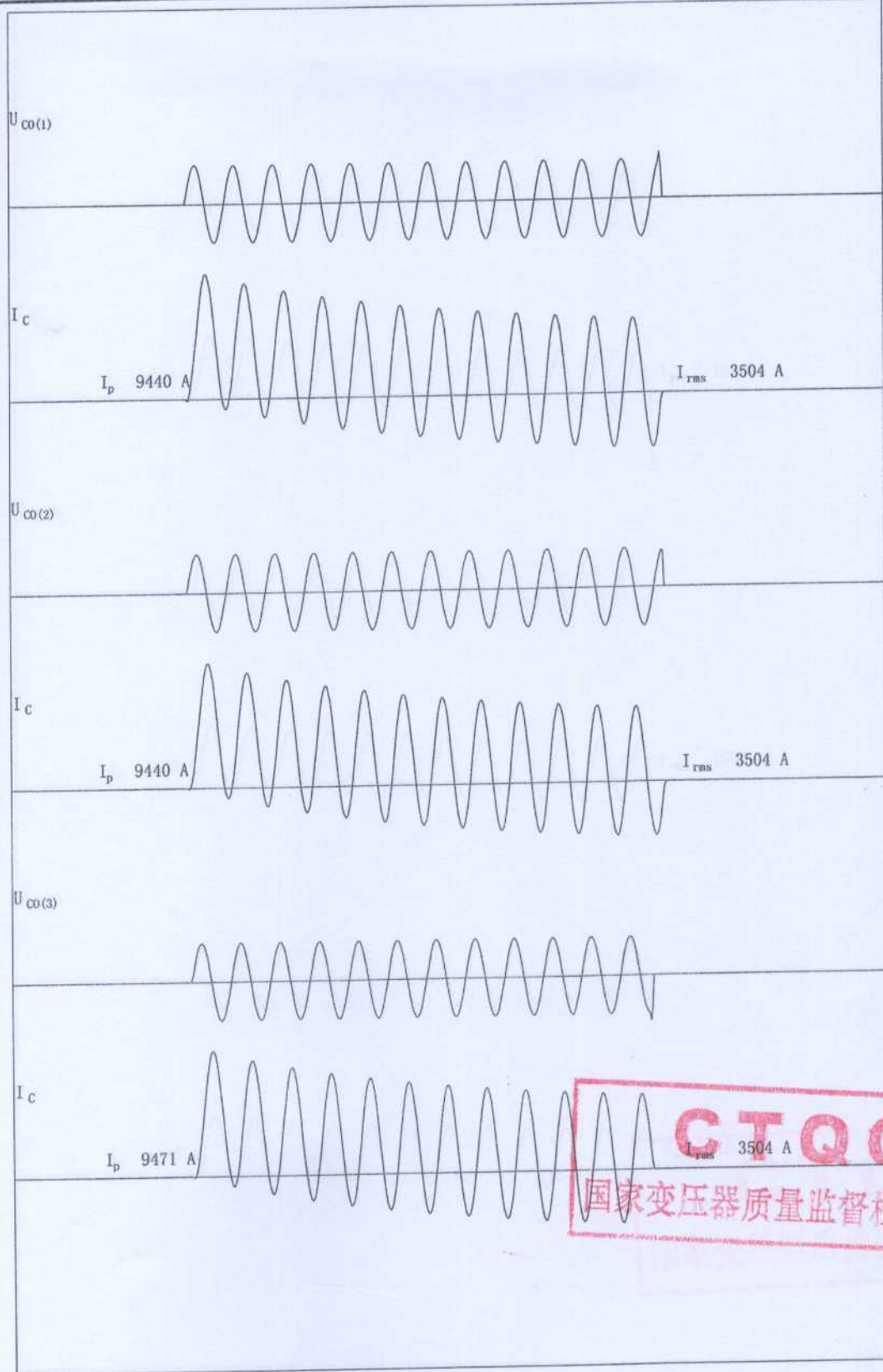
HC8404-S05

Address: Hushitai Country Xinchengzi District Shenyang  
 E-mail: [ctqc@vip.sina.com](mailto:ctqc@vip.sina.com) <http://www.ctn.cn>

Phone: (024)89874449  
 Postal code: 110122

(024)89702527  
 Fax: (024)89707949

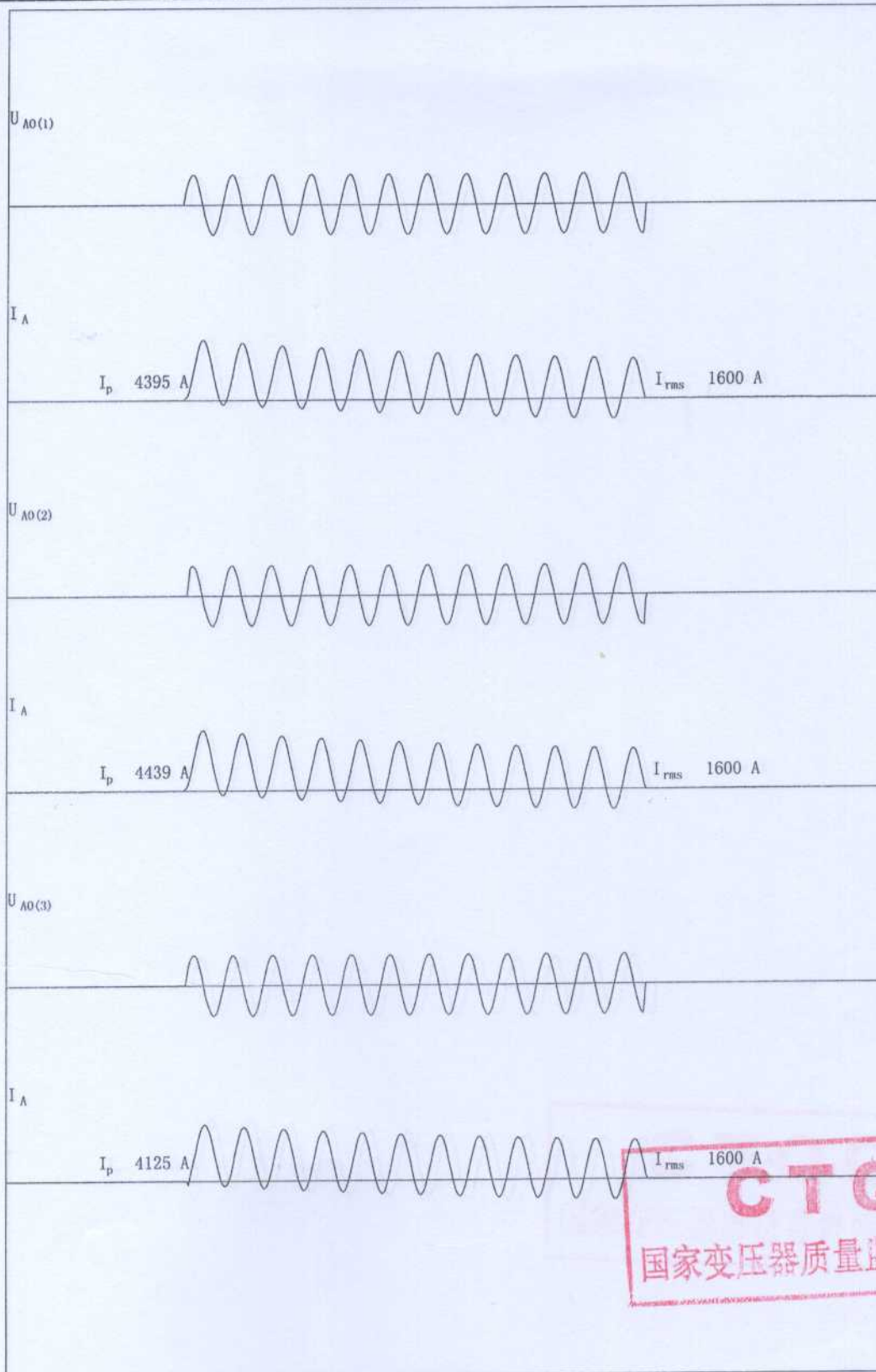
*[Handwritten signatures]*



H08404-S06

*(Handwritten signatures)*





B08404-S01

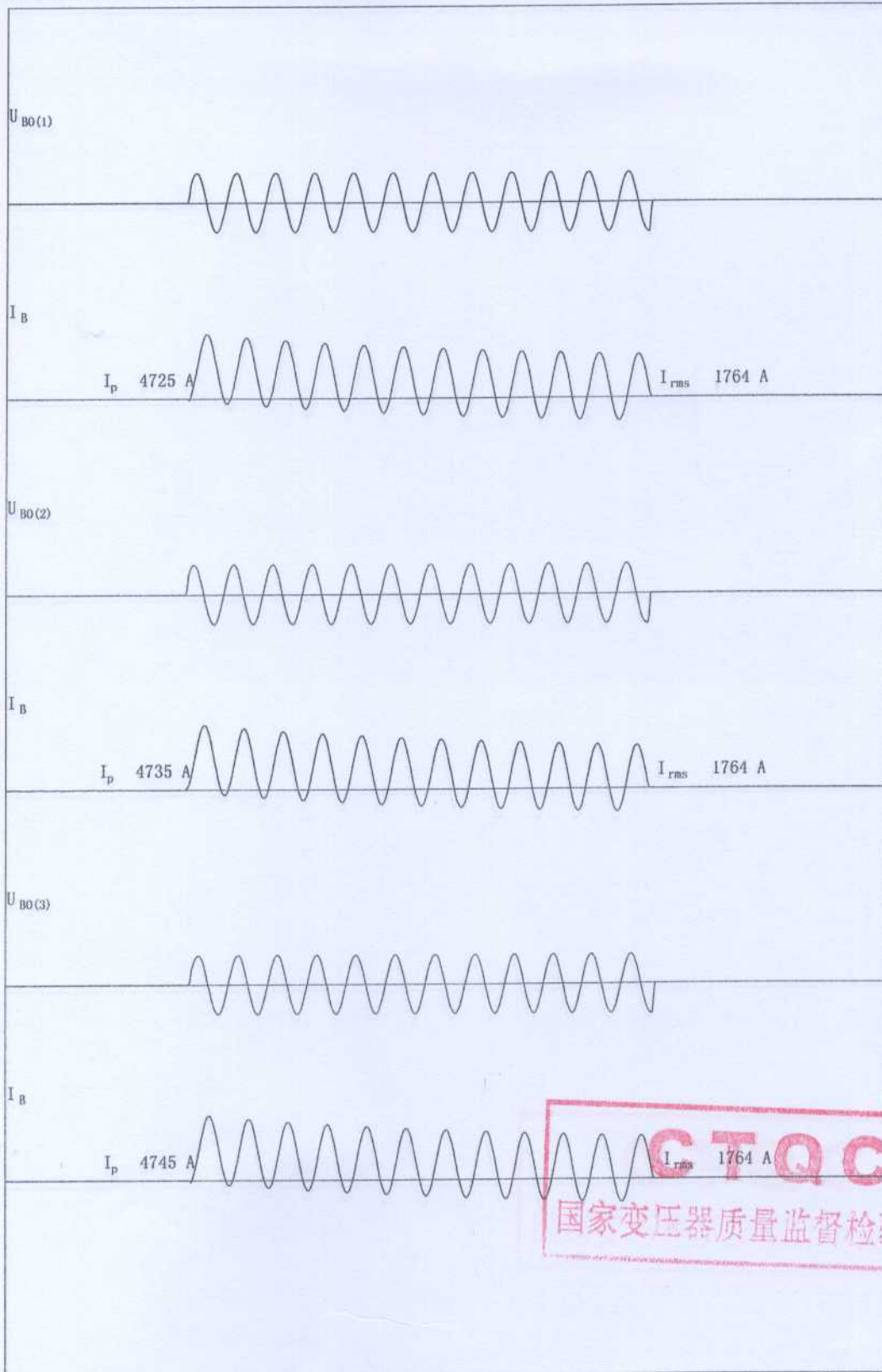
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## Test Report

China National Transformer Quality  
Supervision Testing Center

No.: CTQC/B-08.404

Total 47 Page 44



308404-S02

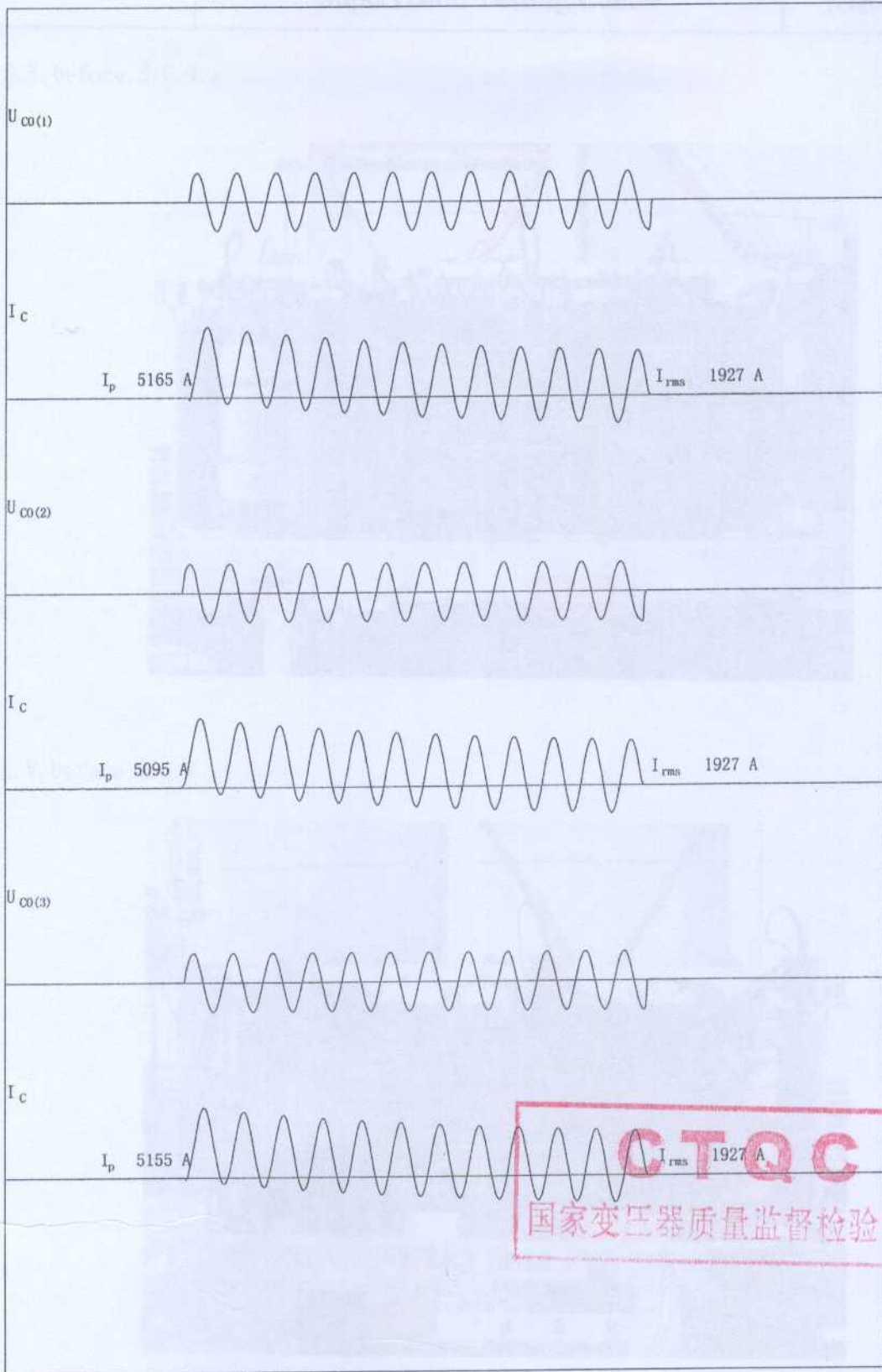
Address: Hushitai Country Xinchengzi District Shenyang  
E-mail: [ctqc@vip.sina.com](mailto:ctqc@vip.sina.com) <http://www.ctn.cn>

Phone: (024)89874449  
Postal code: 110122

(024)89702527  
Fax: (024)89707949



<h2>Test Report</h2>	<h3>China National Transformer Quality Supervision Testing Center</h3>	No: CTQC/B-08.404 Total 47 Page 45
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B08404-S03

Address: Hushitai Country Xinchengzi District Shenyang  
 E-mail: [ctqc@vip.sina.com](mailto:ctqc@vip.sina.com) <http://www.ctn.cn>

Phone: (024)89874449  
 Postal code: 110122

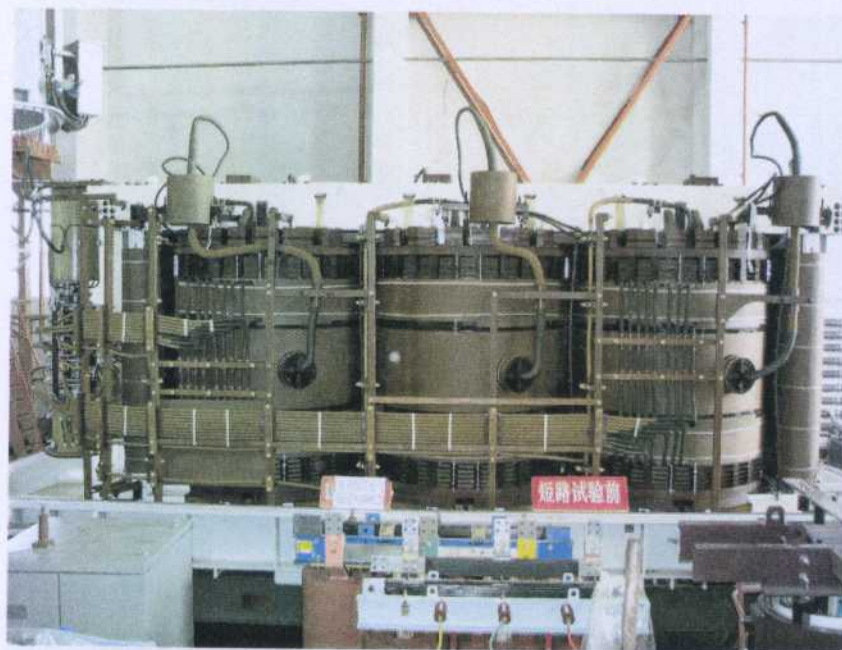
(024)89702527  
 Fax: (024)89707949

Test Report	China National Transformer Quality Supervision Testing Center	No: CTQC/B-08. 404 Total 47 Page 46
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H. V. before S. C. T. :



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



*Handwritten signature*

**CTQC**  
 国家变压器质量监督检验中心

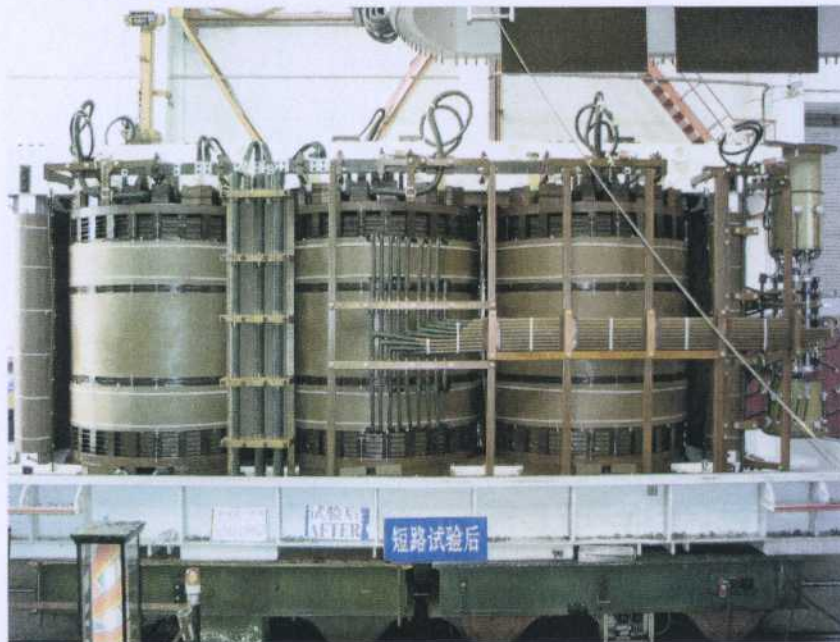


Test Report	China National Transformer Quality Supervision Testing Center	No: CTQC/B-08. 404 Total 47 Page 47
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H. V. after S. C. T. :



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

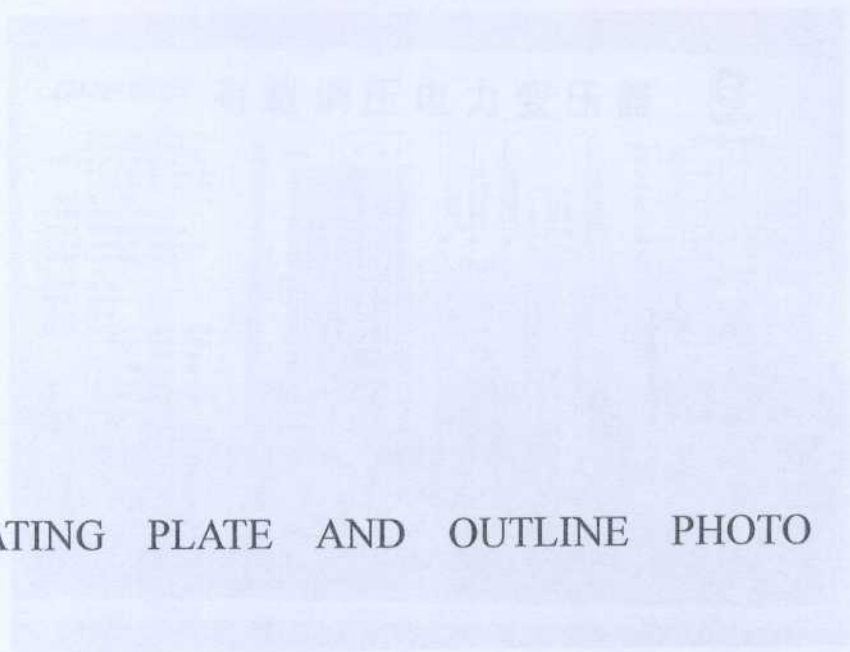


*Handwritten signatures*

**CTQC**  
国家变压器质量监督检验中心

NO. 17923-08 101

Rating plate



RATING PLATE AND OUTLINE PHOTO

Outline




CT00  
S11-M

Handwritten notes or signatures in the bottom left corner, including the number '103'.



Rating plate:

**QRE 钱江电气** **有载调压电力变压器** 

地址: 180001 2000 18014001 2004  
 D=56518001 1800 1800 1800

标准代号: GB 1094.1-1985 GB 1094.2-1985  
 GB 1094.3-2003 GB 1094.4-2003  
 GB 1094.5-2003 GB 1094.6-1985

产品代号: 100 310 5008

产品型号: SPPQZ11-180000/220

额定容量: 180000/180000/90000 kVA

额定电压: 220kV/220kV/110kV/110kV

额定电流: 471.38/471.38/942.76 A

组别: 3/0

额定频率: 50 Hz

冷却方式: Y/Nyn0d11

冷却介质: ODAF

绝缘水平: H.V. 最高电压 L.V. AC 850/385 kV  
 H.V. 中压耐受 L.V. AC 490/250 kV  
 M.V. 中压耐受 L.V. AC 480/250 kV  
 M.V. 特高压耐受 L.V. AC 250/125 kV  
 L.V. 电压耐受 L.V. AC 75/35 kV

空载损耗: [592.2] kW 负载损耗: [5.97] %

短路损耗: [545.2] kW

短路阻抗: 短路阻抗 1.0% 短路阻抗

HV-LV: [25.50] % [24.43] % [24.51] %

HV-MV: [4.20] % [4.02] % [4.12] %

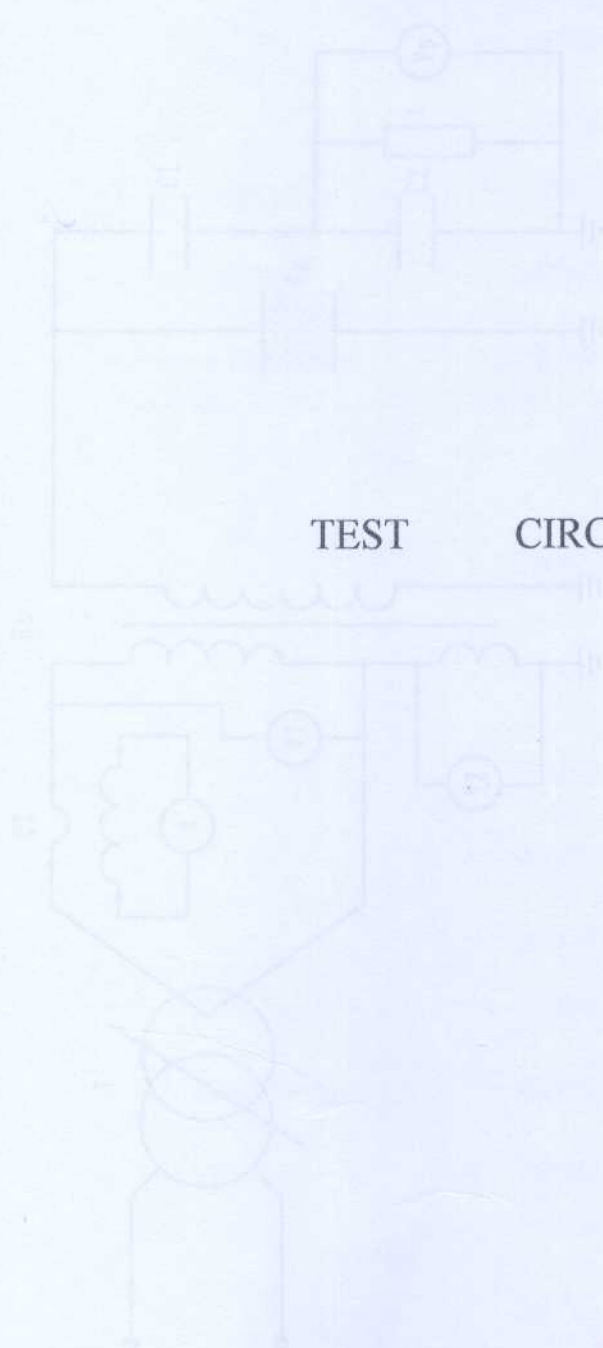
MV-LV: [0.04] %

重量: 14200 kg 总重量: 15200 kg  
 最大重量: 18700 kg 最大重量: 43400 kg  
 G: 20000 kg 总重量: 42200 kg

分接电压	容量	重量
11.712kV	20000	240.47
11.712kV	20000	253.97
11.712kV	20000	267.47
11.712kV	20000	280.97
11.712kV	20000	294.47
11.712kV	20000	307.97
11.712kV	20000	321.47
11.712kV	20000	334.97
11.712kV	20000	348.47
11.712kV	20000	361.97
11.712kV	20000	375.47
11.712kV	20000	388.97
11.712kV	20000	402.47
11.712kV	20000	415.97
11.712kV	20000	429.47
11.712kV	20000	442.97
11.712kV	20000	456.47
11.712kV	20000	469.97
11.712kV	20000	483.47
11.712kV	20000	496.97
11.712kV	20000	510.47
11.712kV	20000	523.97
11.712kV	20000	537.47
11.712kV	20000	550.97
11.712kV	20000	564.47
11.712kV	20000	577.97
11.712kV	20000	591.47
11.712kV	20000	604.97
11.712kV	20000	618.47
11.712kV	20000	631.97
11.712kV	20000	645.47
11.712kV	20000	658.97
11.712kV	20000	672.47
11.712kV	20000	685.97
11.712kV	20000	699.47
11.712kV	20000	712.97
11.712kV	20000	726.47
11.712kV	20000	739.97
11.712kV	20000	753.47
11.712kV	20000	766.97
11.712kV	20000	780.47
11.712kV	20000	793.97
11.712kV	20000	807.47
11.712kV	20000	820.97
11.712kV	20000	834.47
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11.712kV	20000	969.47
11.712kV	20000	982.97
11.712kV	20000	996.47
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11.712kV	20000	1117.97
11.712kV	20000	1131.47
11.712kV	20000	1144.97
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11.712kV	20000	1266.47
11.712kV	20000	1279.97
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11.712kV	20000	1563.47
11.712kV	20000	1576.97
11.712kV	20000	1590.47
11.712kV	20000	1603.97
11.712kV	20000	1617.47
11.712kV	20000	1630.97
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11.712kV	20000	1765.97
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11.712kV	20000	1792.97
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11.712kV	20000	2778.47
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11.712kV	20000	3399.47
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GB 1983-80 GB 494  
Annex 2

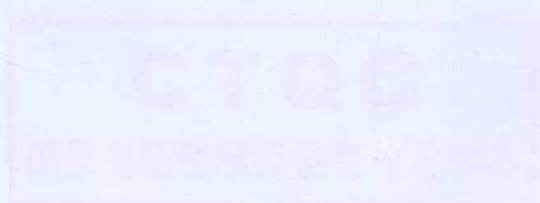
TEST CIRCUITS



多量测试电路示意图

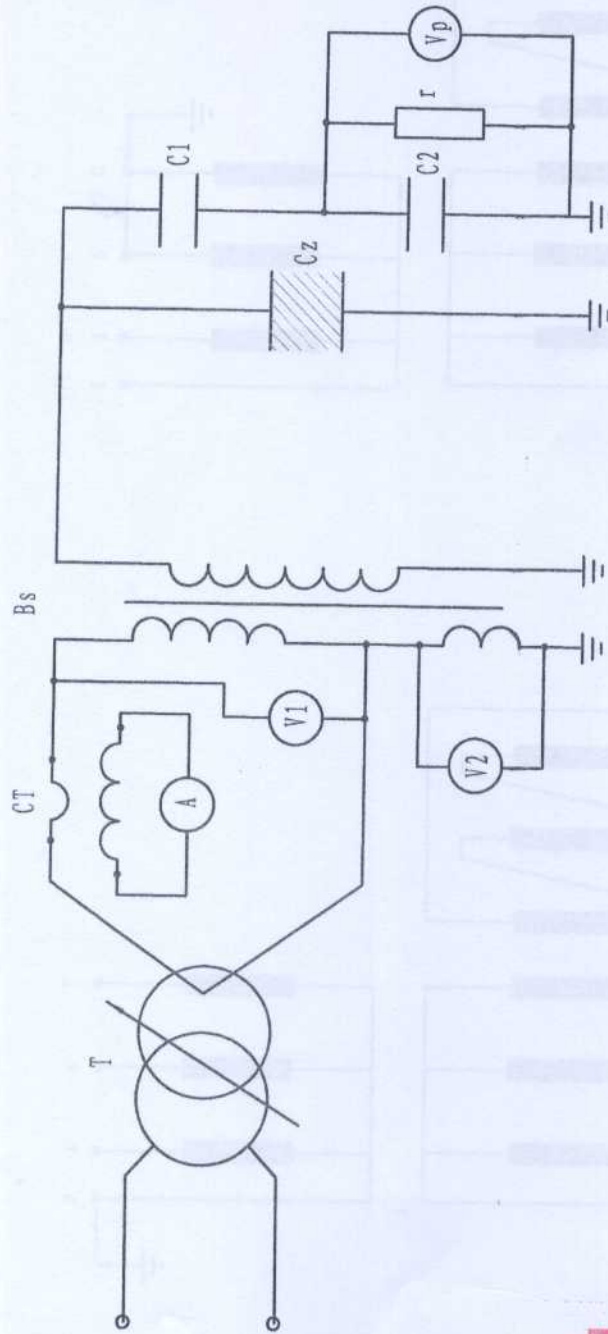
Diagram illustrating test circuits for multiple measurements

- 1-高压绝缘子 1-High voltage insulator
- 2-电压互感器 2-Voltage transformer
- 3-电流互感器 3-Current transformer
- 4-电阻器 4-Resistor
- 5-电压表 5-Voltmeter
- 6-电流表 6-Ammeter
- 7-功率表 7-Wattmeter
- 8-功率因数表 8-Power factor meter
- 9-电能表 9-Energy meter
- 10-电能表 10-Energy meter
- 11-电能表 11-Energy meter
- 12-电能表 12-Energy meter
- 13-电能表 13-Energy meter
- 14-电能表 14-Energy meter
- 15-电能表 15-Energy meter
- 16-电能表 16-Energy meter
- 17-电能表 17-Energy meter
- 18-电能表 18-Energy meter
- 19-电能表 19-Energy meter
- 20-电能表 20-Energy meter
- 21-电能表 21-Energy meter
- 22-电能表 22-Energy meter
- 23-电能表 23-Energy meter
- 24-电能表 24-Energy meter
- 25-电能表 25-Energy meter
- 26-电能表 26-Energy meter
- 27-电能表 27-Energy meter
- 28-电能表 28-Energy meter
- 29-电能表 29-Energy meter
- 30-电能表 30-Energy meter
- 31-电能表 31-Energy meter
- 32-电能表 32-Energy meter
- 33-电能表 33-Energy meter
- 34-电能表 34-Energy meter
- 35-电能表 35-Energy meter
- 36-电能表 36-Energy meter
- 37-电能表 37-Energy meter
- 38-电能表 38-Energy meter
- 39-电能表 39-Energy meter
- 40-电能表 40-Energy meter
- 41-电能表 41-Energy meter
- 42-电能表 42-Energy meter
- 43-电能表 43-Energy meter
- 44-电能表 44-Energy meter
- 45-电能表 45-Energy meter
- 46-电能表 46-Energy meter
- 47-电能表 47-Energy meter
- 48-电能表 48-Energy meter
- 49-电能表 49-Energy meter
- 50-电能表 50-Energy meter
- 51-电能表 51-Energy meter
- 52-电能表 52-Energy meter
- 53-电能表 53-Energy meter
- 54-电能表 54-Energy meter
- 55-电能表 55-Energy meter
- 56-电能表 56-Energy meter
- 57-电能表 57-Energy meter
- 58-电能表 58-Energy meter
- 59-电能表 59-Energy meter
- 60-电能表 60-Energy meter
- 61-电能表 61-Energy meter
- 62-电能表 62-Energy meter
- 63-电能表 63-Energy meter
- 64-电能表 64-Energy meter
- 65-电能表 65-Energy meter
- 66-电能表 66-Energy meter
- 67-电能表 67-Energy meter
- 68-电能表 68-Energy meter
- 69-电能表 69-Energy meter
- 70-电能表 70-Energy meter
- 71-电能表 71-Energy meter
- 72-电能表 72-Energy meter
- 73-电能表 73-Energy meter
- 74-电能表 74-Energy meter
- 75-电能表 75-Energy meter
- 76-电能表 76-Energy meter
- 77-电能表 77-Energy meter
- 78-电能表 78-Energy meter
- 79-电能表 79-Energy meter
- 80-电能表 80-Energy meter
- 81-电能表 81-Energy meter
- 82-电能表 82-Energy meter
- 83-电能表 83-Energy meter
- 84-电能表 84-Energy meter
- 85-电能表 85-Energy meter
- 86-电能表 86-Energy meter
- 87-电能表 87-Energy meter
- 88-电能表 88-Energy meter
- 89-电能表 89-Energy meter
- 90-电能表 90-Energy meter
- 91-电能表 91-Energy meter
- 92-电能表 92-Energy meter
- 93-电能表 93-Energy meter
- 94-电能表 94-Energy meter
- 95-电能表 95-Energy meter
- 96-电能表 96-Energy meter
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- 98-电能表 98-Energy meter
- 99-电能表 99-Energy meter
- 100-电能表 100-Energy meter



100 100





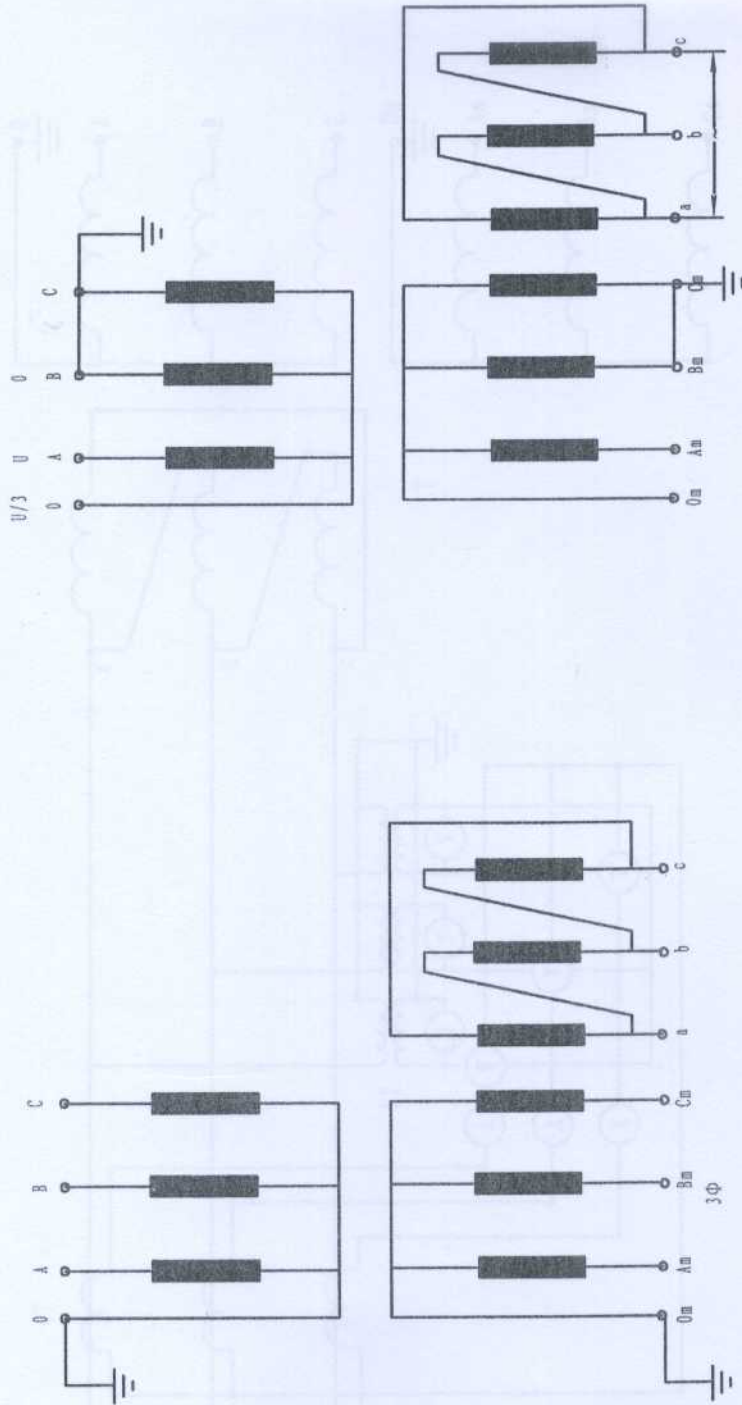
外施耐压试验线路图

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 divider   | Cz-试品      | Sample               |          |                     |
| r-放电电阻      | Discharge resistance | Vp-峰值电压表   | Peak value voltmeter |          |                     |

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单相施加电压的相对地试验  
A phase-to-earth test with  
single-phase supply

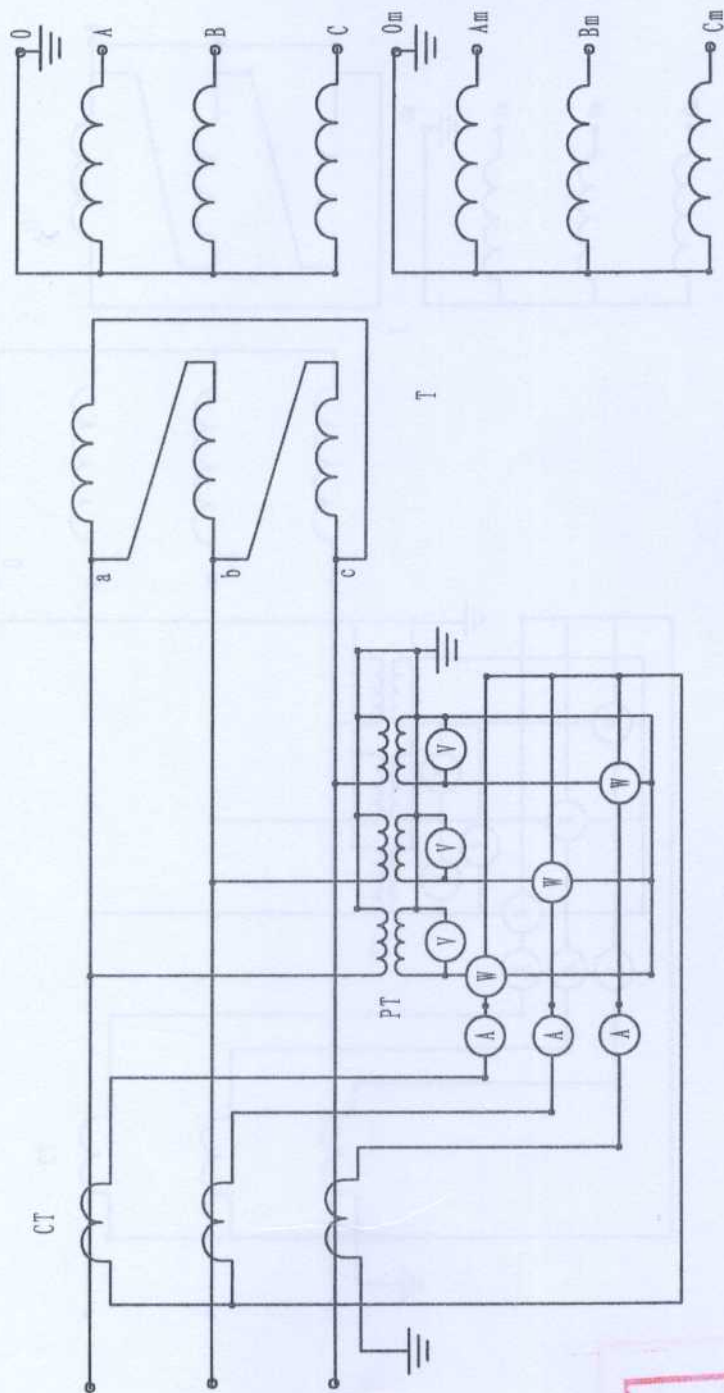
短时交流耐压试验  
Short duration AC withstand  
voltage test circuit

三相施加电压的相间试验  
A phase to phase test with  
three phase supply

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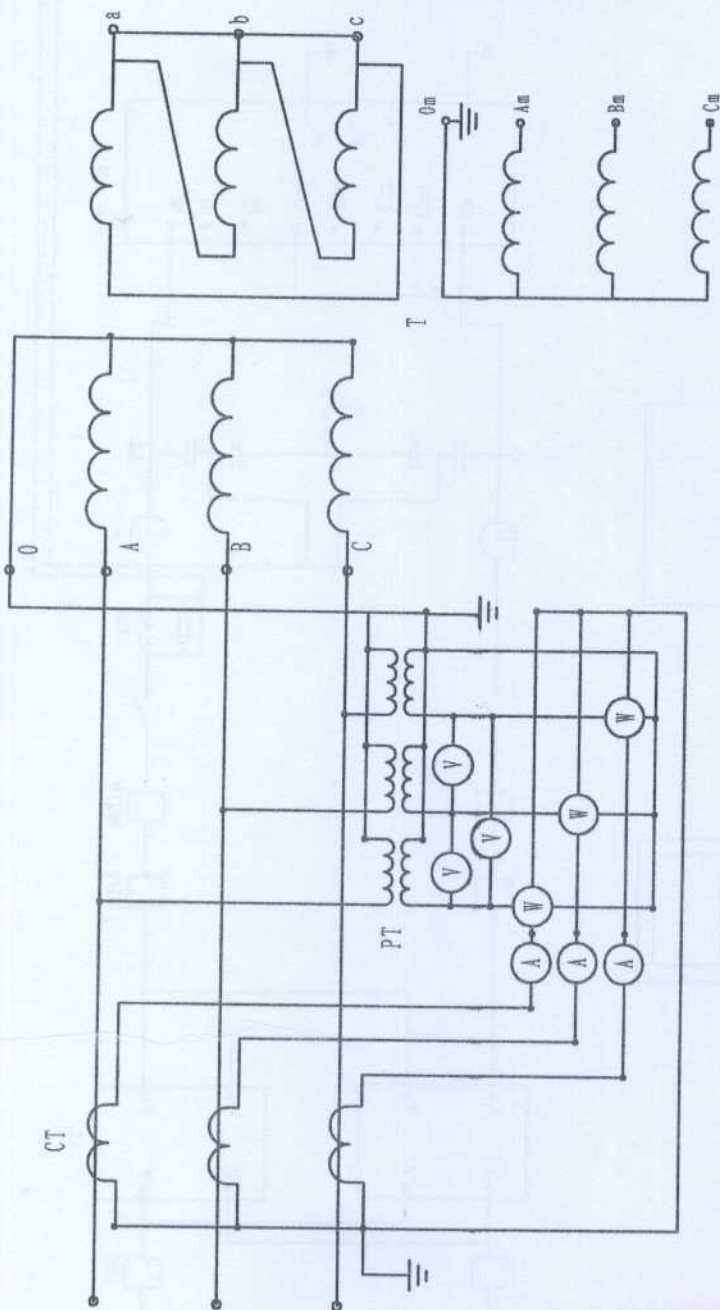
空载损耗及空载电流测量线路图

No-load loss and current measurement circuit

- T-被试变压器 Sample
- PT-电压互感器 Voltage transformer
- W-瓦特表 Wattmeter
- CT-电流互感器 Current transformer
- A-电流表 Amperemeter
- V-电压表 voltmeter



W 李



短路阻抗及负载损耗测量线路图 (高压-低压)

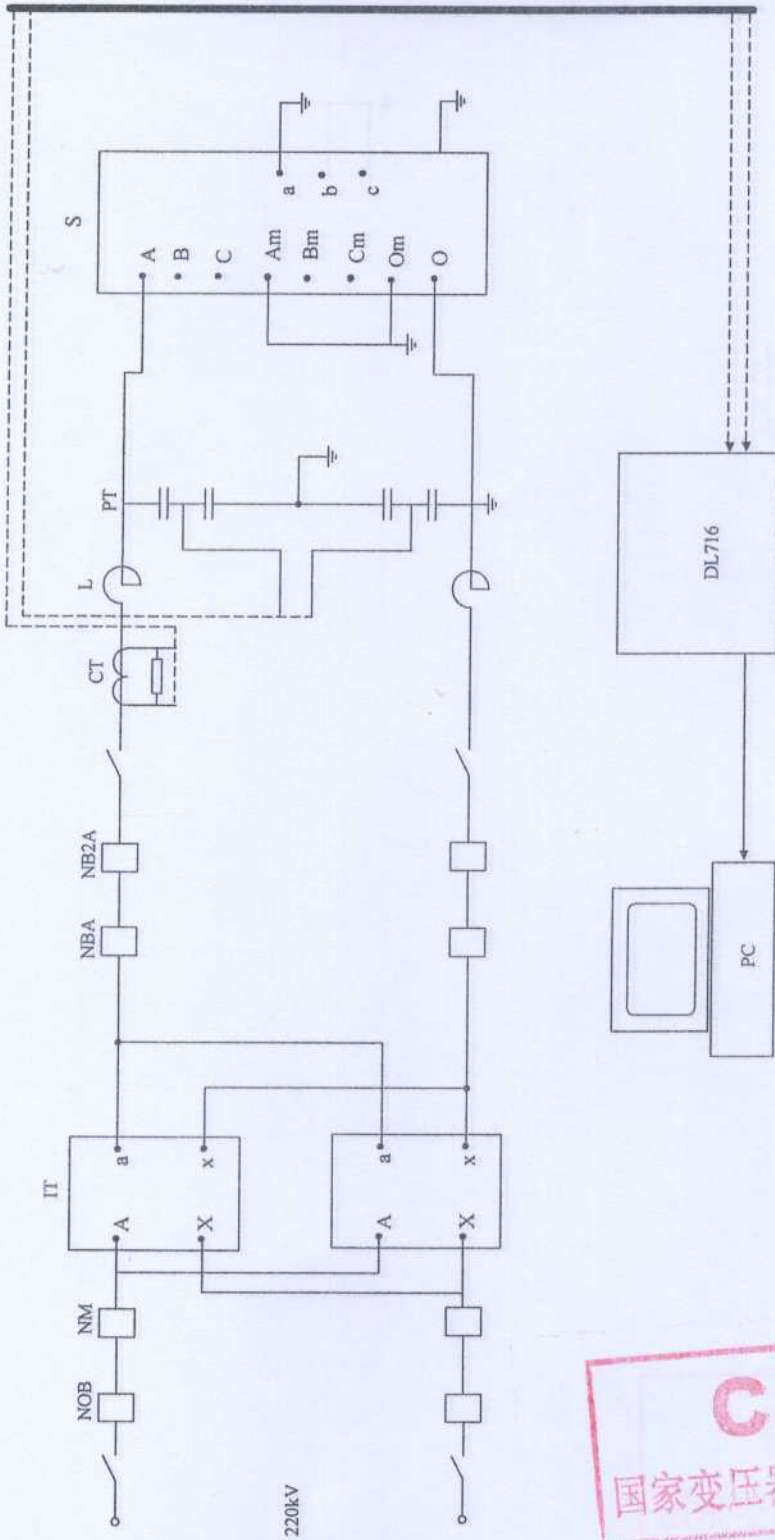
Short circuit impedance and on load loss measurement circuit

- |          |                     |          |                     |
|----------|---------------------|----------|---------------------|
| 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           |

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短路试验线路图 (H-M) Short circuit tests of transformer(H-M):

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

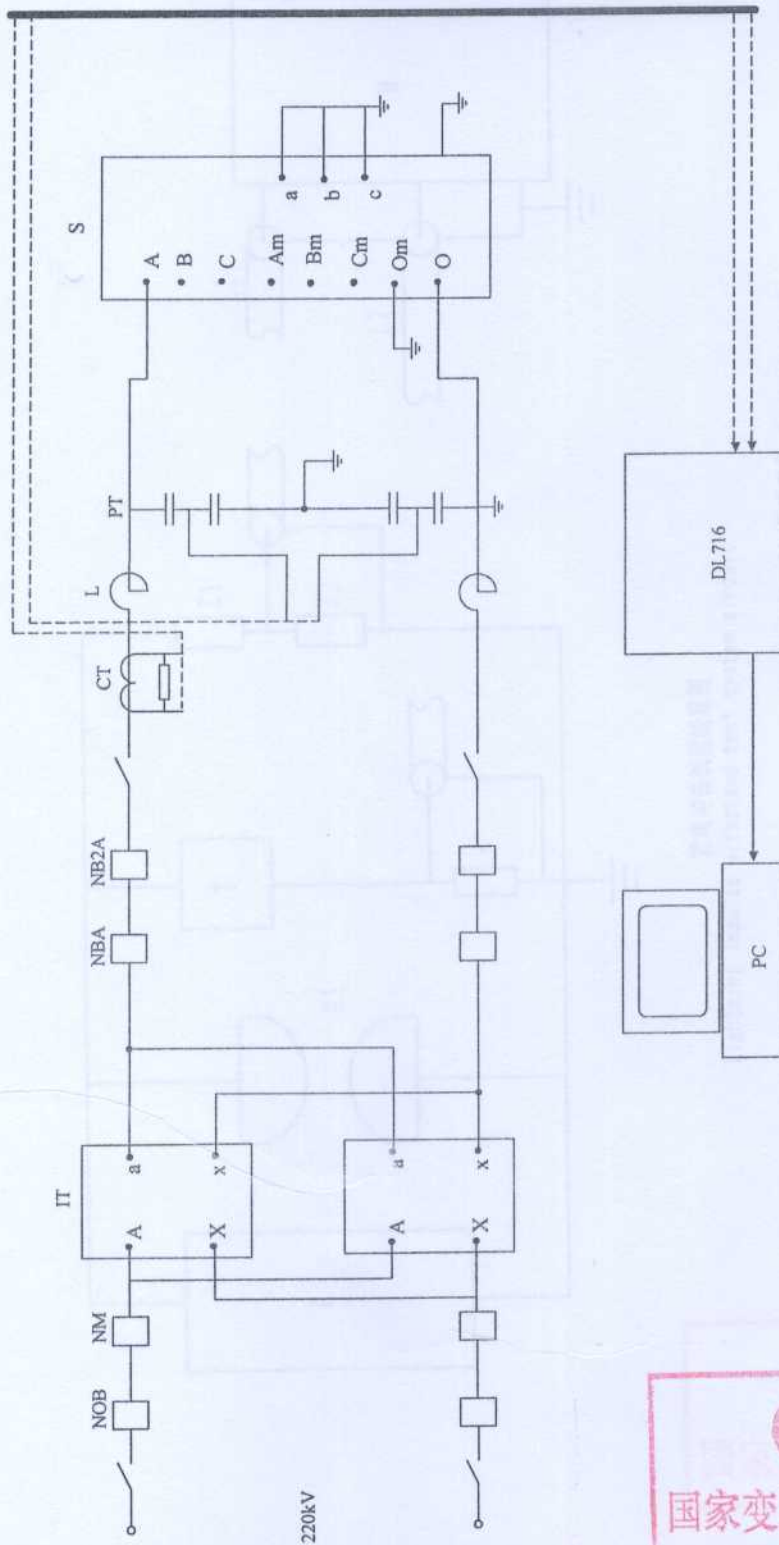
PT: 电容分压器 Voltage divider

S: 被试变压器 Sample

NOB,NM,NB,NB2: SF6断路器 SF6 switchgear

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*Handwritten signature*



短路试验线路图 (H-L) Short circuit tests of transformer(H-L):

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: 电容分压器 Voltage divider

DL716: 瞬态记录仪 16 channels analyzer

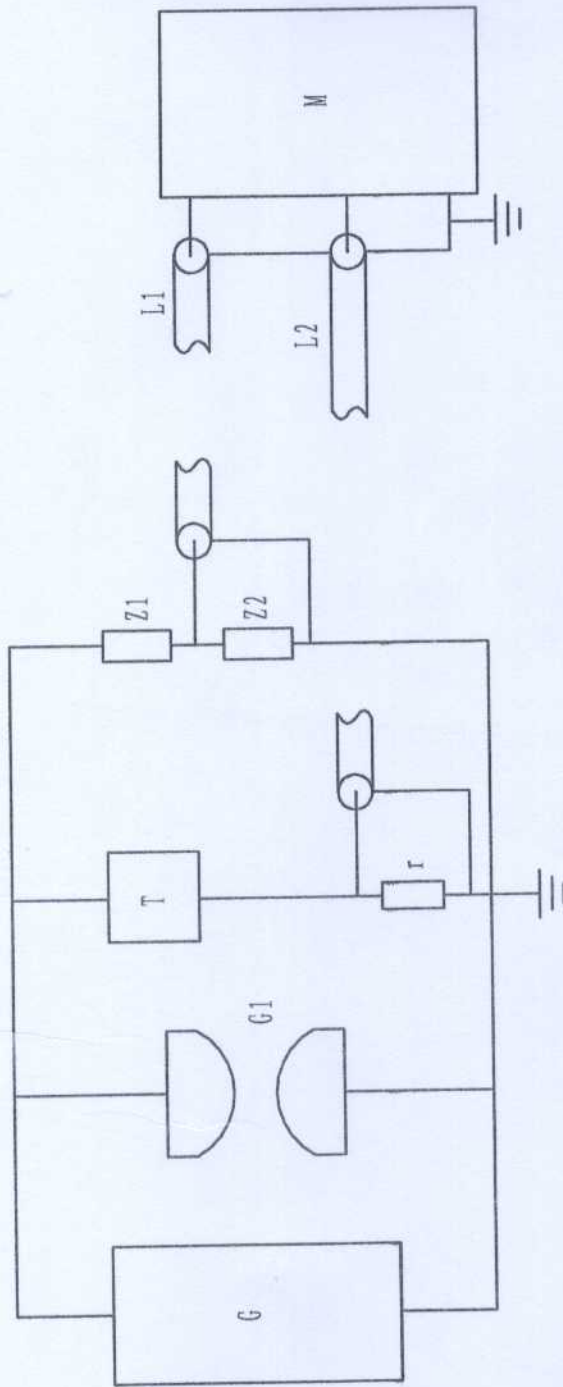
S: 被试变压器 Sample

NOB, NM, NB, NB2: SF6断路器 SF6 switchgear

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*Handwritten signatures and initials.*





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
- Z1, Z2-阻容分压器 Voltage divider
- L1, L2-高频传输电缆 High frequency transmission cable
- r-分流器 Shunt
- G1-载新装置 Chopping device
- M-测量仪器 Measurement instrument
- T-试品 Sample

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