

Attestation of conformity

Based on tests witnessed

Hangzhou Qiantang River Electric Group Co., Ltd.

has passed the type test sequence on a

Power Transformer 50 MVA

Type: SSZ11-50000/110

Rating: 50 MVA – 110/38.5/11 kV – 50 Hz – YNyn0d11

The test object passed the specification of test duties of

IEC 60076

The tests were carried out strictly in accordance with the standard. The tests were carried out at SVET.CTQC, Shenyang, P.R. China. The test results are recorded in Inspection Report 70755040-TDT 07-64524A

This Report is issued on 17 December 2007

KEMA Nederland B.V.



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

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Report.

Report number 07-64524A

Project number 70755040

Apparatus Power Transformer 50 MVA

Client SVET.CTQC

Test location SVET.CTQC, Shenyang, P.R. China

Manufacturer Hangzhou Qiantang River Electric Group
Co., Ltd.

Arnhem, 17 December 2007

INSPECTION REPORT

Report number 70755040-TDT 07-64524A
Client SVET.CTQC
Shenyang Hunnan New & High-Tech. Industrial Development Zone
Shenyang 110179
China
Reference Trust testing
Concerning Routine, type and special tests
Date Between 14 and 23 November 2007
Place Shenyang, China
Object Power Transformer 50 MVA
Manufacturer Hangzhou Qiantang River Electric Group Co., Ltd

REQUIREMENTS

Requirements as specified in the standards IEC 60076-1, IEC 60076-2, IEC 60076-3, IEC 60076-5 and IEC 60076-10.

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.

KEMA Nederland B.V.



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

Arnhem, 17 December 2007

Author G.J. Veldscholten

This report consists of:
111 pages incl. 11 annexes (99 pages)

MATERIAL DATA

Manufacturer	Hangzhou Qiantang River Electric Group Co., Ltd
Type	SSZ11-50000/110
Serial number	0730780001
Rated power	50 MVA/ 50 MVA/ 50 MVA
Rated voltage	110/ 38.5/ 11 kV
Rated current	262.4/ 749.8/ 2624.3 A
Rated frequency	50 Hz
Number of phases	3
Tapping range h.v.	+10%, -10%
Number of steps/ tapping step	17/ 1.25%
Tapping range m.v.	+5%, -5%
Vector group	YNyn0d11
Cooling method	ONAN
Temperature class of insulation	A
Insulation levels	h.v. terminal : LI/LIC/AC – 480/530/200 kV h.v. neutral : LI/AC – 325/140 kV m.v. terminal : LI/LIC/AC – 200/220/85 kV l.v. terminal : LI/LIC/AC – 75/85/35 kV
Short-circuit impedance h.v/m.v.	10.5% at 75 °C
Short-circuit impedance h.v/l.v.	17.5% at 75 °C
Short-circuit impedance m.v/l.v.	6.5% at 75 °C
Total mass	88600 kg

TEST OBJECT IDENTIFICATION

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

During the untanking operation the test object was checked with the drawings enclosed in the SVET.CTQC report, nr. CTQC/B-07.644.

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

TEST PROGRAMME

	kind of test ¹⁾	standard/ specification	clause
0			
1			
2	S	IEC 60076-5	
3			
3.1			
Measurement of insulation resistances, absorption ratio and tan δ	S	IEC 60076-1	10.1
3.2	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	R	IEC 60076-3	5,11
3.5	T	IEC 60076-3	13, 14
3.6	R	IEC 60076-3	5,12
3.7	S	IEC 60076-3	5, 12
3.8	R	IEC 60076-1	10.4
3.9	S	IEC 60076-1	10.7
3.10	R	IEC 60076-1	10.5
3.11	S	IEC 60076-1	10.6
3.12	S	IEC 60076-10	
3.13	R	IEC60076-1	10.8
3.14	T	IEC 60076-2	
3.15		Requirement	
3.16	S	IEC 60076-5	4.2

¹⁾R = routine test T = type test S = special test

PERSONS ATTENDING THE TEST

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

DESCRIPTION AND RESULTS OF THE TESTS PERFORMED

0 INSPECTION OF THE TEST SET-UP

The tests were carried out in the laboratory of SVET, 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 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 laboratory without attendance of KEMA.

For comparison reason the test results 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 60076-11, clause 25. The transformer is of category 2.

Calculations of the short-circuit current were made with a short-circuit rating of 9000 MVA and a system voltage of 110 kV.

For this transformer two short-circuit tests had to be carried out. The tests were performed according to the single-phase method. The single-phase supply is provided between one terminal and to the other two terminals connected together. A secondary winding is short-circuited.

The first test was carried out with the power supply to the h.v. winding and the m.v. winding short-circuited, while the l.v. winding was open. The three times three shots applied to the extreme and nominal tap position of the h.v. coil were made in three different tap positions of the m.v. winding, the extreme-and the nominal one.

The second test was carried out with the power supply to h.v. winding and the l.v. winding short-circuited while the m.v. winding was open. The three times three shots were applied to the extreme and nominal tap position of the h.v. coil.

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 SVET.CTQC report, see annex K.

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, 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.- and m.v. windings were measured in all positions of the tap-changers. The results of the measurements of the h.v. and m.v. and l.v. windings are represented in annex C.

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, and measured were the combination h.v.- to l.v. windings and h.v.- to m.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 D.

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.-, m.v.-, and l.v. windings were tested with respectively 140 kV, 85 kV and 35 kV, 50 Hz for 1 minute.

Results

No collapse of the test voltages occurred.

3.5 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 for the h.v.-, m.v.- and l.v. windings were respectively 480 kV, 200 kV and 75 kV. The h.v.- and m.v. neutrals were tested with respectively 325 kV and 200 kV. The h.v.- m.v.- and l.v. windings were tested with chopped waves on the tail. Their test levels were respectively 530 kV, 220 kV and 85 kV.

The three h.v., m.v.- and l.v. phase 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 results are represented in the SVET.CTQC report, see annex K, pages 31 up to 42.

Results

The transformer passed the test successfully.

3.6 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 transformer was submitted to an induced over voltage withstand test between one h.v. terminal and earth at an AC voltage of respectively 80 kV ($1.1 U_m/\sqrt{3}$) during 5 minutes, 109.1 kV ($1.5 U_m/\sqrt{3}$) during 5 minutes, 200 kV (= U1) during 40 s, 109.1 kV during 5 minutes and 80 kV during 5 minutes. The tap changer was in position 5 ($115.5/\sqrt{3}$ kV). During the application of the voltage a measurement of partial discharges was carried out. The acceptance criterion is: a pd level < 70 pC at $1.5 U_m/\sqrt{3}$ and < 70 pC at $1.1 U_m/\sqrt{3}$ after U1.

In the phase-to-phase test the transformer was submitted to an induced over voltage withstand test between the h.v. terminals with an AC voltage of respectively 138.6 kV ($1.1 U_m$) during 5 minutes, 163.8 kV ($1.3 U_m$) during 5 minutes, 200 kV (= U1) during 40 s, 163.8 kV during 5 minutes and 138.6 kV during 5 minutes. The tap changer was in position 9b (110 kV). During the application of the voltage a measurement of partial discharges was carried out. The acceptance criterion is: a pd level < 70 pC at $1.3 U_m$ and < 70 pC at $1.1 U_m$ after U1.

The voltage levels, their durations and their PD levels are represented in annex E.

Results

The transformer withstood the test and the requirements for the pd measurement were fulfilled.

3.7 Long-duration AC withstand voltage test

This test was carried out in accordance with IEC 60076-3, clauses 12.4.

The transformer was submitted to an induced over voltage withstand test between one h.v. terminal and earth at an AC voltage of respectively 80 kV ($1.1 U_m/\sqrt{3}$) during 5 minutes, 109.1 kV ($1.5 U_m/\sqrt{3}$) during 5 minutes, 123.7 kV ($1.7 U_m/\sqrt{3} = U_1$) during 40 s, 109.1 kV during 30 minutes and 80 kV during 5 minutes. The tap changer was in position 9b ($110/\sqrt{3}$ kV). During the application of the voltage a measurement of partial discharges was carried out. The acceptance criterion is: a pd level < 70 pC at $1.5 U_m/\sqrt{3}$ and < 70 pC at $1.1 U_m/\sqrt{3}$ after U_1 . The voltage levels, their durations and their PD levels are represented in annex F.

Result

The transformer withstood the test and the requirements for the pd measurement were fulfilled.

3.8 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. With the power supply connected to the h.v. winding the following combinations were measured.

In tapping positions 1, 9b, 17. with the l.v. winding short-circuited and the m.v. winding open.

In tapping positions 1, 9b, 17 with the m.v. winding short-circuited and the l.v. winding open.

In this configuration the measurements were made in the extreme and rated tap position of the m.v. winding.

With the power supply connected to the m.v. winding with the l.v. winding short-circuited and the h.v. winding open, the measurements were made in the tap positions 1, 3, 5 of the m.v. winding.

The measuring results were recalculated to 75 °C and are represented in annex G, pages 1 up to 5.

Results

The measured values were within the specified tolerance.

3.9 Measurement of zero sequence impedance

The measurement was carried out in accordance with IEC 60076-1, clause 10.7, measured in tapping position 9b. There is no value specified for this impedance. The measured values are given in annex B.

Results

The measured values do not give rise to remarks.

3.10 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 H.

Results

The measured values were within the specified tolerance.

3.11 Measurement of the harmonics of the no-load current

The measurement was carried out in accordance with IEC 60076-1, clause 10.1.3. The harmonics of the no-load current were measured at nominal voltage. The measured values are given in the SVET.CTQC report, see annex K, page 19.

Results

The measured values don't give rise to remarks.

3.12 Determination of sound levels

The sound level test was carried out in accordance with IEC 60076-10. Sound level measurements were carried out at 100% of the rated voltage. The measurements were carried out indoor. The measured values are represented in annex J.

Results

The measured values don't give rise to remarks.

3.13 Tests on on-load tap changer

The tests on the on load tap changer were carried out in accordance with IEC 60076-1, clause 10.8.

Results

The tests do not give rise to remarks

3.14 Temperature-rise test

The temperature-rise test was carried out in accordance with IEC 60076-2. The test was split into two parts.

First part was a test between the h.v.- and the short-circuited m.v winding, while the l.v. winding was open.

The transformer was loaded with its highest measured total losses (no-load loss and load loss), which was in tap 17 for the h.v. winding and tap 5 for the m.v. winding and measured was 294.4 kW. The injected total loss was 278.5 kW. After a steady stage was reached for 3 hours the transformer was loaded with its rated current of 291.6 A. After one hour the transformer was switched off and the resistances for the cool down curves were measured during 10 minutes for the h.v.- and m.v. winding. By means of the formulas of clause 5.6 the measured values are corrected to the values presented in annex G. The cool down curves are presented in annex K, pages 15 and 16.

The second part of the test was between the h.v.- and the short-circuited l.v. winding and was carried out immediately after the first part.

The windings were loaded with the rated current for tap 17 of 291.6 A for one hour. After one hour the transformer was switched off and the resistance for the cool down curve was measured during 10 minutes for the l.v. winding. The cool down curve is presented on page 17 of annex K.

The calculated temperatures are presented in annex I.

Results

The transformer did meet the requirements for the temperature rise test.

3.15 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 performed, see page 13 of annex K.

Results

Breakdown voltage was 64.13 kV, while requirement was higher than 40 kV.

$\tan \delta$ was 0.001 while requirement was less than 0.01.

Water content was 12.46 mg/l, while requirement is less than 20 mg/l.

No excessive gases were developing.

3.16 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 reveal no defects.

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

Results

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

ANNEX A INSULATION RESISTANCES AND TAN δ

Transformer number: 0730780001

Before short circuit, humidity: 35%, temperature: 14.0 °C				
Measurement position	R15 (GΩ)	R60(GΩ)	R600(GΩ)	Tan δ
h.v. – m.v, l.v.& tank to earth	18.7	21.0	50.7	0.0022
m.v. – h.v., l.v.& tank to earth	9.65	15.4	-	0.0022
l.v. – h.v., m.v.& tank to earth	10.4	17.6	-	0.0021
h.v., m.v. – l.v., tank to earth	13.6	23.7	-	0.0022
h.v., m.v., l.v. – tank to earth	22.5	27.2	-	0.0022
Core – tank to earth	-	19.3	-	-
Clamp – tank to earth	-	13.8	-	-
After short circuit, humidity: 40%, temperature: 8.0 °C				
Measurement position	R15 (GΩ)	R60(GΩ)	R600(GΩ)	Tan δ
h.v. – m.v, l.v.& tank to earth	30.8	34.5	60.8	0.0026
m.v. – h.v., l.v.& tank to earth	30.3	32.0	58.3	0.0023
l.v. – h.v., m.v.& tank to earth	18.5	30.1	-	0.0024
h.v., m.v. – l.v., tank to earth	32.2	43.8	-	0.0022
h.v., m.v., l.v. – tank to earth	35.1	40.7	-	0.0023
Core – tank to earth	-	23.0	-	-
Clamp – tank to earth	-	21.3	-	-

ANNEX B ZERO SEQUENCE IMPEDANCE

Transformer number: 0730780001

Connection group	Applied Voltage terminal	Open Circuit terminal	Short Circuit terminal	Tap position	Applied Current (A)	Measured Voltage (V)	Impedance (Ω)
Yyn0d11	ABC-0	Am,Bm,Cm, 0m,abc	/	9b	133.2	1674	37.70
Yyn0d11	ABC-0	abc	/	9b	129.5	972.9	22.54
Yyn0d11	AmBmCm-0	A,B,C,0,abc	/	9b	290.3	178.5	1.84
Yyn0d11	AmBmCm-0	abc	/	9b	324.5	119.4	1.10

ANNEX C WINDING RESISTANCE MEASUREMENT

Transformer number: 0730780001

Winding	Tap position	Measured values after short-circuit test before/after		
		T-ambient before 14.0 °C/after 8.0 °C		
		A-0	B-0	C-0
h.v. (Ω)	1	0.392/0.3793	0.3928/0.3802	0.3950/0.3820
	2	0.3845/0.3719	0.3855/0.3726	0.3870/0.3744
	3	0.3781/0.3657	0.3786/0.3661	0.3804/0.3679
	4	0.3706/0.3583	0.3709/0.3589	0.3727/0.3606
	5	0.3653/0.3520	0.3647/0.3527	0.3662/0.3542
	6	0.3564/0.3447	0.3572/0.3454	0.3586/0.3468
	7	0.3503/0.3383	0.3503/0.3388	0.3521/0.3404
	8	0.3424/0.3310	0.3432/0.3317	0.3449/0.3331
	9b	0.3347/0.3237	0.3349/0.3241	0.3360/0.3249
	10	0.3453/0.3320	0.3443/0.3324	0.3453/0.3338
	11	0.3516/0.3383	0.3504/0.3387	0.3520/0.3401
	12	0.3588/0.3456	0.3579/0.3461	0.3594/0.3476
	13	0.3659/0.3520	0.3648/0.3526	0.3663/0.3540
	14	0.3725/0.3591	0.3725/0.3598	0.3737/0.3614
	15	0.3794/0.3657	0.3790/0.3662	0.3805/0.3679
	16	0.3865/0.3728	0.3867/0.3736	0.3884/0.3753
	17	0.3939/0.3796	0.3935/0.3802	0.3955/0.3819
m.v. (mΩ)		Am-0m	Bm-0M	Cm-0m
	1	50.61/48.88	50.73/49.05	51.15/49.41
	2	48.79/47.26	48.92/47.30	49.30/47.68
	3	46.71/45.17	46.69/45.16	46.90/45.34
	4	48.81/47.19	48.99/47.36	49.38/47.73
	5	50.81/49.07	50.94/49.22	51.31/49.60
l.v. (mΩ)	/	a-b	b-c	c-a
	/	5.825/5.642	5.829/5.644	5.866/5.680

ANNEX D RATIO AND CONNECTION GROUP

Transformer number: 0730780001

Tap position	Rated Voltages h.v./l.v. (kV)	Ratio	Measured deviation (%) before/after short-circuit test			Connection Symbol
			AB-ab	BC-bc	CA-ca	
1	121.00/11.00	11.000	0.05/0.02	0.07/0.14	0.23/0.29	YNd11
2	119.62/11.00	10.875	-0.04/-0.07	-0.02/0.05	0.15/0.20	
3	118.25/11.00	10.750	0.03/0.00	0.04/0.11	0.22/0.26	
4	116.88/11.00	10.625	-0.06/-0.09	-0.05/0.02	0.13/0.17	
5	115.50/11.00	10.500	0.01/-0.03	0.02/0.09	0.20/0.24	
6	114.12/11.00	10.375	-0.09/-0.02	-0.07/-0.01	0.11/0.15	
7	112.75/11.00	10.250	-0.01/-0.05	0.00/0.06	0.17/0.22	
8	111.38/11.00	10.125	-0.11/-0.14	-0.10/-0.03	0.08/0.13	
9a,b,c	110.00/11.00	10.000	-0.04/-0.07	-0.03/0.04	0.15/0.20	
10	108.62/11.00	9.875	-0.14/-0.17	-0.13/-0.06	0.06/0.10	
11	107.25/11.00	9.750	-0.06/-0.09	-0.05/0.01	0.14/0.18	
12	105.88/11.00	9.625	-0.16/-0.20	-0.15/-0.09	0.04/0.08	
13	104.50/11.00	9.500	-0.09/-0.12	-0.08/-0.02	0.11/0.15	
14	103.12/11.00	9.375	-0.20/-0.23	-0.18/-0.12	0.01/0.05	
15	101.74/11.00	9.250	-0.12/-0.14	-0.11/-0.05	0.09/0.13	
16	100.38/11.00	9.125	-0.22/-0.25	-0.21/-0.15	-0.01/0.04	
17	99.00/11.00	9.000	-0.15/-0.18	-0.13/-0.08	0.07/0.11	
	m.v./l.v. (kV)		AmBm/ab	BmCm/bc	CmAm/ca	YNd11
1	40.23/11.00	3.675	-0.25/-0.25	-0.25/-0.22	-0.24/-0.23	
2	39.46/11.00	3.588	-0.16/-0.16	-0.16/-0.14	-0.15/-0.14	
3	38.50/11.00	3.500	-0.06/-0.07	-0.06/-0.04	-0.06/-0.04	
4	37.54/11.00	3.413	0.04/0.03	0.04/0.06	0.04/0.06	
5	36.58/11.00	3.325	0.14/0.13	0.14/0.16	0.14/0.16	

ANNEX E SHORT DURATION AC WITHSTAND VOLTAGE TEST

Transformer number: 0730780001

Phase to earth test, tap position 5, frequency 150 Hz						
Induced voltage		Time	Partial discharge levels (pC)			
x U_m	Voltage		A	B	C	Limits
1.1 $U_m/\sqrt{3}$	80 kV	5 min.	-	-	-	-
1.5 $U_m/\sqrt{3}$	109.1 kV	5 min.	-	-	-	-
U1	200 kV	40 s	-	-	-	-
1.5 $U_m/\sqrt{3}$	109.1 kV	5 min.	< 20	< 30	< 30	< 70
1.1 $U_m/\sqrt{3}$	80 kV	5 min.	< 20	< 20	< 20	< 70

Phase to phase test, tap position 9b, frequency 150 Hz						
Induced voltage		Time	Partial discharge levels (pC)			
x U_m	Voltage		A	B	C	Limits
1.1 U_m	138.6 kV	5 min.	-	-	-	-
1.3 U_m	163.8 kV	5 min.	-	-	-	-
U1	200 kV	40 s	-	-	-	-
1.3 U_m	163.8 kV	5 min.	< 30	< 30	< 20	< 70
1.1 U_m	138.6 kV	5 min.	< 20	< 20	< 20	< 70

Background level was less than 10 pC before and after test.

ANNEX F LONG DURATION AC WITHSTAND VOLTAGE TEST

Transformer number: 0730780001

Phase to earth test, tap position 9b, frequency 150 Hz						
Induced voltage		Time	Partial discharge levels (pC)			
x Um	Voltage		A	B	C	Limits
1.1 $U_m/\sqrt{3}$	80 kV	5 min.	-	-	-	-
1.5 $U_m/\sqrt{3}$	109.1 kV	5 min.	-	-	-	-
$U_1=1.7 U_m/\sqrt{3}$	123.7 kV	40 s	-	-	-	-
1.5 $U_m/\sqrt{3}$	109.1 kV	5 min.	< 20	< 30	< 40	< 70
		10 min.	< 20	< 30	< 30	
		15 min.	< 30	< 30	< 30	
		20 min.	< 20	< 30	< 30	
		25 min.	< 20	< 30	< 30	
		30 min.	< 20	< 30	< 30	
1.1 $U_m/\sqrt{3}$	80 kV	5 min.	< 30	< 30	< 30	< 70

Background level was less than 10 pC before and after test.

ANNEX G RESISTANCES, JOULE-LOSS, SHORT-CIRCUIT LOSS AND SHORT-CIRCUIT IMPEDANCES

Transformer number: 0730780001, page 1

Resistances, Joule-loss, short-circuit loss and short-circuit impedances						
h.v.- to l.v. winding						
Tap position	1		9b		17	
Ratio in tap (kV)	121.0/11.0		110.0/11.0		99.0/11.0	
Rated currents in tap (A).	238.6/2624.3		262.4/2624.3		291.6/2624.3	
	Before SCT			After SCT		
Tap changer position	1	9b	17	1	9b	17
Average resistance at 75 °C h.v. (Ω)	0.9794	0.8346	0.9818	0.9709	0.8274	0.9710
Average resistance at 75 °C l.v.	7.2416 mΩ			7.2152 mΩ		
Joule-losses at 75 °C (kW)	158.7	161.3	200.3	157.4	160.0	198.4
Joule-losses at T-measure (kW)	128.0	130.1	161.5	124.2	126.2	156.5
Short-circuit losses measured at 15.0 °C BSCT/ 9.5 °C ASCT	186.8	177.8	201.1	183.9	175.3	197.8
Eddy-current losses at T-measure	58.8	47.7	38.5	59.8	49.1	41.4
Eddy-current losses at T-75 °C	47.4	38.5	31.9	47.1	38.8	32.6
Short-circuit losses at 75 °C	206.1	199.8	232.2	204.5	198.8	231.0
Guaranteed losses (kW)	-	-	-	-	-	-
Tolerance						
Short-circuit impedances (%)	19.35	18.74	18.47	19.36	18.75	18.48
Guaranteed values (%)		17.5			17.5	
Tolerance		± 7.5%			± 7.5%	

Transformer number: 0730780001

Resistances, Joule-loss, short-circuit loss and short-circuit impedances						
h.v.- to m.v. 1 winding						
Tap position	1		9b		17	
Ratio in tap (kV)	121.0/40.43		110.0/40.43		99.0/40.43	
Rated currents in tap (A).	238.6/714.1		262.4/714.1		291.6/714.1	
	Before SCT			After SCT		
Tap changer position	1	9b	17	1	9b	17
Average resistance at 75 °C h.v. (Ω)	0.9794	0.8346	0.9818	-	-	0.9710
Average resistance at 75 °C m.v.	126.57 m Ω			125.32 m Ω		
Joule-losses at 75 °C (kW)	180.5	183.1	222.1	-	-	219.7
Joule-losses at T-measure (kW)	145.6	147.7	179.1	-	-	173.3
Short-circuit losses measured at 15.0 °C BSCT/ 9.5 °C ASCT	169.7	166.2	196.1	-	-	193.2
Eddy-current losses at T-measure	24.0	18.6	17.0	-	-	19.9
Eddy-current losses at T-75 °C	19.5	15.0	13.8	-	-	15.7
Short-circuit losses at 75 °C	200.0	198.1	235.9	-	-	235.4
Guaranteed losses (kW)	-	-	-	-	-	-
Tolerance				-	-	
Short-circuit impedances (%)	9.81	9.43	9.41	-	-	9.42

Transformer number: 0730780001

Resistances, Joule-loss, short-circuit loss and short-circuit impedances						
h.v.- to m.v. 3 winding						
Tap position	1		9b		17	
Ratio in tap (kV)	121.0/38.5		110.0/38.5		99.0/38.5	
Rated currents in tap (A).	238.6/749.8		262.4/749.8		291.6/749.8	
	Before SCT			After SCT		
Tap changer position	1	9b	17	1	9b	17
Average resistance at 75 °C h.v. (Ω)	0.9794	0.8346	0.9818	0.9794	0.8346	0.9818
Average resistance at 75 °C l.v.	116.45 mΩ			115.4		
Joule-losses at 75 °C (kW)	181.8	184.4	223.4	180.2	182.8	221.1
Joule-losses at T-measure (kW)	146.6	148.7	180.2	142.1	144.1	174.4
Short-circuit losses measured at 15.0 °C BSCT/ 9.5 °C ASCT	179.0	172.3	198.5	175.6	169.0	194.7
Eddy-current losses at T-measure	32.3	23.6	18.3	33.5	24.8	20.3
Eddy-current losses at T-75 °C	26.2	19.1	14.8	26.5	19.6	16.1
Short-circuit losses at 75 °C	208.0	203.5	238.2	206.7	202.4	237.2
Guaranteed losses (kW)	-	212.5			212.5	
Tolerance		+15%			+15%	
Short-circuit impedances (%)	11.03	10.44	10.17	11.04	10.46	10.18
Guaranteed values (%)		10.5			10.5	
Tolerance		± 7.5%			± 7.5%	

Transformer number: 0730780001

Resistances, Joule-loss, short-circuit loss and short-circuit impedances						
h.v.- to m.v. 5 winding						
Tap position	1		9b		17	
Ratio in tap (kV)	121.0/36.58		110.0/36.58		99.0/36.58	
Rated currents in tap (A).	238.6/789.3		262.4/789.3		291.6/789.3	
	Before SCT			After SCT		
Tap changer position	1	9b	17	1	9b	17
Average resistance at 75 °C h.v. (Ω)	0.9794	0.8346	0.9818	0.9709	0.8274	0.9710
Average resistance at 75 °C l.v.	127.0 m Ω			125.8 m Ω		
Joule-losses at 75 °C (kW)	202.3	204.9	243.9	200.4	-	241.4
Joule-losses at T-measure (kW)	163.1	165.2	196.7	158.1	-	190.4
Short-circuit losses measured at 15.0 °C BSCT/ 9.5 °C ASCT	211.2	200.7	221.9	207.2	-	216.9
Eddy-current losses at T-measure	48.1	35.5	25.1	49.1	-	26.5
Eddy-current losses at T-75 °C	38.8	28.6	20.4	38.7	-	20.9
Short-circuit losses at 75 °C	241.1	233.5	264.3	239.2	-	262.3
Guaranteed losses (kW)	-	-	-	-	-	-
Tolerance						
Short-circuit impedances (%)	12.72	11.92	11.37	12.74	-	11.38
Guaranteed values (%)	-	-	-	-	-	-
Tolerance						

Transformer number: 0730780001

Resistances, Joule-loss, short-circuit loss and short-circuit impedances						
m.v.- to l.v. winding						
Tap position	1		3		5	
Ratio in tap (kV)	40.43/11.0		38.50/11.0		36.58/11.0	
Rated currents in tap (A).	714.1/2624.3		749.8/2624.3		789.3/2624.3	
	Before SCT			After SCT		
Tap changer position	1	3	5	1	3	5
Average resistance at 75 °C m.v.(mΩ)	126.6	116.4	127.0		116.4	
Average resistance at 75 °C l.v.	7.2707 mΩ			7.2152 mΩ		
Joule-losses at 75 °C (kW)	171.9	173.3	193.8	-	171.2	-
Joule-losses at T-measure (kW)	138.6	139.8	156.3	-	135.5	-
Short-circuit losses measured at 15.0 °C BSCT/ 9.5 °C ASCT	153.8	150.5	167.1	-	148.1	-
Eddy-current losses at T-measure	15.2	10.7	10.8	-	13.7	-
Eddy-current losses at T-75 °C	12.3	8.7	8.8	-	10.5	-
Short-circuit losses at 75 °C	184.2	182.0	202.6	-	181.7	-
Guaranteed losses (kW)	-	-	-	-	-	-
Tolerance						
Short-circuit impedances (%)	6.94	6.73	6.87	-	6.76	-
Guaranteed values (%)		6.50			6.50	
Tolerance		-2.5%			-2.5%	
		+7.5%			+7.5%	

ANNEX H NO-LOAD LOSS AND NO-LOAD CURRENT

Transformer number: 0730780001

No-load loss and no-load current						
	RMS Voltage (kV)	Average voltage (kV)	Average current (A)	Average current (%)	Measured loss (kW)	Corrected loss (kW)
BSCT	11.0	11.0	1.94	0.07	30.11	30.11
ASCT	11.0	11.0	1.93	0.07	29.84	29.84
Guaranteed				0.77 +30%		42.72 +15%

ANNEX I RESULTS OF THE TEMPERATURE-RISE TEST

Transformer number: 0730780001

		required/ [max. allowed]
General		
Power	kVA	50000
Cooling		ONAN
Position of tap changer		h.v. 17 – m.v. 5
Ratio	kV	99.00/ 36.58
Supplied losses (sum of load and no-load losses at 75 °C)	kW	278.5
Supplied current 1 hour	A	291.6
Results temperature-rises		
Top-oil	K	50.6/ [52]
Mean high voltage windings	K	51.6/ [62]
Mean medium voltage windings	K	56.7/ [62]
Mean low voltage windings	K	44.3/ [62]

ANNEX J RESULTS OF SOUND LEVEL MEASUREMENT

Transformer number: 0730780001

Location		Indoor
Excitation	% U _n	100
Cooling method		ONAN
Number of measuring points		
At 1/3 height, 1.2 m		24
At 2/3 height, 2.4 m		24
Measuring distance	m	0.3
Logarithmic mean of		
Measured value	dB _A	60.4
Corrected measuring result	dB _A	57
Calculated sound power	dB _A	77
Guaranteed sound pressure	dB _A	58
Guaranteed sound power	dB _A	86

ANNEX K

**SVET.CTQC TEST REPORT CTQC/B-07.644 REGARDING
TESTS, OSCILLOGRAMS, CURVES, LISTS OF TEST
EQUIPMENTS, TEST CIRCUITS AND MANUFACTURER
DRAWINGS**

CTQC



No. L0681



(2006)国认监认字(080)号



2006000394Z



机检电(2004)07号

TEST REPORT

No:CTQC/B-07.644

Apparatus: POWER TRANSFORMER

Manufacturer: HANGZHOU QIANTANG RIVER ELECTRIC
GROUP CO., LTD.

Kind of testing: TRUST TESTING

CHINA NATIONAL TRANSFORMER QUALITY
SUPERVISION TESTING CENTER


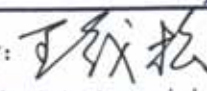
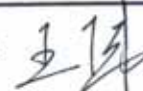


Test Report

No: CTQC/B-07.644

Total 50 Page 1

Test object name	Power transformer	Test object type	SSZ11-50000/110
		Brand	/
Entrusted by	HANGZHOU QIANTANG RIVER ELECTRIC GROUP CO., LTD.	Kind of testing	Trust testing
Manufacturer	HANGZHOU QIANTANG RIVER ELECTRIC GROUP CO., LTD.	Sampling date	Nov. 12, 2007
Address	Kanshan town, Xiaoshan District, Hangzhou City, Zhejiang Province, P.R. China	Serial No	0730780001
Standards	IEC60076-1:2000 IEC60076-2:1993 IEC60076-3:2000 IEC60076-5:2000 IEC60076-10:2001 Technical contract	Test items	Routine test, temp.-rise test, measurement of sound level, measurement of zero sequence impedance on three phase transformers, measurement of the harmonics of the no-load current, long-duration AC withstand voltage test, radio interference voltage measurement, short-circuit withstand test, lightning impulse test.
Results	The test results of routine test, temp.-rise test, measurement of sound level, measurement of zero sequence impedance on three phase transformers, measurement of the harmonics of the no-load current, long-duration AC withstand voltage test, radio interference voltage measurement, short-circuit withstand test, lightning impulse test of SSZ11-50000/110 are in accordance with standards and technical contract requirements. The sample passed the above tests.		
Note	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).

<h2 style="margin: 0;">Test Report</h2>	<p style="margin: 0;">China National Transformer Quality Supervision Testing Center</p>	<p style="margin: 0;">No: CTQC/B-07.644</p> <p style="margin: 0;">Total 50 Page 2</p>
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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 $\tan \delta$ (Routine test)	Providing insulation resistance, Providing absorption ratio(R_{60}/R_{15}) and $\tan \delta$	See 4.1	See 4.17.4.1	/
2	Measurement of voltage ratio and check of phase displacement (Routine test)	The tolerances of voltage ratio : $\pm 0.5\%$ Connection symbol: YNyn0d11	H.V.~L.V.: -0.04%~0.15% M.V.~L.V.: -0.06% YNyn0d11	H.V.~L.V.: -0.07%~0.20% M.V.~L.V.: -0.07%~-0.04% YNyn0d11	Passed
3	Measurement of winding resistance (Routine test)	Providing winding resistance (Ω)	See 4.3	See 4.17.4.3	/
4	Separate-source AC withstand voltage test (Routine test)	H.V. neutral: 140kV; 60s M.V. neutral: 85kV; 60s L.V.: 35kV; 60s	140kV; 60s 85kV; 60s 35kV; 60s	140kV; 60s 85kV; 60s 35kV; 60s	Passed
5	Long-duration AC withstand voltage test (Special test)	Phase to earth test			Passed
		$U_1=1.7U_m/\sqrt{3}$ (kV)	123.7		
		Duration (s): 120 (f_n/f)	40		
		$U_2=1.5U_m/\sqrt{3}$ (kV)	109.1		
		Duration(min): 30	30		
PD \leq (70) pC	<40				
$1.1U_m/\sqrt{3}$ (kV)	80				
Duration(min): 5	5				
PD \leq (70) pC	<30				
Frequency (Hz): >50	150				



<h2 style="margin: 0;">Test Report</h2>	<h3 style="margin: 0;">China National Transformer Quality Supervision Testing Center</h3>	No: CTQC/B-07.644 Total 50 Page 3
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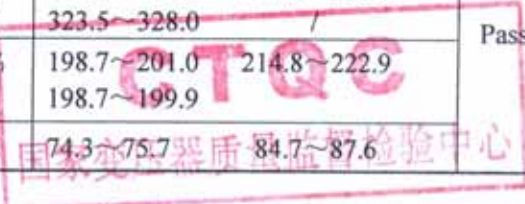
No	Test items	Specified values	Measured values		Conclusions
		Standards (Technical contract)	Before S.C.T.	After S.C.T.	
6	Short-duration AC withstand voltage test (Routine test)	A phase-to-earth test with single-phase supply			Passed
		U ₁ (kV): 200	200	200	
		Duration (s): 120 (f _n f)	40	40	
		U ₂ =1.5U _m /√3 (kV)	109.1	109.1	
		Duration(min): 5	5	5	
		PD ≤ (70) pC	<20	<30	
		1.1U _m /√3 (kV)	80	80	
		Duration(min): 5	5	5	
		PD ≤ (70) pC	<20	<20	
		Frequency (Hz): >50	150		
7	Measurement of no-load loss and current (Routine test)	A phase-to-phase test with three-phase supply			Passed
		U ₁ (kV): 200	200	200	
		Duration (s): 120 (f _n f)	40	40	
		U ₂ =1.3U _m (kV)	163.8	163.8	
		Duration(min): 5	5	5	
		PD ≤ (70) pC	<30	<30	
		1.1U _m (kV)	138.6	138.6	
		Duration(min): 5	5	5	
PD ≤ (70) pC	<30	<20			
Frequency (Hz): >50	150				
8	Measurement of short-circuit impedance and load loss (Routine test)	t: 75°C			Passed
		Z%:			
	H.V. ~L.V.: (17.5 -2.5%~+7.5%)	18.74	18.75		
	H.V. ~M.V.: (10.5 -2.5%~+7.5%)	10.44	10.46		
	M.V.~L.V.: (6.5 -2.5%~+7.5%)	6.73	6.76		
	H.V. ~M.V.:				
	P _k (kW): 212.50 +15%	203.51	202.36		
	P _a (kW): 255.22 +10%	233.62	232.20		



Test Report		China National Transformer Quality Supervision Testing Center		No: CTQC/B-07.644 Total 50 Page 4	
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): ≥ 40 tan δ (90°C): ≤ 0.01 Water dissolved in oil (mg/L): ≤ 20 Providing gas chromatography	64.20 0.0009 12.41 Providing gas chromatography	64.13 0.0010 12.46 Providing gas chromatography	Passed
10	Leakage test (Routine test)	Applied pressure (kPa): 50 Duration (h): 36 No leakage and damage	50 36 No leakage and damage		Passed
11	Test on on-load tap-changers (Routine test)	According to Clause 10.8 of GB1094.1-1996	Comply with standard	Comply with standard	Passed
12	Temp.-rise test (Type test)	Temp.-rise limit (K): Top oil: (52) Winding: (62)	Top oil: 50.6 H.V.: 51.6 M.V.: 56.7 L.V.: 44.3		Passed
13	Measurement of sound level (Special test)	Sound level \overline{L}_{PA} (dB): (≤ 58) Sound power level $L_{WA,SN}$ dB(A): ≤ 86	57 77	CTQC 国家变压器质量监督检验中心	Passed
14	Measurement of the harmonics of the no-load current (Special test)	Providing no-load current harmonic values of each phase	I_1 - I_{19} no-load current harmonic values of each phase		/
15	Measurement of zero sequence impedance on three phase transformers (Special test)	Providing zero sequence impedance value (Ω)	See 4.15		/
16	Radio interference voltage measurement (Special test)	Measured voltage(kV): 138.6 Radio interference level(μ V): (≤ 1000)	138.6 A: 841.4 B: 177.8 C: 841.4		Passed

Test Report	China National Transformer Quality Supervision Testing Center	No: CTQC/B-07.644 Total 50 Page 5
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No	Test items	Specified values	Measured values		Conclusions																																												
		Standards (Technical contract)																																															
17	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.: 0.52% H.V.-L.V.: 0.81%	No apparent defects	Passed																																									
18	Lightning impulse test (Routine test, type test)	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="text-align: center;">Full wave</th> <th style="text-align: center;">Chopped wave</th> <th></th> <th style="text-align: center;">Full wave</th> <th style="text-align: center;">Chopped wave</th> </tr> </thead> <tbody> <tr> <td>H.V. (kV):</td> <td style="text-align: center;">480</td> <td style="text-align: center;">530 $\pm 3\%$</td> <td></td> <td style="text-align: center;">477.4~487.2</td> <td style="text-align: center;">531.8~538.3</td> </tr> <tr> <td>O (kV):</td> <td style="text-align: center;">325</td> <td style="text-align: center;">/ $\pm 3\%$</td> <td></td> <td style="text-align: center;">323.5~328.0</td> <td style="text-align: center;">/</td> </tr> <tr> <td>M.V. (kV):</td> <td style="text-align: center;">200</td> <td style="text-align: center;">220 $\pm 3\%$</td> <td></td> <td style="text-align: center;">198.7~201.0</td> <td style="text-align: center;">214.8~222.9</td> </tr> <tr> <td>O (kV):</td> <td style="text-align: center;">200</td> <td style="text-align: center;">/ $\pm 3\%$</td> <td></td> <td style="text-align: center;">198.7~199.9</td> <td style="text-align: center;">/</td> </tr> <tr> <td>L.V. (kV):</td> <td style="text-align: center;">75</td> <td style="text-align: center;">85 $\pm 3\%$</td> <td></td> <td style="text-align: center;">74.3~75.7</td> <td style="text-align: center;">84.7~87.6</td> </tr> </tbody> </table>		Full wave	Chopped wave		Full wave	Chopped wave	H.V. (kV):	480	530 $\pm 3\%$		477.4~487.2	531.8~538.3	O (kV):	325	/ $\pm 3\%$		323.5~328.0	/	M.V. (kV):	200	220 $\pm 3\%$		198.7~201.0	214.8~222.9	O (kV):	200	/ $\pm 3\%$		198.7~199.9	/	L.V. (kV):	75	85 $\pm 3\%$		74.3~75.7	84.7~87.6	477.4~487.2	531.8~538.3	323.5~328.0	/	198.7~201.0	214.8~222.9	198.7~199.9	/	74.3~75.7	84.7~87.6	Passed
	Full wave	Chopped wave		Full wave	Chopped wave																																												
H.V. (kV):	480	530 $\pm 3\%$		477.4~487.2	531.8~538.3																																												
O (kV):	325	/ $\pm 3\%$		323.5~328.0	/																																												
M.V. (kV):	200	220 $\pm 3\%$		198.7~201.0	214.8~222.9																																												
O (kV):	200	/ $\pm 3\%$		198.7~199.9	/																																												
L.V. (kV):	75	85 $\pm 3\%$		74.3~75.7	84.7~87.6																																												



- Annex 1: Rating plate and outline photo (1 page totally)
- Annex 2: Test circuits (9 pages totally)
- Annex 3: Transformer drawings (10 pages totally)
- № 1 Name plate 8QB.868.3078
- № 2 Outline dimensions 1QB.710.3078
- № 3 Transportation Drawing 1QB.710.3078YS
- № 4 H.V. winding 6QB.600.3078.1
- № 5 M.V. winding 6QB.600.3078.2
- № 6 L.V. winding 6QB.600.3078.3
- № 7 H.V. & M.V. tapping windings 6QB.600.3078.4
- № 8 H.V. lead 5QB.516.3078.1
- № 9 M.V. & L.V. lead 5QB.516.3078.2
- № 10 Core assembly 5QB.640.3078MX
- Annex 4: List of instruments and meters used (7 pages totally)

Test Report	China National Transformer Quality Supervision Testing Center	№: CTQC/B-07.644 Total 50 Page 6
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1. Test object parameters

Rated power: 50000 kVA

Rated voltage: 110/38.5/11 kV

Rated current: 262.4/749.83/2624.4 A

Rated frequency: 50 Hz

Number of phases: 3

Tap range: $(110 \pm 8 \times 1.25\%) / (38.5 \pm 2 \times 2.5\%) / 11$ kV

Connection symbol: YNyn0d11

Cooling method: ONAN

Temperature class of insulation: A

Insulation level: h.v. line terminal	LI/AC	480/200 kV
h.v. neutral	LI/AC	325/140 kV
m.v line terminal	LI/AC	200/85 kV
l.v. line terminal	LI/AC	75/35kV

CTQC

国家变压器质量监督检验中心

2. Sample condition description

- (1) Sample exterior construction and major dimensions(length, width, height) are in compliance with drawing. Measured values: length is 7749mm, width is 5132mm, height is 5742mm.
- (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》

IEC60076-2:1993 《Power transformers Part2: Temperature rise》

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》

IEC60076-10:2001 《Power transformers Part10: Determination of sound levels》

Technical contract

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4.2 Measurement of voltage ratio and check of phase displacement (Routine test)
Test date: Nov. 12, 2007

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	121.000	/	11	11.000	0.05	0.07	0.23	YNd11
2	119.625			10.875	-0.04	-0.02	0.15	
3	118.250			10.750	0.03	0.04	0.22	
4	116.875			10.625	-0.06	-0.05	0.13	
5	115.500			10.500	0.01	0.02	0.20	
6	114.125			10.375	-0.09	-0.07	0.11	
7	112.750			10.250	-0.01	0.00	0.17	
8	111.375			10.125	-0.11	-0.10	0.08	
9a, 9b, 9c	110.000			10.000	-0.04	-0.03	0.15	
10	108.625			9.875	-0.14	-0.13	0.06	
11	107.250			9.750	-0.06	-0.05	0.14	
12	105.875			9.625	-0.16	-0.15	0.04	
13	104.500			9.500	-0.09	-0.08	0.11	
14	103.125			9.375	-0.20	-0.18	0.01	
15	101.750			9.250	-0.12	-0.11	0.09	
16	100.375			9.125	-0.22	-0.21	-0.01	
17	99.000			9.000	-0.15	-0.13	0.07	
M.V.		L.V.		Ratio	Measured deviation (%)			Conne- tion symbol
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AmBm/ab	BmCm/ bc	CmAm/ca	
1	40.425	/	11	3.675	-0.25	-0.25	-0.24	ynd11
2	39.463			3.588	-0.16	-0.16	-0.15	
3	38.500			3.500	-0.06	-0.06	-0.06	
4	37.538			3.413	0.04	0.04	0.04	
5	36.575			3.325	0.14	0.14	0.14	



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4.3 Measurement of winding resistance (Routine test) Test date: Nov.12,2007					Oil temperature: 14.0°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	0.3920	0.3928	0.3950	0.76
	2	0.3845	0.3855	0.3870	0.65
	3	0.3781	0.3786	0.3804	0.61
	4	0.3706	0.3709	0.3727	0.57
	5	0.3653	0.3647	0.3662	0.41
	6	0.3564	0.3572	0.3586	0.62
	7	0.3503	0.3503	0.3521	0.51
	8	0.3424	0.3432	0.3449	0.73
	9a, 9b, 9c	0.3347	0.3349	0.3360	0.39
	10	0.3453	0.3443	0.3453	0.29
	11	0.3516	0.3504	0.3520	0.46
	12	0.3588	0.3579	0.3594	0.42
	13	0.3659	0.3648	0.3663	0.41
	14	0.3725	0.3725	0.3737	0.32
	15	0.3794	0.3790	0.3805	0.40
	16	0.3865	0.3867	0.3884	0.49
	17	0.3939	0.3935	0.3955	0.51
M.V.	1	0.05061	0.05073	0.05115	1.06
	2	0.04879	0.04892	0.04930	1.04
	3	0.04671	0.04669	0.04690	0.45
	4	0.04881	0.04899	0.04938	1.16
	5	0.05081	0.05094	0.05131	0.98
L.V.	/	0.005825	0.005829	0.005866	0.70

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4.4 Separate-source AC withstand voltage test (Routine test) Test date: Nov. 13, 2007

Test circuit is given in Annex2-a

Humidity: 60%; Ambient temperature: 15.0°C; Oil temperature: 15.0°C; Atmospheric pressure: 101.6kPa

Position	Applied voltage (kV)	Duration (s)	Results
H.V.neutral—M.V.、L.V.&E	140	60	Passed
M.V.neutral—H.V.、L.V.&E	85	60	
L.V.—H.V. M.V &E	35	60	

4.5 Long-duration AC withstand voltage test (ACLD) (Special test) Test date: Nov. 18,2007

Phase to earth test ,Tap position 9b, Frequency 150Hz.

Induced voltage		Duration	Partial discharge levels (pC)		
Multiple	Phase-to-earth (kV)		A	B	C
$1.1U_m/\sqrt{3}$	80	5 min	/	/	/
$U_2=1.5U_m/\sqrt{3}$	109.1	5 min	/	/	/
$U_1=1.7U_m/\sqrt{3}$	123.7	40s	/	/	/
$U_2=1.5U_m/\sqrt{3}$	109.1	5 min	<20	<30	<40
		10 min	<20	<30	<30
		15 min	<30	<30	<30
		20 min	<20	<30	<30
		25 min	<20	<30	<30
		30 min	<20	<30	<30
$1.1U_m/\sqrt{3}$	80	5 min	<30	<30	<30



Note: $U_m=126kV$

Background noise level is 10pC before and after test.

Start voltage:80.0kV Extinction voltage:72.7kV.

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4.6 Short-duration AC withstand voltage test(Routine test) Test date: Nov.13,2007

Test circuit is given in Annex2-b

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

Tap position 5. Frequency 150Hz.

Induced voltage		Duration	Partial discharge levels (pC)		
Multiple	Phase-to-earth (kV)		A	B	C
$1.1U_m/\sqrt{3}$	80	5 min	/	/	/
$U_2=1.5U_m/\sqrt{3}$	109.1	5 min	/	/	/
U_1	200	40s	/	/	/
$U_2=1.5U_m/\sqrt{3}$	109.1	5 min	<20	<20	<20
$1.1U_m/\sqrt{3}$	80	5 min	<20	<20	<20

Note: $U_m=126kV$

Background noise level is 10pC before and after test.

Start voltage:80.0kV Extinction voltage:72.7kV

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

Tap position 9b, Frequency 150Hz.

Induced voltage		Duration	Partial discharge levels (pC)		
Multiple	Phase-to-phase (kV)		A	B	C
$1.1U_m$	138.6	5 min	/	/	/
$U_2=1.3U_m$	163.8	5 min	/	/	/
U_1	200	40s	/	/	/
$U_2=1.3U_m$	163.8	5 min	<30	<30	<30
$1.1U_m$	138.6	5 min	<30	<30	<30

Note: $U_m=126kV$ Background noise level is 10pC before and after test.

Start voltage:138.6kV Extinction voltage:126kV

4.7 Measurement of no-load loss and current(Routine test) Test date: Nov.13,2007

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
11	11	1.94	0.07	30.11	30.11

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

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4.8 Measurement of short-circuit impedance and load loss (Routine test) Test date: Nov. 13, 2007
Test circuit is given in Annex2-d

Oil temperature: 15.0°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	122.4	51.3	12.011	56.66	19.35	206.18	236.29
	9b	134.8	51.4	10.591	45.35	18.74	199.80	229.91
	17	147.0	50.4	9.220	36.20	18.47	232.27	262.38
H.V. M.V. (Tap1)	1	125.2	52.5	6.227	28.73	9.81	200.01	230.12
	9b	133.1	50.7	5.262	22.82	9.43	198.14	228.25
	17	150.8	51.7	4.820	18.45	9.41	235.90	266.01
H.V. M.V. (Tap3)	1	120.0	50.3	6.713	32.30	11.03	207.97	238.08
	9b	132.5	50.5	5.798	25.26	10.44	203.51	233.62
	17	147.9	50.7	5.109	19.94	10.17	238.23	298.45
H.V. M.V. (Tap5)	1	120.7	50.6	7.789	37.26	12.72	241.07	271.18
	9b	134.9	51.4	6.738	28.85	11.92	233.51	263.62
	17	146.3	50.2	5.647	22.29	11.37	264.32	294.43
M.V. L.V.	1	390.4	54.7	1.533	2.27	6.94	184.19	214.30
	3	382.0	50.9	1.321	2.00	6.73	181.97	212.08
	5	422.3	53.5	1.345	1.84	6.87	202.60	232.71

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4.9 Test on transformer oil (Routine test) Test date: Nov. 14,2007							
tan δ (90°C)		Breakdown voltage (kV)			Water dissolved in oil (mg/L)		
0.0009		64.20			12.41		
Gas chromatography (before all the tests) Test date: Nov. 14,2007 μ L/L							
H ₂	CO	CO ₂	CH ₄	C ₂ H ₆	C ₂ H ₄	C ₂ H ₂	Hydro carbon
0	22.19	190.6	1.01	0	0	0	1.01
Gas chromatography(after insulation tests, before temp.-rise test) Test date: Nov.16, 2007 μ L/L							
H ₂	CO	CO ₂	CH ₄	C ₂ H ₆	C ₂ H ₄	C ₂ H ₂	Hydro carbon
0	25.81	217.2	1.26	0	0	0	1.26
Gas chromatography (after temp.-rise test, after all the tests) Test date: Nov. 23,2007 μ /L							
H ₂	CO	CO ₂	CH ₄	C ₂ H ₆	C ₂ H ₄	C ₂ H ₂	Hydro carbon
0	37.86	245.18	1.88	0	0.1	0	1.98
4.10 Leakage test (Routine test) Test date: Oct.27, 2007							
Test method	Applied pressure (kPa)	Duration (h)	Residual pressure (kPa)	Result			
Atmospheric pressure	50	36	49	No leakage and damage			
4.11 Test on on-load tap-changers (Routine test) Test date: Nov. 16, 2007							
Operation test:							
a. 8 complete operating cycles with the transformer not energized;							
b. 1 complete operate cycle with the transformer is not energized, with 85% of the rated operation voltage;							
c. 1 complete operating cycle with the transformer is energized at rated voltage and rated frequency at no-load;							
d. 10 tap-change operations with ± 2 steps on either side of the principal tap at rated current.							
Auxiliary circuits dielectric test:							
2kV (RMS) 1 min separate-source voltage withstand test. passed.							

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4.12 Temperature-rise test (Type test) Test date: Nov.23,2007

Measure top oil temp.-rise:

The test is conducted by means of short-circuit method, supply power on H.V.(Tap 17), M.V.(Tap 5) is short-circuit, L.V. is open circuit, the test duration is 13h, stability duration is 4h. Specified total loss is 294.43kW, injected total loss of 278.53kW during test.

Measure H.V. , M.V. winding temp.-rise:

Supply specified current is 291.6A, injected current of 291.6 to H.V. winding on during test.

Measure L.V. winding temp.-rise:

Supply power on H.V.winding, L.V. is short-circuit, M.V. is open circuit, the test duration is 1h, supply specified current is 291.6A , injected current of 291.6A.

Measured values

Win- ding	Temperature of top oil (°C)		Temperature of bottom oil (°C)		Average temperature of oil (°C)		Ambient temperature (°C)		Measurement of Resistance (Ω) ×10 ⁻³	
	Total losses	Measured current	Total losses	Measured current	Total losses	Measured current	Total losses	Cold R	Hot R	Cold R
H.V.		64.5		37.2		50.9			485.8	393.5
M.V.	64.7	64.5	37.4	37.2	51.1	50.9	22.5	14.0	63.93	50.94
L.V.		59.9		35.4		47.7			7.016	5.825

Conclusions of temperature-rise

Top oil temp. -rise (K)	50.6	
Winding temp.-rise (K)	H.V.	51.6
	M.V.	56.7
	L.V.	44.3
Tank surface hot spot tem (K)	49.7	

Note: The results of top oil temperature rise calculation is the corrected values under total losses.

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4. Test items and conclusions:

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

Test date: Nov. 12, 2007

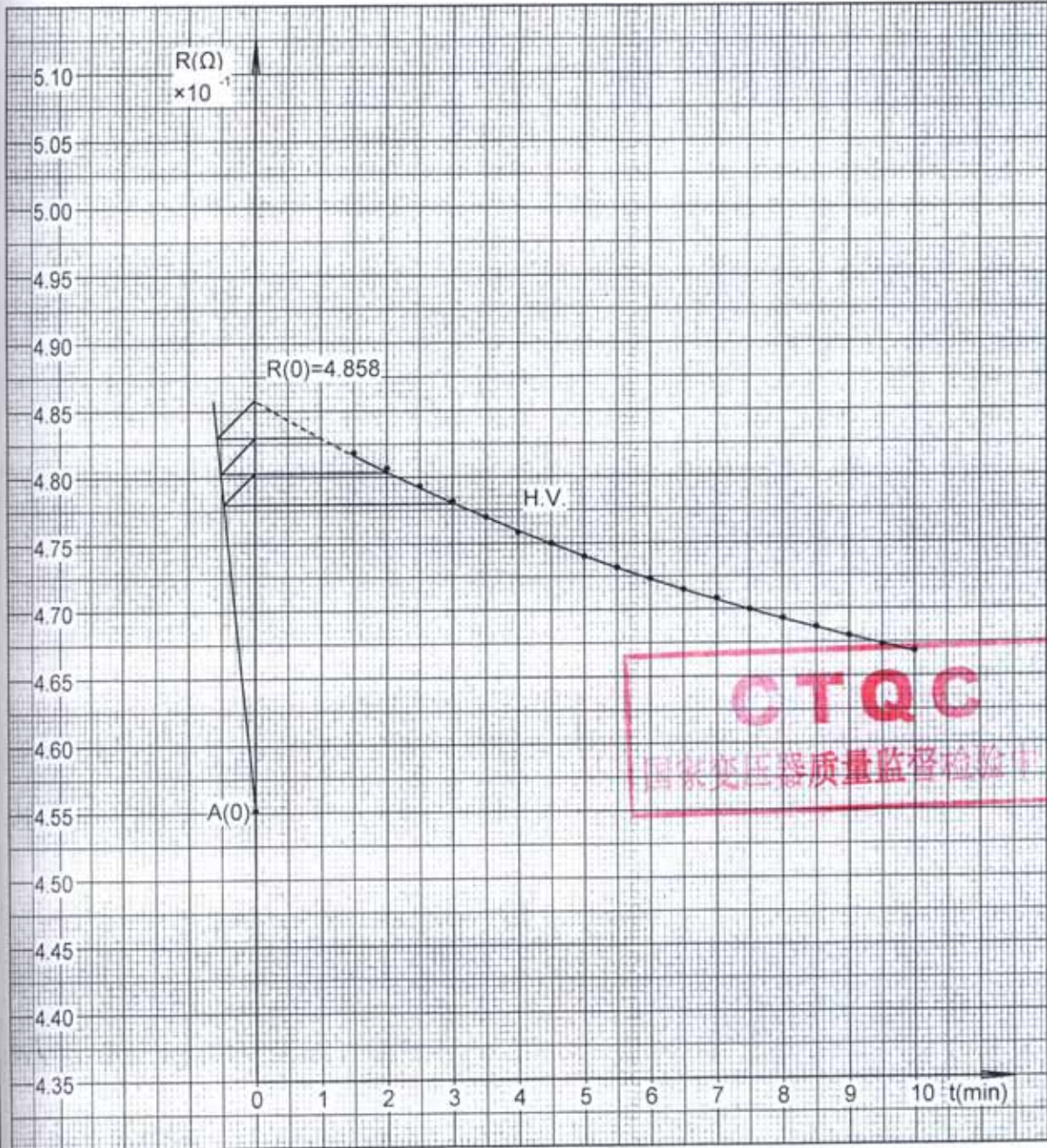
Humidity: 35%; Oil temperature: 14.0°C

Measurement position	Insulation resistance (GΩ)			R ₆₀ /R ₁₅	R ₆₀₀ /R ₆₀	tan δ
	R ₆₀₀	R ₆₀	R ₁₅			
H.V.—M.V.、L.V.&E	50.7	21	18.7	1.12	2.41	0.0022
M.V.—H.V.、L.V.&E	/	15.4	9.65	1.60	/	0.0022
L.V.—H.V.、M.V.&E	/	17.6	10.4	1.69	/	0.0021
H.V.、M.V.—L.V.、E	/	23.7	13.6	1.74	/	0.0022
H.V.、M.V.、L.V.—E	/	27.2	22.5	1.21	/	0.0022
Core—E	/	19.3	/	/	/	/
Clamp—E	/	13.8	/	/	/	/



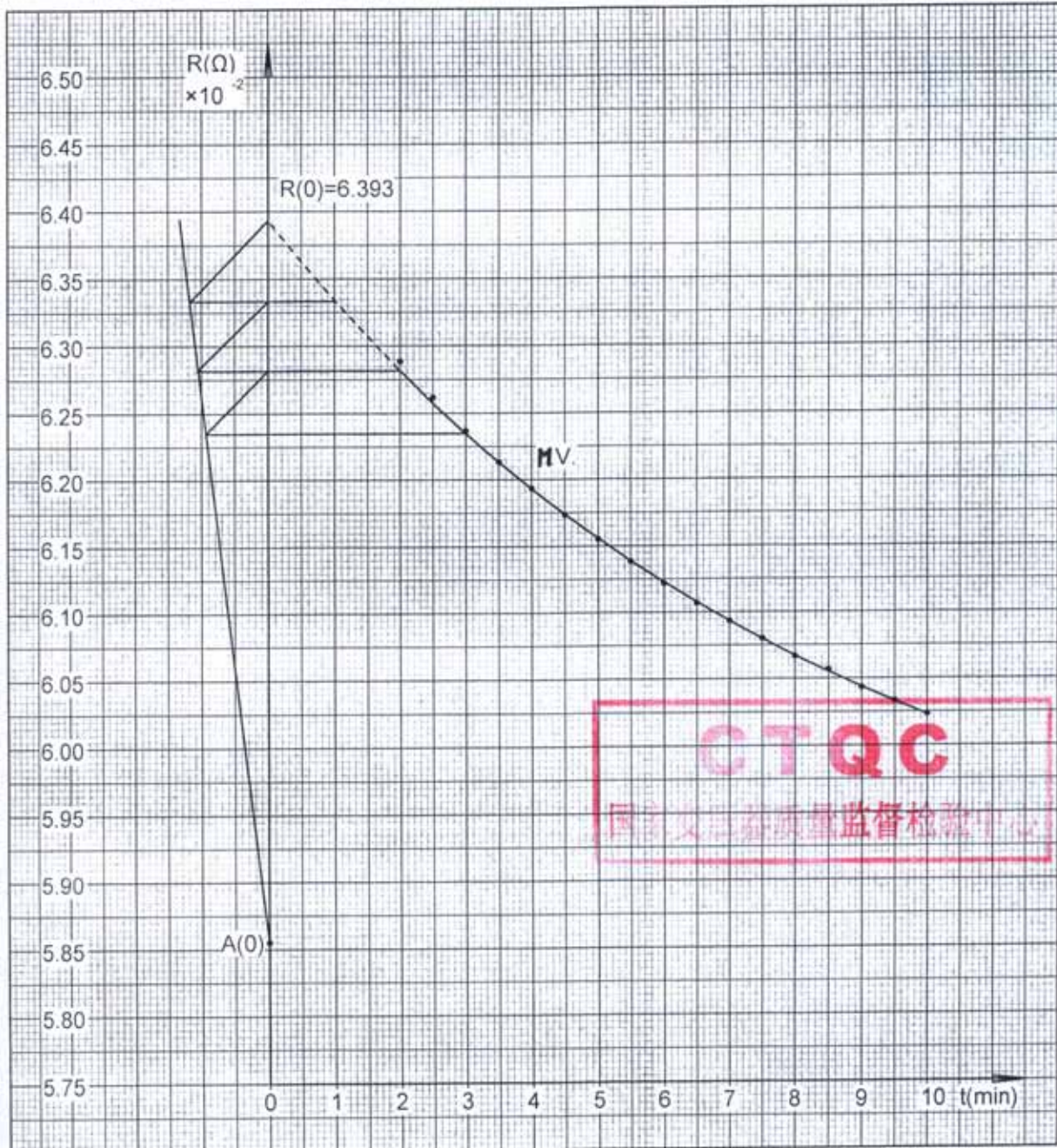
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Hot resistance curve



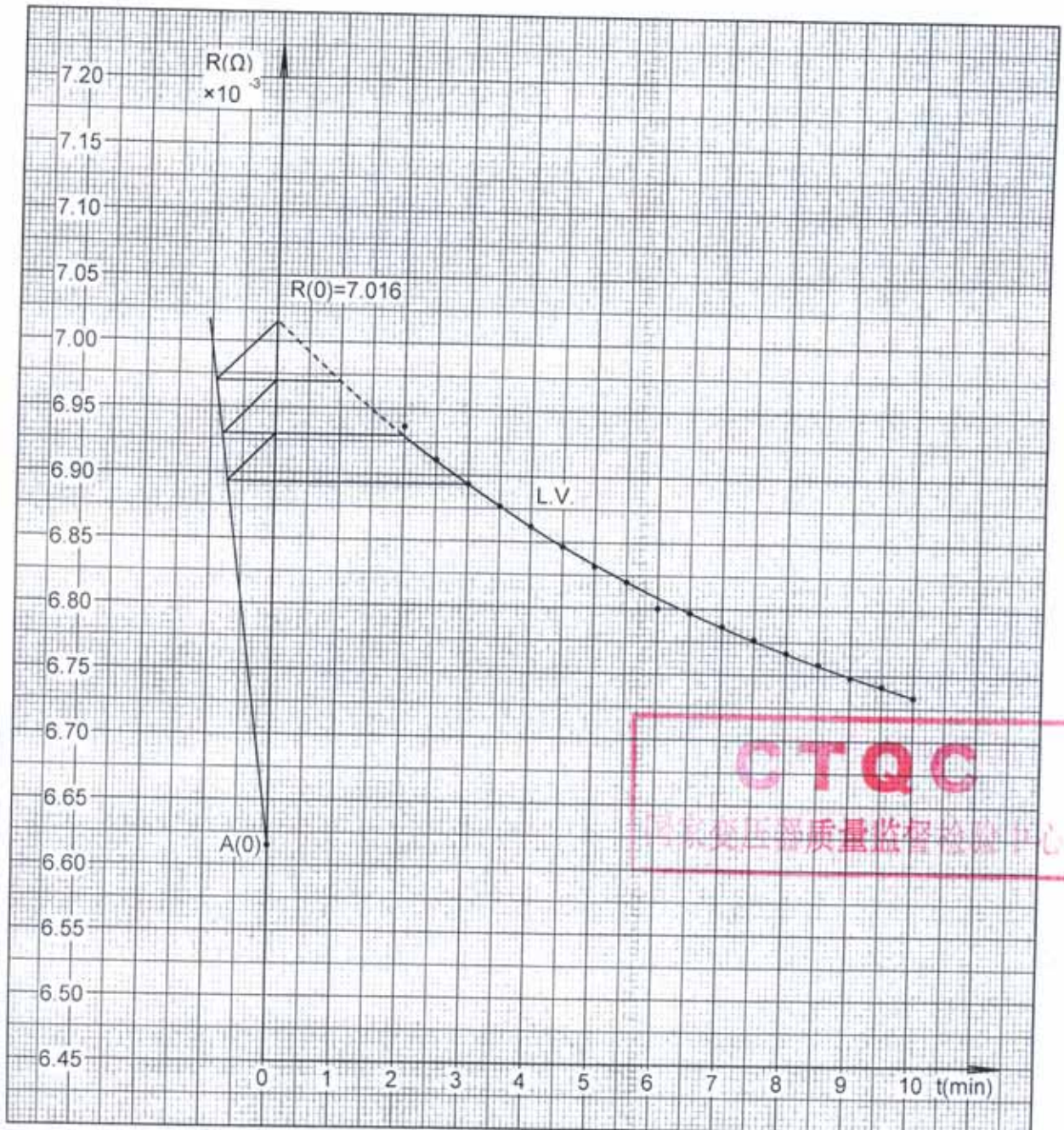
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Hot resistance curve



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Hot resistance curve



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4.13 Measurement of sound level(Special test) Test date: Nov.23,2007
 4.13.1 Sound power level calculation under on load current:

Calculation equation: $L_{WA,IN} \approx 39 + 18 \lg \frac{S_r}{S_p} = 73 \text{dB (A)}$

In which: S_r —Rated power 75MVA;

S_p —Reference power 1MVA.

$L_{WA,IN}$ 73dB (A), is 13dB lower than guaranteed sound power level limited of 86dB (A), so on load current sound level measurements are not appropriate.

4.13.2 Sound pressure level measurement and sound power level calculation

Transformer is energized under rated voltage, the outline is 0.3m away from the principal radiating surface, there are 24 measurement points, the measurement point interval is 0.92m. The height of oil tank is 3.6m, the height of measurement points are 1.2m and 2.4m.

Environmental conditions

Area of the surface of the test room S_v (m ²)	Mean sound absorption coefficient α	Sound absorption A (m ²)	d (m)	Area of effective surface S (m ²)	Environmental correction factor K (dB)
2300	0.15	345	0.3	99	3.3

d—Distance between specified contour and principal radiating surface.

Test results dB (A)

Cooling method	The average noise level of background		The average noise level of transformer $\overline{L_{PAO}}$	A-weighted surface sound pressure level $L_{PA} = 10 \lg(10^{0.1L_{PA0}} - 10^{0.1L_{bgA}}) - K$	A-weighted sound power level $L_{WA,IN} = L_{PA} + 10 \lg(S/S_0)$
	Before	After			
ONAN	45.9	44.3	60.4	57	77

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

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

In according to 4.13.1, $L_{WA,SN} = 77 \text{dB}$.

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4.14 Measurement of the harmonics of the no-load current (Special test) Test date: Nov.23, 2007
 Test circuit is given in Annex2-e

CH--Ua				CH--Ub				CH--Uc			
No.	Un (%)	Un (kV)	PHASE	No.	Un (%)	Un (kV)	PHASE	No.	Un (%)	Un (kV)	PHASE
01	100.0	6.414	359	01	100.0	6.333	119	01	100.0	6.346	239
02	0.110	0.007	057	02	0.121	0.008	166	02	0.122	0.008	340
03	0.802	0.051	297	03	0.177	0.011	140	03	0.429	0.027	016
04	0.050	0.003	268	04	0.046	0.003	169	04	0.098	0.006	179
05	0.864	0.055	030	05	1.004	0.064	288	05	1.298	0.082	149
06	0.057	0.004	008	06	0.078	0.005	197	06	0.055	0.003	122
07	1.003	0.064	013	07	0.792	0.050	122	07	1.021	0.065	234
08	0.074	0.005	074	08	0.061	0.004	212	08	0.049	0.003	272
09	0.149	0.010	028	09	0.223	0.014	187	09	0.131	0.008	289
10	0.055	0.004	037	10	0.044	0.003	207	10	0.039	0.002	132
11	0.035	0.002	035	11	0.174	0.011	114	11	0.114	0.007	252
12	0.046	0.003	273	12	0.055	0.004	078	12	0.053	0.003	056
13	0.103	0.007	117	13	0.089	0.006	228	13	0.172	0.011	334
14	0.048	0.003	198	14	0.050	0.003	299	14	0.037	0.002	157
15	0.051	0.003	087	15	0.052	0.003	044	15	0.055	0.003	115
16	0.054	0.003	190	16	0.040	0.003	289	16	0.048	0.003	003
17	0.063	0.004	017	17	0.089	0.006	339	17	0.045	0.003	185
18	0.045	0.003	197	18	0.042	0.003	080	18	0.052	0.003	217
19	0.110	0.007	274	19	0.042	0.003	234	19	0.072	0.005	144
UT	1.610	0.103	000	UT	1.386	0.088	000	UT	1.767	0.112	000

CH--Ia				CH--Ib				CH--Ic			
No.	In (%)	In (A)	PHASE	No.	In (%)	In (A)	PHASE	No.	In (%)	In (A)	PHASE
01	100.0	1.591	344	01	100.0	1.627	075	01	100.0	2.255	210
02	2.332	0.037	008	02	2.639	0.043	247	02	1.735	0.039	121
03	25.28	0.402	022	03	20.03	0.326	233	03	9.046	0.204	148
04	1.781	0.028	010	04	1.727	0.028	121	04	1.394	0.031	244
05	26.48	0.421	091	05	22.54	0.367	358	05	24.07	0.543	229
06	0.151	0.002	037	06	0.264	0.004	213	06	0.097	0.002	027
07	15.56	0.248	105	07	12.18	0.198	208	07	12.46	0.281	328
08	0.640	0.010	182	08	0.665	0.011	046	08	0.385	0.009	291
09	2.359	0.038	133	09	2.624	0.043	300	09	0.488	0.011	064
10	0.326	0.005	145	10	0.266	0.004	288	10	0.170	0.004	033
11	1.456	0.023	254	11	3.108	0.051	143	11	2.113	0.048	350
12	0.085	0.001	023	12	0.064	0.001	134	12	0.050	0.001	269
13	1.473	0.023	218	13	1.060	0.017	314	13	1.219	0.028	076
14	0.109	0.002	315	14	0.073	0.001	150	14	0.035	0.001	121
15	0.347	0.006	166	15	0.308	0.005	017	15	0.143	0.003	289
16	0.069	0.001	253	16	0.083	0.001	049	16	0.023	0.001	215
17	0.144	0.002	346	17	0.218	0.004	119	17	0.116	0.003	257
18	0.079	0.001	126	18	0.046	0.001	295	18	0.046	0.001	251
19	0.601	0.010	359	19	0.165	0.003	118	19	0.369	0.008	202
IT	40.05	0.637	000	IT	32.99	0.537	000	IT	28.79	0.649	000

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

Test date: Nov.20, 2007

Test circuit is given in Annex2-f

Connection group	Applied voltage terminal	Open circuit terminal	Short circuit terminal	Applied current (A)	Measured voltage (V)	Impedance (Ω)
YNyn0d11	A,B,C-O	Am,Bm,Cm,Om a,b,c	/	133.20	1673.96	37.70
		a,b,c	Am,Bm,Cm,Om	129.47	972.85	22.54
	Am,Bm,Cm-Om	A,B,C,O a,b,c	/	290.26	178.47	1.84
		a,b,c	A,B,C,O	324.50	119.38	1.10

4.16 Radio interference voltage measurement (Special test) Test date: Nov.23,2007

Measured frequency (MHz)	Measured terminal	Attenuation factor of resistance network B_R (dB)	Attenuation factor of measurement circuit B_C (dB)	Measured circuit Radio interference level B_m (dB)	Applied voltage(kV)	Sample Radio interference level $B=B_m+B_C+B_R$ (μV)
1.2	A	22	18.0	18.5	138.6	841.4
	B		18.0	5.0	138.6	177.8
	C		17.5	19.0	138.6	841.4

No apparent discharge.



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4.17 Short-circuit withstand test (Special test) Test date: Nov.15,2007

4.17.1 H.V. — M.V.

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

Tap position		Peak value (A)	Symmetrical value (A)	Multiple ($K\sqrt{2}$)
H.V.	M.V.			
1	5	4616	1810	2.550
9b	3	6087	2387	2.550
17	1	7364	2888	2.550

4.17.1.2 Measurement of short-circuit current

Test circuit is given in Annex2-g

Perform single-phase test, Voltage is applied between one line terminal and the other two line terminal connected together, supply power on H.V. winding, M.V. is short-circuit, L.V. is open circuit, 9 times, 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)	(%)		
H.V.	A-BC	No1	4675	101.3	1741	96.2	0.24	B07644-S04-1
		No2	4725	102.4	1741	96.2	0.24	B07644-S04-2
		No3	4735	102.6	1741	96.2	0.24	B07644-S04-3
(1)	A-BC	Degree	Single-phase reactance value (Ω)			Deviation (%)		
			A	B	C	A	B	C
(5)	A-BC	before test	36.50	37.82	36.37	/	/	/
		No1	36.46	37.82	36.22	-0.11	<0.1	-0.41
		No2	36.41	37.83	36.25	-0.25	<0.1	-0.33
		No3	36.40	37.84	36.27	-0.27	<0.1	-0.28



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Tap position	Apply current terminal	Degree	Current measured					Duration (s)	Wave serial No
			Peak value (A)		Symmetrical value (A)				
			(A)	(%)	(A)	(%)			
H.V. (9b) M.V. (3)	B-AC	No1	5855	96.2	2229	93.4	0.24	B07644-S05-1	
		No2	5915	97.2	2229	93.4	0.24	B07644-S05-2	
		No3	5885	96.7	2229	93.4	0.24	B07644-S05-3	
		Degree	Reactance measured						
			Single-phase reactance value (Ω)			Deviation (%)			
			A	B	C	A	B	C	
		before test	24.97	25.46	24.89	/	/	/	
		No1	25.00	25.47	24.80	0.12	<0.1	-0.36	
		No2	25.00	25.48	24.77	0.12	<0.1	-0.48	
		No3	25.00	25.48	24.76	0.12	<0.1	-0.52	

Tap position	Apply current terminal	Degree	Current measured					Duration (s)	Wave serial No
			Peak value (A)		Symmetrical value (A)				
			(A)	(%)	(A)	(%)			
H.V. (17) M.V. (1)	C-AB	No1	7155	97.2	2720	94.2	0.24	B07644-S06-1	
		No2	7235	98.2	2720	94.2	0.24	B07644-S06-2	
		No3	7255	98.5	2720	94.2	0.24	B07644-S06-3	
		Degree	Reactance measured						
			Single-phase reactance value (Ω)			Deviation (%)			
			A	B	C	A	B	C	
		before test	18.31	18.55	18.25	/	/	/	
		No1	18.33	18.56	18.23	0.11	<0.1	-0.11	
		No2	18.34	18.57	18.21	0.16	0.11	-0.22	
		No3	18.34	18.57	18.21	0.16	0.11	-0.22	

The maximum deviation of short-circuit reactance is 0.52%.

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4.17.2 H.V. -L.V.

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

Tap position	Peak value (A)	Symmetrical value (A)	Multiple ($K\sqrt{2}$)
1	3070	1204	2.550
9b	3468	1360	2.550
17	3881	1522	2.550

4.17.2.2 Measurement of short-circuit current

Test circuit is given in Annex2-h

Perform single-phase test, Voltage is applied between one line terminal and the other two line terminal connected together, supply power on H.V. winding, L.V. is short-circuit, M.V. is open circuit, 9 times, Test waveshapes have no distortion, Test oscillograms are shown in Page 46-48.

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	A-BC	No1	3055	99.5	1130	93.9	0.24	B07644-S01-1		
		No2	3065	99.8	1130	93.9	0.24	B07644-S01-2		
		No3	3105	101.1	1130	93.9	0.24	B07644-S01-3		
		Degree	Reactance measured							
			Single-phase reactance value (Ω)			Deviation (%)				
					A	B	C	A	B	C
				before test	55.54	57.14	55.55	/	/	/
				No1	55.67	57.08	55.65	0.23	-0.11	0.18
				No2	55.65	57.09	55.63	0.20	<0.1	0.14
				No3	55.64	57.10	55.64	0.18	<0.1	0.16

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Tap position	Apply current terminal	Degree	Current measured					Duration (s)	Wave serial No
			Peak value (A)		Symmetrical value (A)				
			(A)	(%)	(A)	(%)			
9b	B-AC	No1	3445	99.3	1290	94.9	0.24	B07644-S02-1	
		No2	3445	99.3	1290	94.9	0.24	B07644-S02-2	
		No3	3435	99.0	1290	94.9	0.24	B07644-S02-3	
		Degree	Reactance measured						
			Single-phase reactance value (Ω)			Deviation (%)			
				A	B	C	A	B	C
		before test		44.60	45.64	44.62	/	/	/
		No1		44.70	45.61	44.68	0.22	<0.1	0.13
		No2		44.68	45.62	44.70	0.18	<0.1	0.18
		No3		44.68	45.62	44.68	0.18	<0.1	0.13

Tap position	Apply current terminal	Degree	Current measured					Duration (s)	Wave serial No
			Peak value (A)		Symmetrical value (A)				
			(A)	(%)	(A)	(%)			
17	C-AB	No1	4005	103.2	1459	95.9	0.24	B07644-S03-1	
		No2	4005	103.2	1459	95.9	0.24	B07644-S03-2	
		No3	4005	104.2	1459	95.9	0.24	B07644-S03-3	
		Degree	Reactance measured						
			Single-phase reactance value (Ω)			Deviation (%)			
				A	B	C	A	B	C
		before test		35.67	36.31	35.70	/	/	/
		No1		35.78	36.32	35.73	0.31	<0.1	<0.1
		No2		35.74	36.37	35.54	0.20	0.17	-0.45
		No3		35.77	36.33	35.41	0.28	<0.1	0.81

The maximum deviation of short-circuit reactance is 0.81%.

4.17.3 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 49~50 .

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4.17.4 Repeated routine tests after short-circuit withstand test

4.17.4.1 Measurement of insulation resistance and $\tan\delta$ Test date: Nov.16,2007

Humidity: 40%; Oil temperature: 8.0°C

Measurement position	Insulation resistance (G Ω)			R ₆₀ /R ₁₅	R ₆₀₀ /R ₆₀	tan δ
	R ₆₀₀	R ₆₀	R ₁₅			
H.V.—M.V.、L.V.&E	60.8	34.5	30.8	1.12	1.76	0.0026
M.V.—H.V.、L.V.&E	58.3	32.0	30.3	1.06	1.82	0.0023
L.V.—H.V.、M.V.&E	/	30.1	18.5	1.63	/	0.0024
H.V.、M.V.—L.V.、E	/	43.8	32.2	1.36	/	0.0022
H.V.、M.V.、L.V.—E	/	40.7	35.1	1.16	/	0.0023
Core—E	/	23.0	/	/	/	/
Clamp—E	/	21.3	/	/	/	/



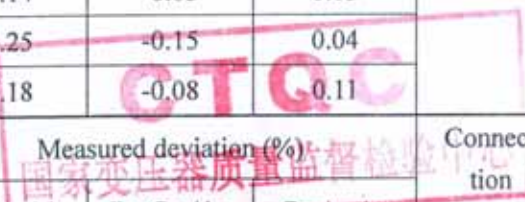
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4.17.4.2 Measurement of voltage ratio and check of phase displacement Test date: Nov. 16,2007

H.V.		L.V.		Ratio	Measured deviation (%)			Connection symbol
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AB/ ab	BC/ bc	CA/ ca	
1	121.000	/	11	11.000	0.02	0.14	0.29	YNd11
2	119.625			10.875	-0.07	0.05	0.20	
3	118.250			10.750	0.00	0.11	0.26	
4	116.875			10.625	-0.09	0.02	0.17	
5	115.500			10.500	-0.03	0.09	0.24	
6	114.125			10.375	-0.02	-0.01	0.15	
7	112.750			10.250	-0.05	0.06	0.22	
8	111.375			10.125	-0.14	-0.03	0.13	
9a, 9b, 9c	110.000			10.000	-0.07	0.04	0.20	
10	108.625			9.875	-0.17	-0.06	0.10	
11	107.250			9.750	-0.09	0.01	0.18	
12	105.875			9.625	-0.20	-0.09	0.08	
13	104.500			9.500	-0.12	-0.02	0.15	
14	103.125			9.375	-0.23	-0.12	0.05	
15	101.750			9.250	-0.14	-0.05	0.13	
16	100.375			9.125	-0.25	-0.15	0.04	
17	99.000			9.000	-0.18	-0.08	0.11	

M.V.		L.V.		Ratio	Measured deviation (%)			Connection symbol
Tap position	Voltage (kV)	Tap position	Voltage (kV)		AmBm/ab	BmCm/ bc	CmAm/ca	
1	40.425	/	11	3.675	-0.25	-0.22	-0.23	ynd11
2	39.463			3.588	-0.16	-0.14	-0.14	
3	38.500			3.500	-0.07	-0.04	-0.04	
4	37.538			3.413	0.03	0.06	0.06	
5	36.575			3.325	0.13	0.16	0.16	



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4.17.4.3 Measurement of winding resistance Test date: Nov.16,2007

Oil temperature: 8.0°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	0.3793	0.3802	0.3820	0.71
	2	0.3719	0.3726	0.3744	0.67
	3	0.3657	0.3661	0.3679	0.60
	4	0.3583	0.3589	0.3606	0.64
	5	0.3520	0.3527	0.3542	0.62
	6	0.3447	0.3454	0.3468	0.61
	7	0.3383	0.3388	0.3404	0.62
	8	0.3310	0.3317	0.3331	0.63
	9a, 9b, 9c	0.3237	0.3241	0.3249	0.37
	10	0.3320	0.3324	0.3338	0.54
	11	0.3383	0.3387	0.3401	0.53
	12	0.3456	0.3461	0.3476	0.58
	13	0.3520	0.3526	0.3540	0.57
	14	0.3591	0.3598	0.3614	0.64
	15	0.3657	0.3662	0.3679	0.60
	16	0.3728	0.3736	0.3753	0.67
	17	0.3796	0.3802	0.3819	0.60
M.V.	1	0.04888	0.04905	0.04941	1.08
	2	0.04726	0.04730	0.04768	0.89
	3	0.04517	0.04516	0.04534	0.40
	4	0.04719	0.04736	0.04773	1.14
	5	0.04907	0.04922	0.04960	1.08
L.V.	/	0.005642	0.005644	0.005680	0.67

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4.17.4.4 Separate-source AC withstand voltage test Test date: Nov. 22, 2007
 Humidity: 30%; Ambient temperature: 11.5°C; Oil temperature: 11.5°C; Atmospheric pressure: 101.0kPa

Position	Applied voltage (kV)	Duration (s)	Results
H.V.neutral—M.V.、 L.V.&E	140	60	Passed
M.V.neutral—H.V.、 L.V.&E	85	60	
L.V.—H.V. M.V &E	35	60	

4.17.4.5 Short-duration AC withstand voltage test Test date: Nov. 20,2007

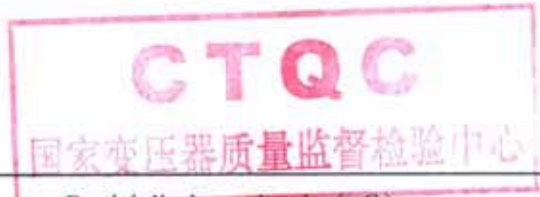
4.17.4.5.1 A phase-to-earth test with single-phase supply

Tap position 5. Frequency 150Hz.

Induced voltage		Duration	Partial discharge levels (pC)		
Multiple	Phase-to-earth (kV)		A	B	C
$1.1U_m/\sqrt{3}$	80	5 min	/	/	/
$U_2=1.5U_m/\sqrt{3}$	109.1	5 min	/	/	/
U_1	200	40s	/	/	/
$U_2=1.5U_m/\sqrt{3}$	109.1	5 min	<20	<30	<20
$1.1U_m/\sqrt{3}$	80	5 min	<20	<20	<20

Note: $U_m=126kV$

Background noise level is 10pC before and after test.
 Start voltage:80.0kV Extinction voltage:72.7kV



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

Tap position 9b, Frequency 150Hz.

Induced voltage		Duration	Partial discharge levels (pC)		
Multiple	Phase-to-phase (kV)		A	B	C
$1.1U_m$	138.6	5 min	/	/	/
$U_2=1.3U_m$	163.8	5 min	/	/	/
U_1	200	40s	/	/	/
$U_2=1.3U_m$	163.8	5 min	<30	<30	<20
$1.1U_m$	138.6	5 min	<20	<20	<20

Note: $U_m=126kV$ Background noise level is 10pC before and after test.

Start voltage:138.6kV Extinction voltage:126kV

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4.17.4.6 Measurement of no-load loss and current Test date: Nov. 20,2007

RMS voltage (kV)		No-load current		No-load loss (kW)	
Reading of mean value voltmeter	Reading of RMS voltmeter	(A)	(%)	Measured value	Corrected value
11	11	1.925	0.07	29.84	29.84

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

4.17.4.7 Measurement of short-circuit impedance and load loss Test date: Nov. 13,2007

Oil temperature: 29.0°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	122.6	51.4	12.038	56.69	19.36	204.58	234.42
	9b	134.1	51.2	10.545	45.38	18.75	198.83	228.67
	17	147.2	50.5	9.236	36.22	18.48	231.05	260.89
H.V. M.V. (Tap1)	17	151.0	51.8	4.831	18.47	9.42	235.41	265.25
H.V. M.V. (Tap3)	1	121.6	51.0	6.806	32.33	11.04	206.67	236.51
	9b	132.3	50.4	5.796	25.31	10.46	202.36	232.20
	17	147.3	50.5	5.094	19.95	10.18	237.20	267.04
H.V. M.V. (Tap5)	1	120.6	50.6	7.794	37.31	12.74	239.16	269.00
	17	146.3	50.2	5.654	22.31	11.38	262.29	292.13
M.V. L.V.	3	386.1	51.5	1.335	2.00	6.76	181.76	211.60



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4.17.4.8 Test on transformer oil Test date: Nov. 16,2007

tan δ (90°C)	Breakdown voltage (kV)	Water dissolved in oil (mg/L)
0.0010	64.13	12.46

Gas chromatography see 4.9

4.17.4.9 Test on on-load tap-changers Test date: Nov. 16, 2007

Operation test:

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

Auxiliary circuits dielectric test:

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



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4.18 Lightning impulse test (Routine test, type test) Test date: Nov.21,2007

Test circuit is given in Annex2-i

Humidity: 28%; Ambient temperature: 11.0°C; Atmospheric press: 102.2kPa

Test items and voltage:

Tested terminals	Rated withstand voltage (kV)		Tap position
	Full wave	Chopped wave	
A, B, C	480	530	A:9b; B:17; C:1
O	325	/	1
Am, Bm, Cm	200	220	3
Om	200	/	3
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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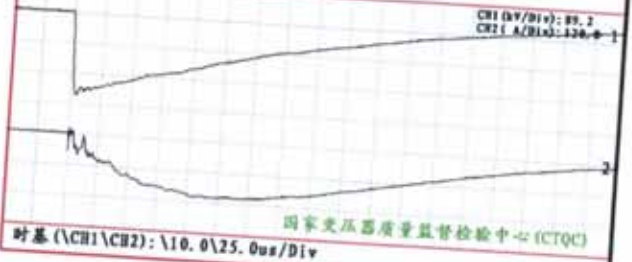
Test Report

China National Transformer Quality
Supervision Testing Center

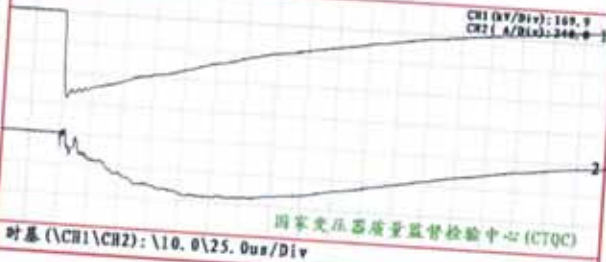
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Tested terminal: A
Test polarity: Negative
CH1. Voltage records
CH2. Neutral current records

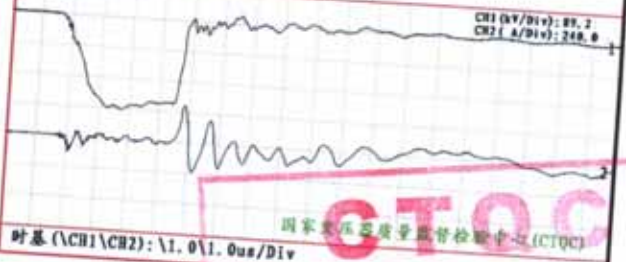
雷电全波 (Lightning Impulse Voltage)
T1-1.42us T2-50.9us Up-246.2kV
备注: Phase A Tapping 9 (B07644-L01)



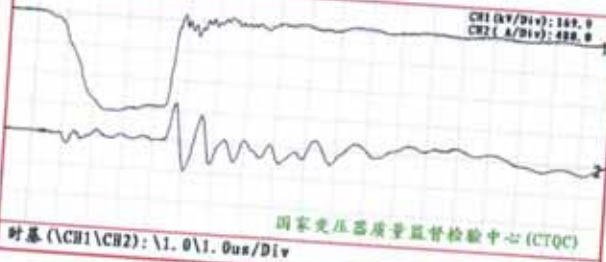
雷电全波 (Lightning Impulse Voltage)
T1-1.42us T2-50.9us Up-486.9kV
备注: Phase A Tapping 9 (B07644-L02)



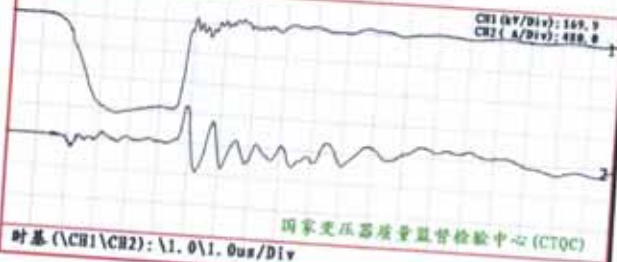
雷电截波 (Chopped Lightning Impulse Voltage)
T1-1.25us Tc-3.75us K-9% Up-267.8kV
备注: Phase A Tapping 9 (B07644-L03)



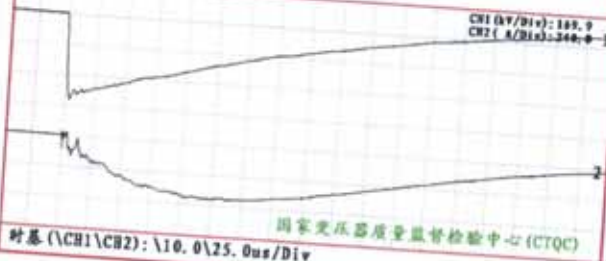
雷电截波 (Chopped Lightning Impulse Voltage)
T1-1.37us Tc-3.66us K-5% Up-538.3kV
备注: Phase A Tapping 9 (B07644-L04)



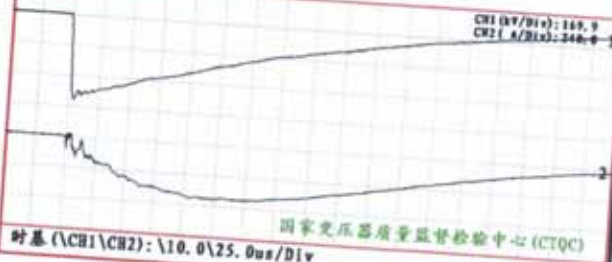
雷电截波 (Chopped Lightning Impulse Voltage)
T1-1.30us Tc-3.84us K-5% Up-532.2kV
备注: Phase A Tapping 9 (B07644-L05)



雷电全波 (Lightning Impulse Voltage)
T1-1.42us T2-51.0us Up-482.3kV
备注: Phase A Tapping 9 (B07644-L06)



雷电全波 (Lightning Impulse Voltage)
T1-1.43us T2-51.5us Up-478.2kV
备注: Phase A Tapping 9 (B07644-L07)



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

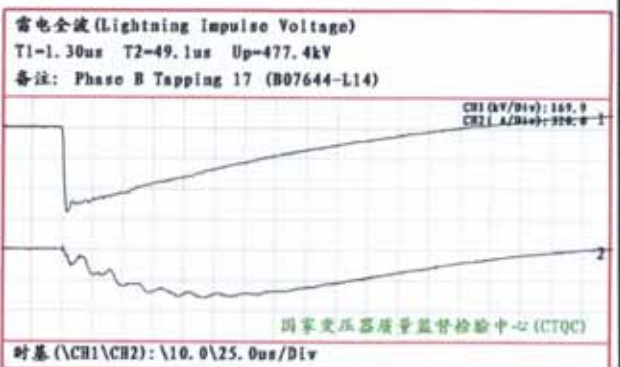
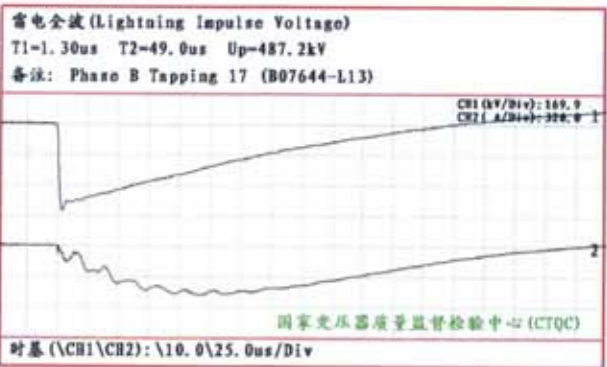
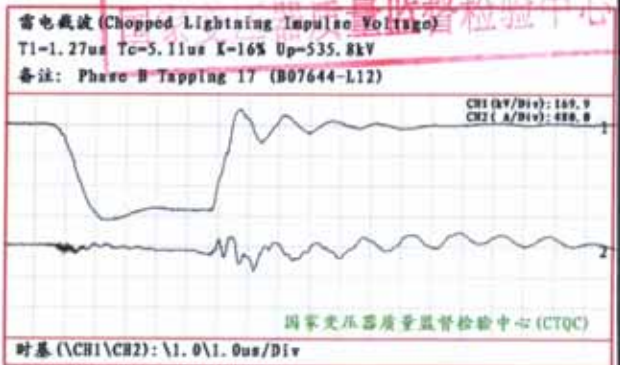
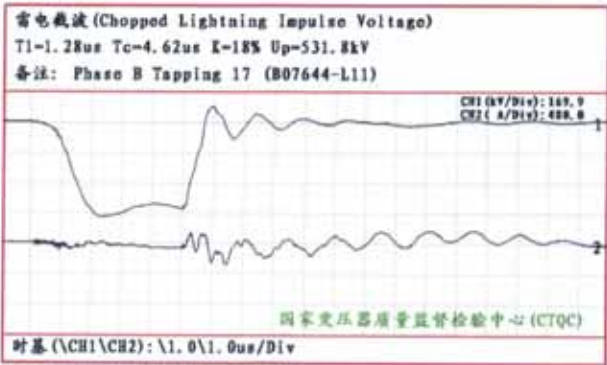
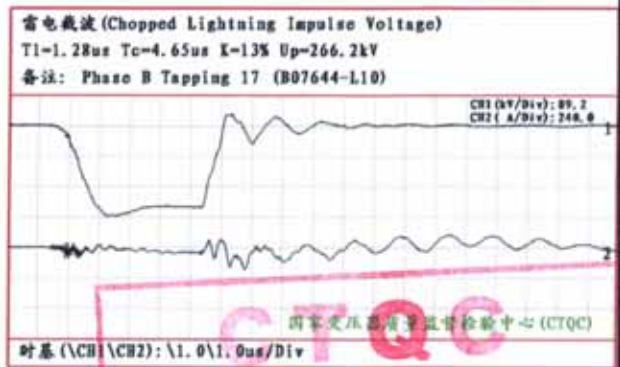
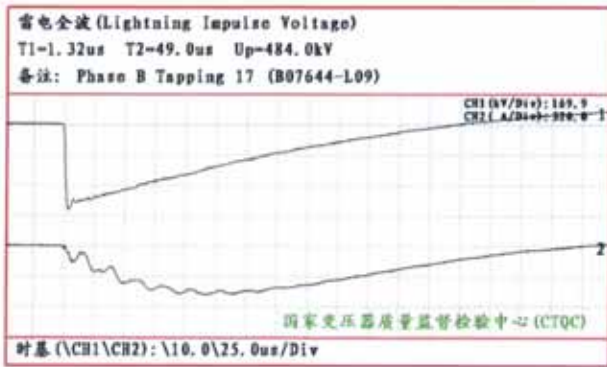
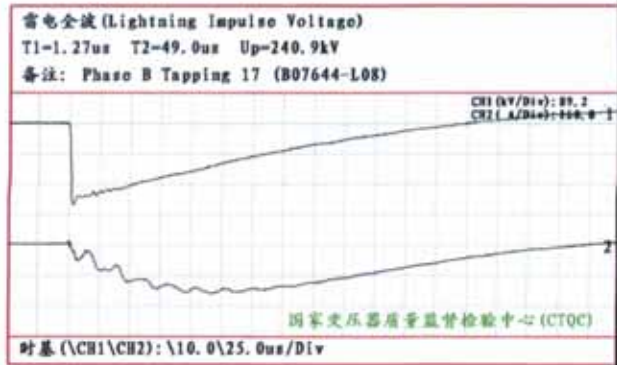
Phone: (024) 89874449
Postal code: 110122

(024) 89702527
Fax: (024) 89707949

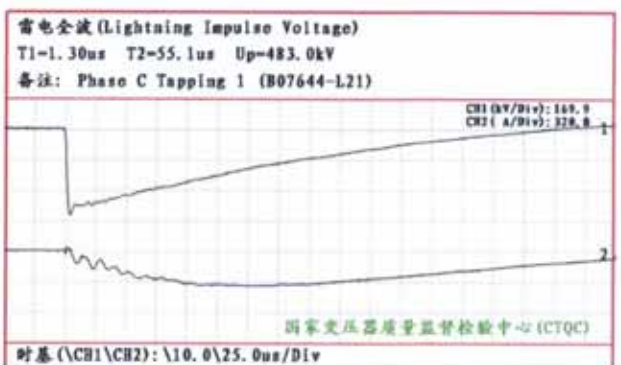
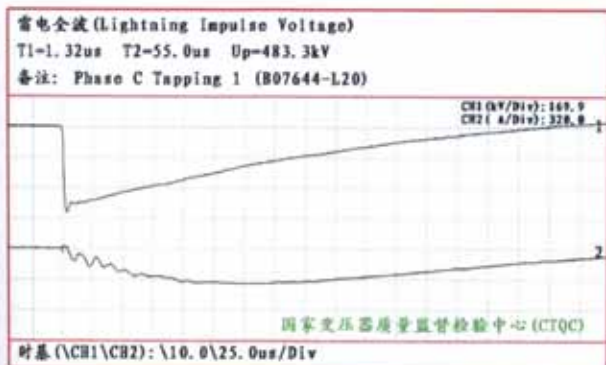
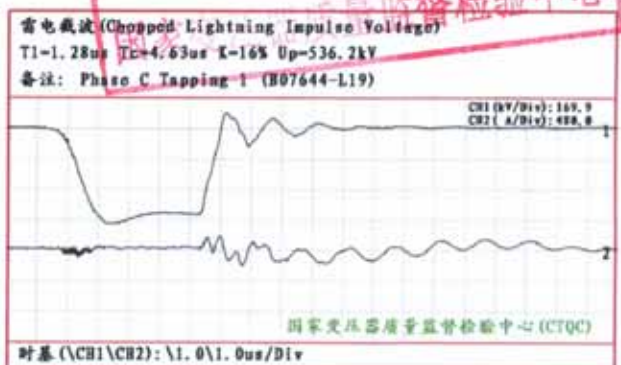
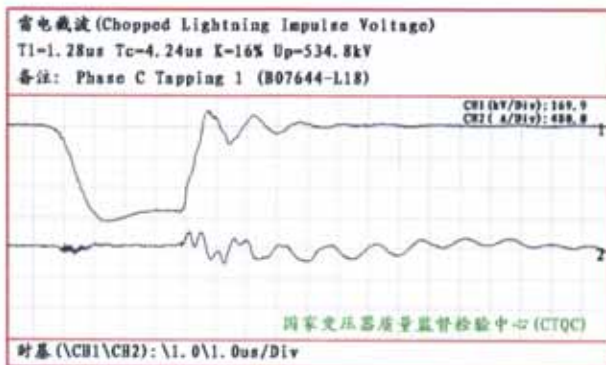
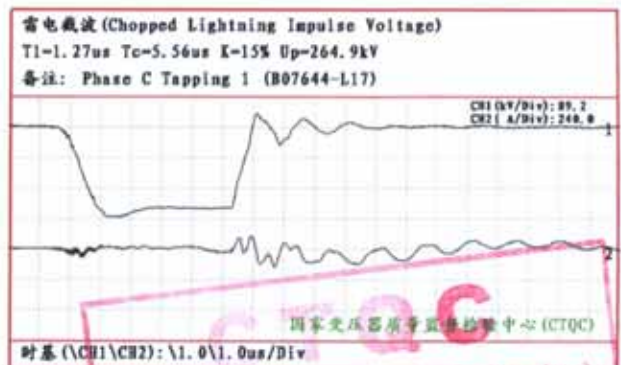
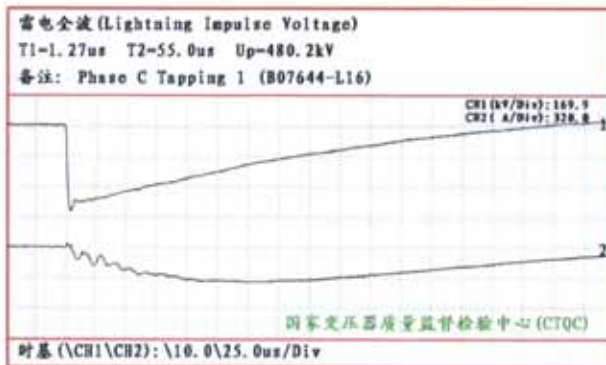
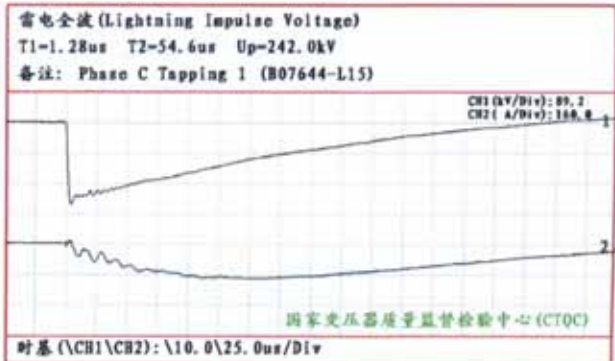
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<h2>Test Report</h2>	<h3>China National Transformer Quality Supervision Testing Center</h3>	No: CTQC/B-07.644 Total 50 Page 33
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Tested terminal: B
 Test polarity: Negative
 CH1. Voltage records
 CH2. Neutral current records



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



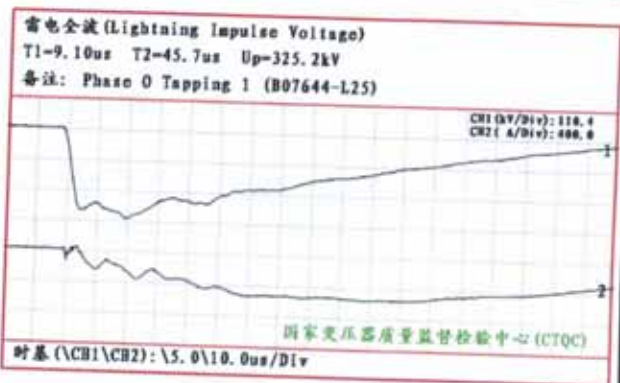
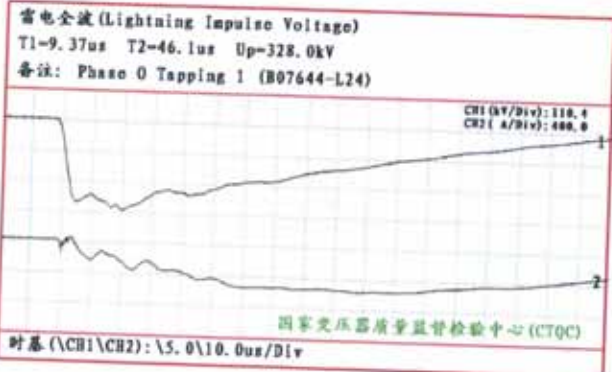
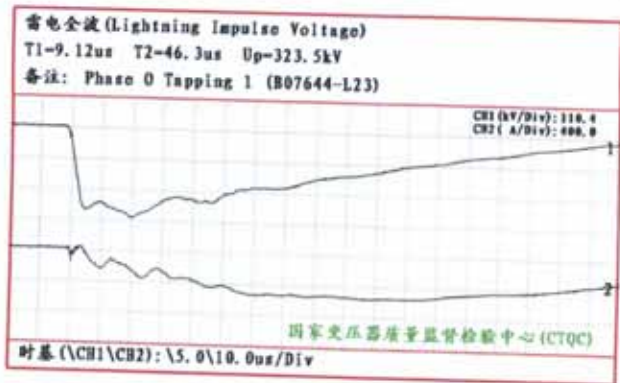
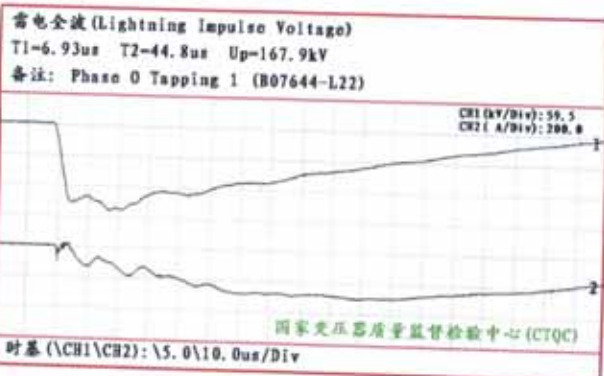
Test Report

China National Transformer Quality
Supervision Testing Center

No: CTQC/B-07.644

Total 50 Page 35

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



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Test Report

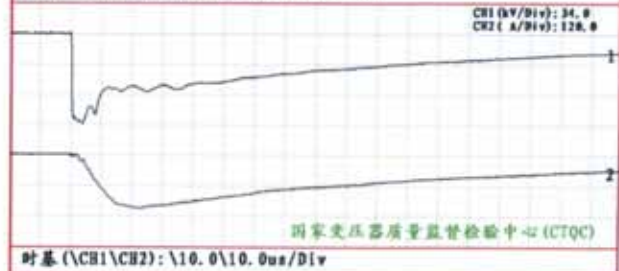
China National Transformer Quality
Supervision Testing Center

No: CTQC/B-07.644

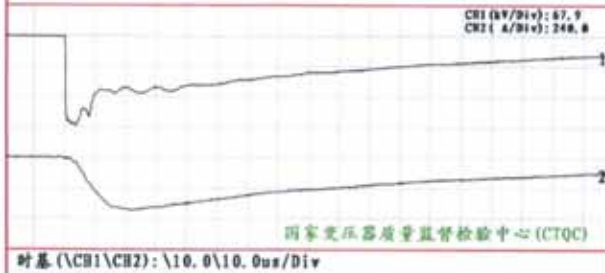
Total 50 Page 36

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

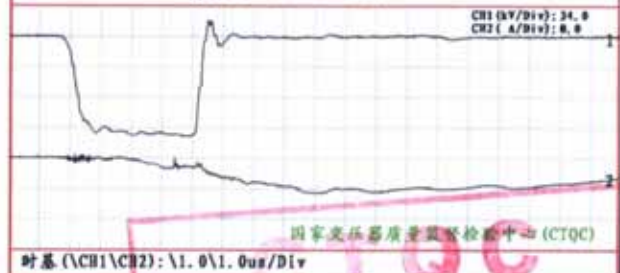
雷电全波 (Lightning Impulse Voltage)
T1=1.48us T2=54.5us Up=100.9kV
备注: Phase Am Tapping 3 (B07644-L26)



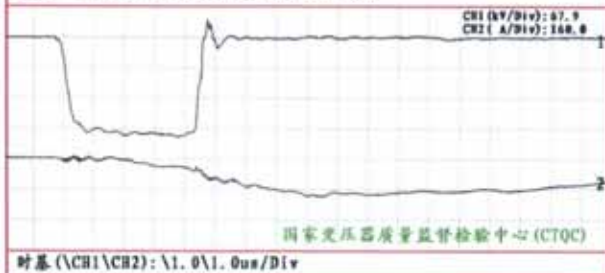
雷电全波 (Lightning Impulse Voltage)
T1=1.48us T2=54.9us Up=200.4kV
备注: Phase Am Tapping 3 (B07644-L27)



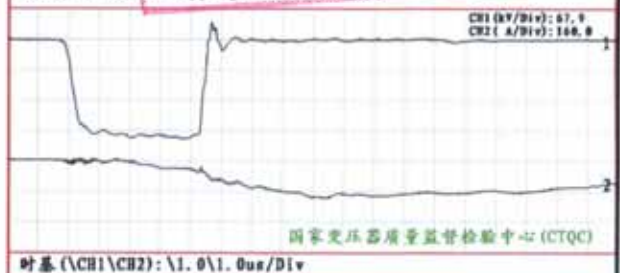
雷电截波 (Chopped Lightning Impulse Voltage)
T1=0.80us Tc=4.26us K=16% Up=110.5kV
备注: Phase Am Tapping 3 (B07644-L28)



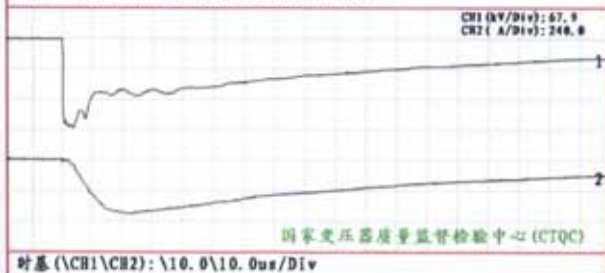
雷电截波 (Chopped Lightning Impulse Voltage)
T1=0.77us Tc=4.51us K=18% Up=220.2kV
备注: Phase Am Tapping 3 (B07644-L29)



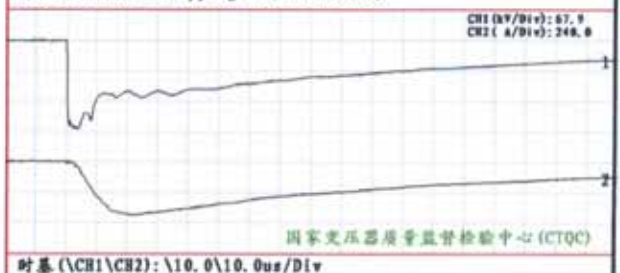
雷电截波 (Chopped Lightning Impulse Voltage)
T1=0.77us Tc=4.46us K=18% Up=220.8kV
备注: Phase Am Tapping 3 (B07644-L30)



雷电全波 (Lightning Impulse Voltage)
T1=1.50us T2=55.3us Up=199.9kV
备注: Phase Am Tapping 3 (B07644-L31)



雷电全波 (Lightning Impulse Voltage)
T1=1.47us T2=55.3us Up=198.9kV
备注: Phase Am Tapping 3 (B07644-L32)



Test Report

China National Transformer Quality
Supervision Testing Center

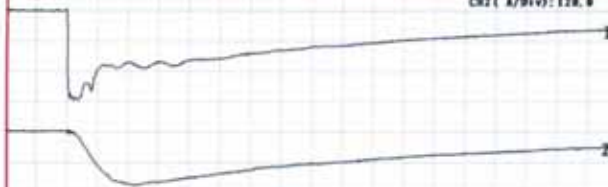
No: CTQC/B-07.644

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

雷电全波 (Lightning Impulse Voltage)
T1=1.48us T2=55.0us Up=101.2kV
备注: Phase Bm Tapping 3 (B07644-L33)

CH1 (kV/Div): 34.0
CH2 (A/Div): 128.0



国家变压器质量监督检验中心 (CTQC)

时基 (\CH1\CH2): \10.0\10.0us/Div

雷电全波 (Lightning Impulse Voltage)
T1=1.48us T2=55.7us Up=200.6kV
备注: Phase Bm Tapping 3 (B07644-L34)

CH1 (kV/Div): 67.9
CH2 (A/Div): 248.0

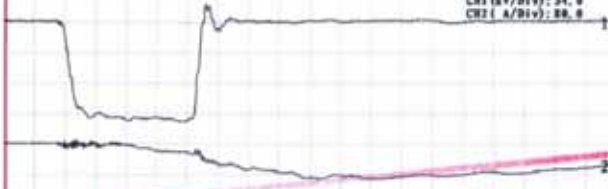


国家变压器质量监督检验中心 (CTQC)

时基 (\CH1\CH2): \10.0\10.0us/Div

雷电截波 (Chopped Lightning Impulse Voltage)
T1=0.75us Tc=4.36us K=18% Up=111.4kV
备注: Phase Bm Tapping 3 (B07644-L35)

CH1 (kV/Div): 34.0
CH2 (A/Div): 88.0



国家变压器质量监督检验中心 (CTQC)

时基 (\CH1\CH2): \1.0\1.0us/Div

雷电截波 (Chopped Lightning Impulse Voltage)
T1=0.77us Tc=4.55us K=18% Up=222.9kV
备注: Phase Bm Tapping 3 (B07644-L36)

CH1 (kV/Div): 67.9
CH2 (A/Div): 168.0

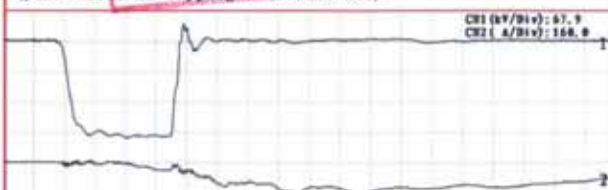


国家变压器质量监督检验中心 (CTQC)

时基 (\CH1\CH2): \1.0\1.0us/Div

雷电截波 (Chopped Lightning Impulse Voltage)
T1=0.72us Tc=3.69us K=17% Up=214.8kV
备注: Phase Bm Tapping 3 (B07644-L37)

CH1 (kV/Div): 67.9
CH2 (A/Div): 168.0

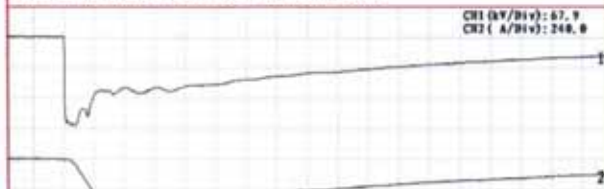


国家变压器质量监督检验中心 (CTQC)

时基 (\CH1\CH2): \1.0\1.0us/Div

雷电全波 (Lightning Impulse Voltage)
T1=1.50us T2=55.3us Up=201.0kV
备注: Phase Bm Tapping 3 (B07644-L38)

CH1 (kV/Div): 67.9
CH2 (A/Div): 248.0

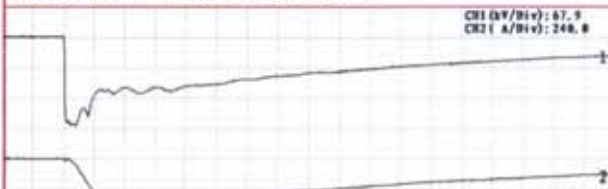


国家变压器质量监督检验中心 (CTQC)

时基 (\CH1\CH2): \10.0\10.0us/Div

雷电全波 (Lightning Impulse Voltage)
T1=1.48us T2=55.4us Up=200.4kV
备注: Phase Bm Tapping 3 (B07644-L39)

CH1 (kV/Div): 67.9
CH2 (A/Div): 248.0

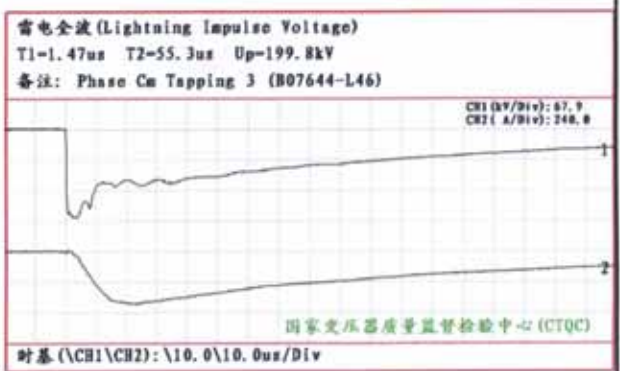
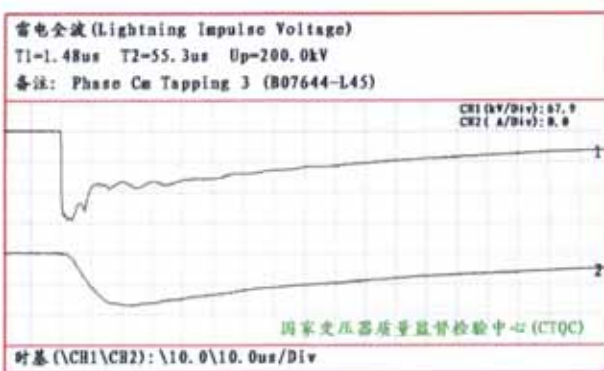
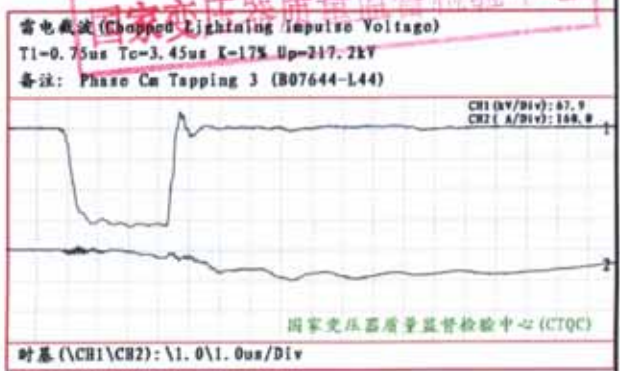
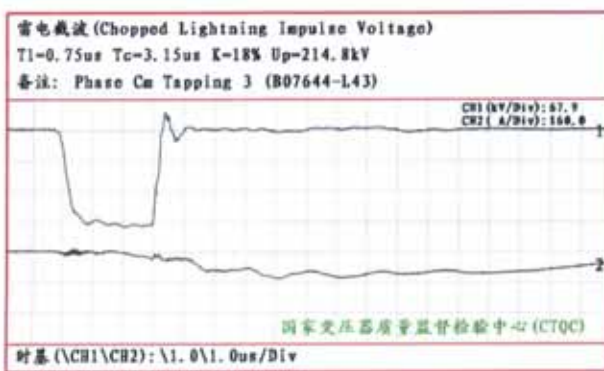
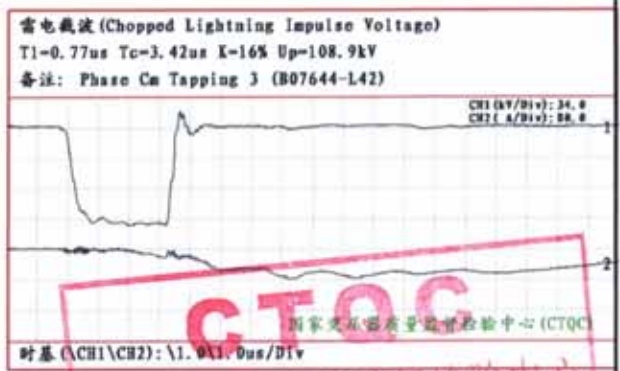
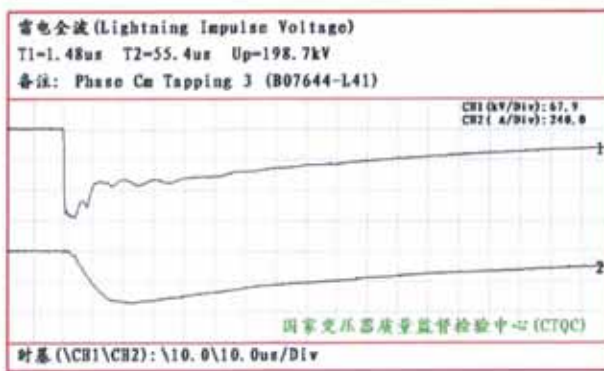
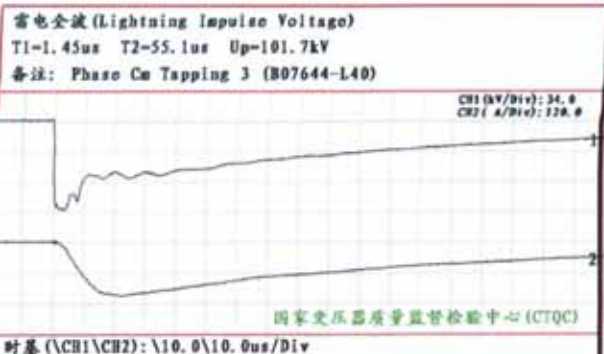


国家变压器质量监督检验中心 (CTQC)

时基 (\CH1\CH2): \10.0\10.0us/Div

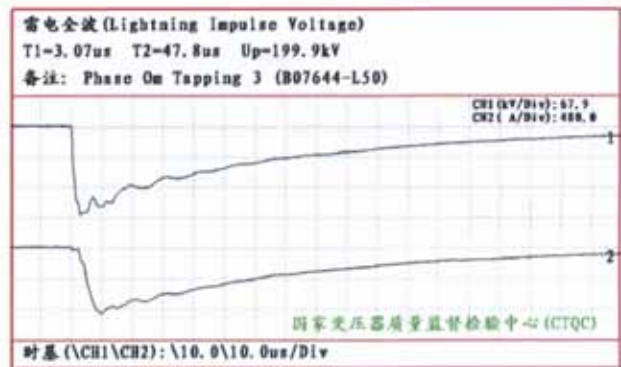
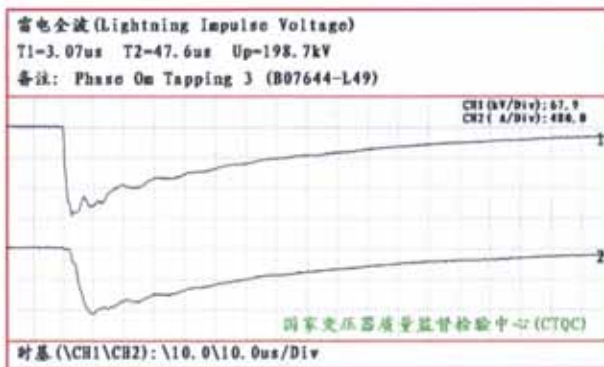
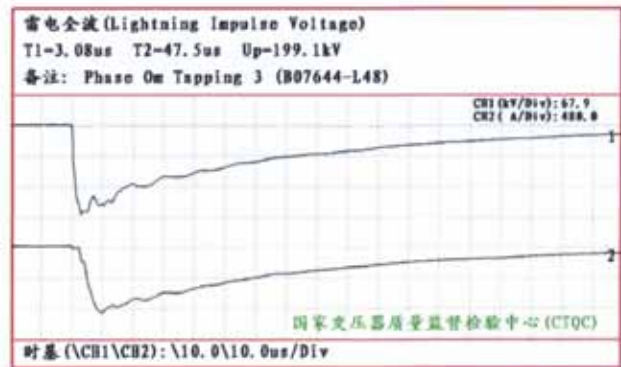
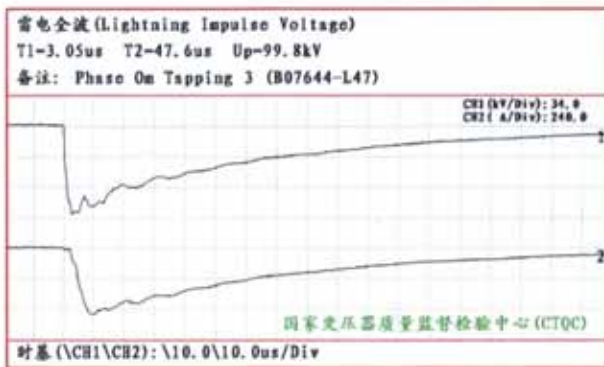
<h2>Test Report</h2>	<h3>China National Transformer Quality Supervision Testing Center</h3>	No: CTQC/B-07.644 Total 50 Page 38
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Tested terminal: Cm
 Test polarity: Negative
 CH1. Voltage records
 CH2. Neutral current records



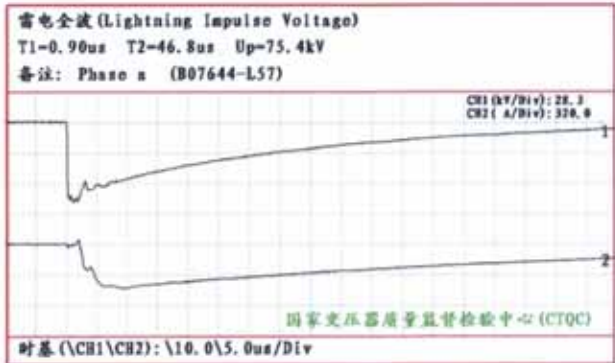
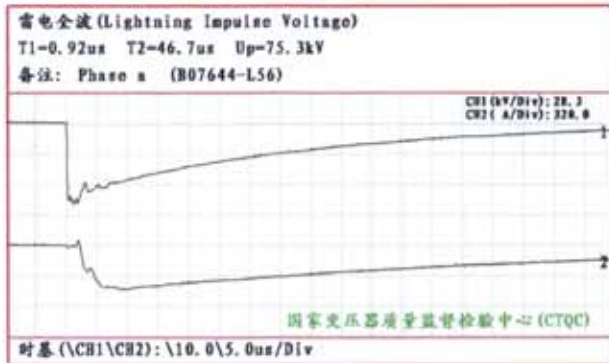
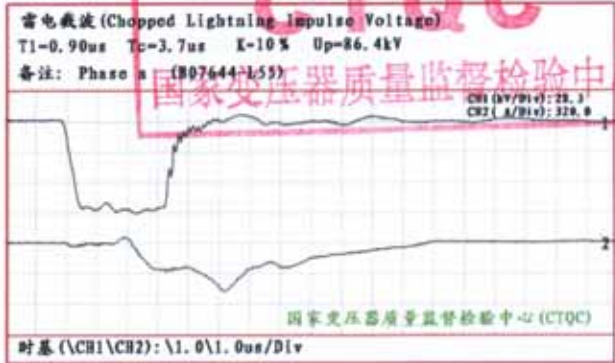
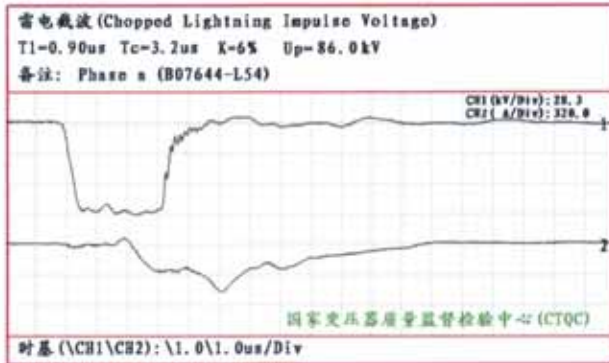
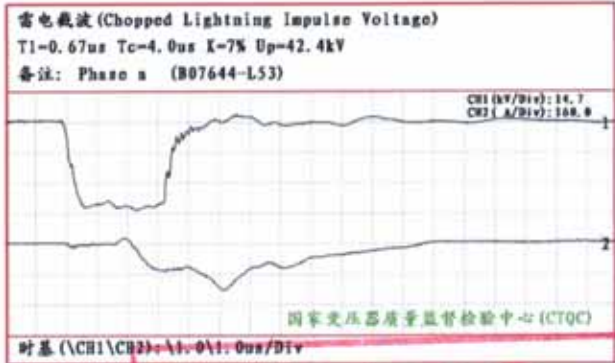
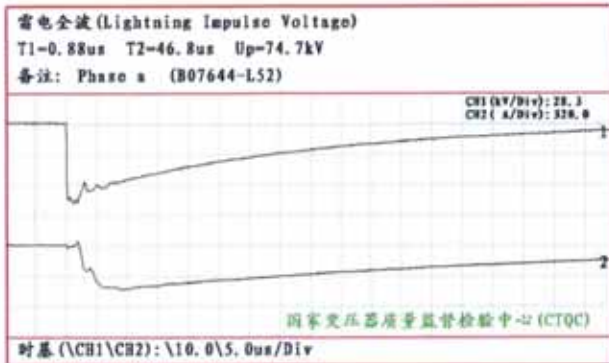
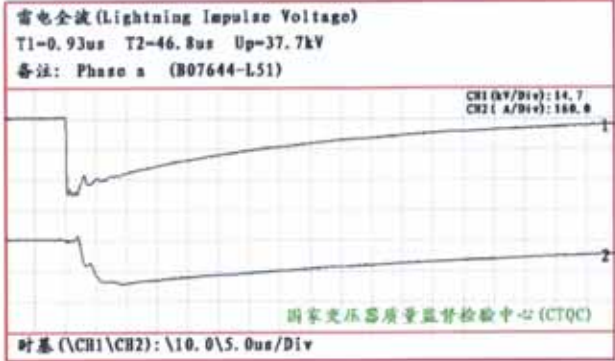
<h2>Test Report</h2>	<h3>China National Transformer Quality Supervision Testing Center</h3>	No: CTQC/B-07.644 Total 50 Page 39
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Tested terminal: Om Test polarity: Negative CH1.Voltage records CH2. Neutral current records



<h2>Test Report</h2>	<h3>China National Transformer Quality Supervision Testing Center</h3>	No: CTQC/B-07.644 Total 50 Page 40
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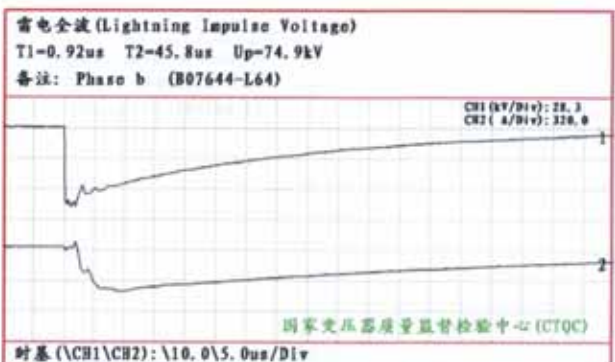
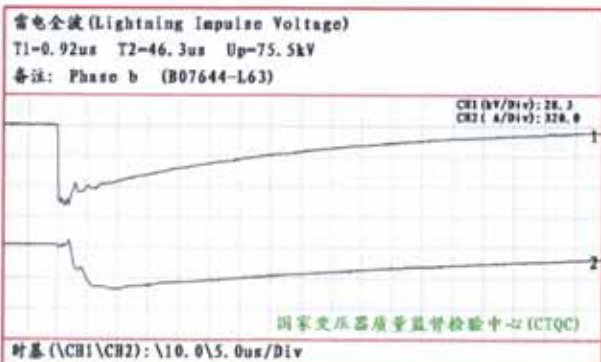
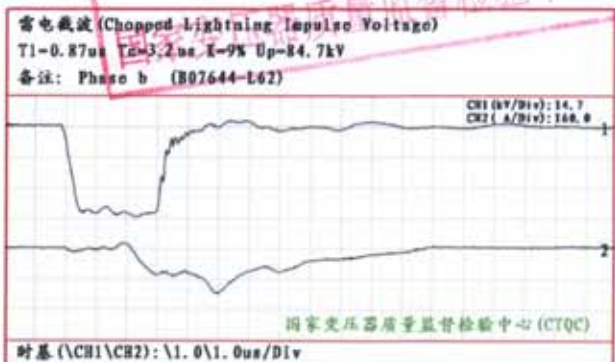
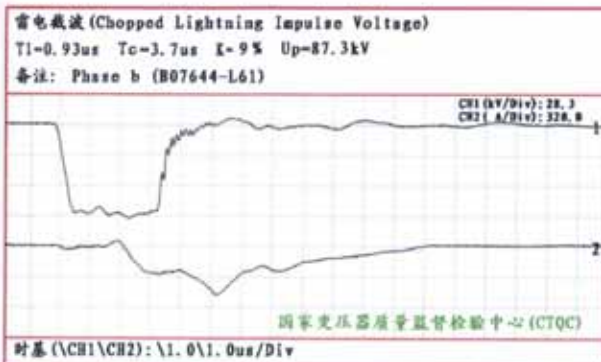
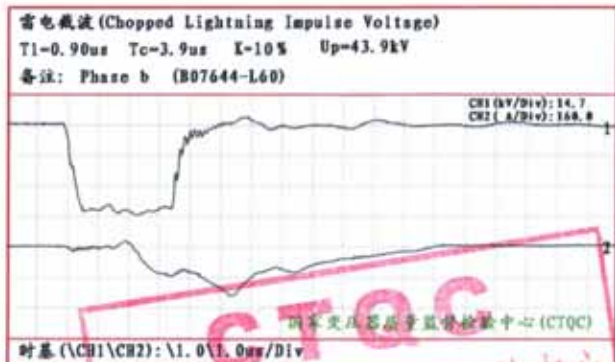
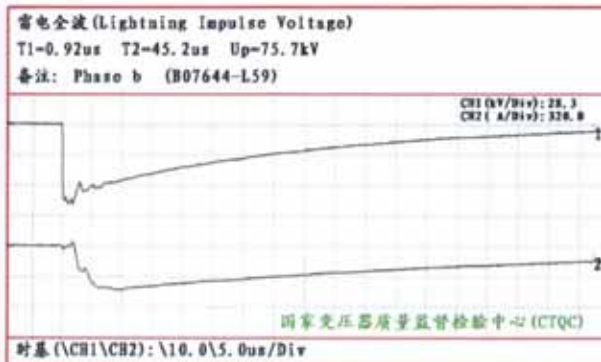
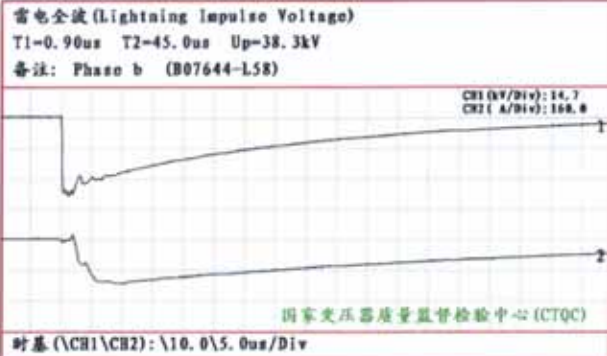
Tested terminal: a
 Test polarity: Negative
 CH1.Voltage records
 CH2. Neutral current records



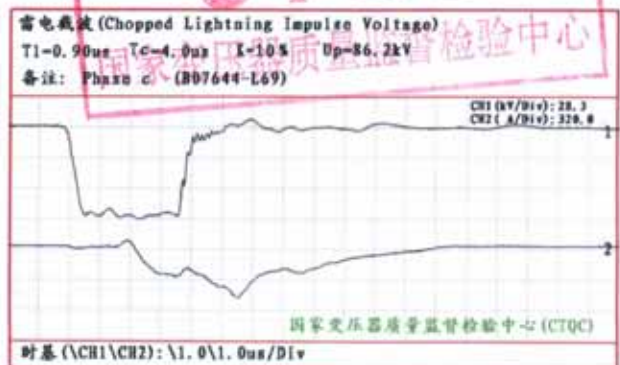
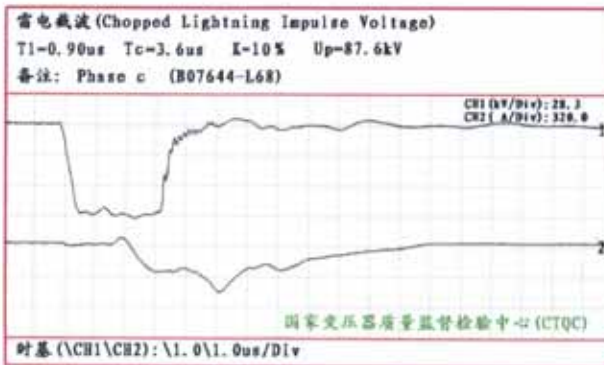
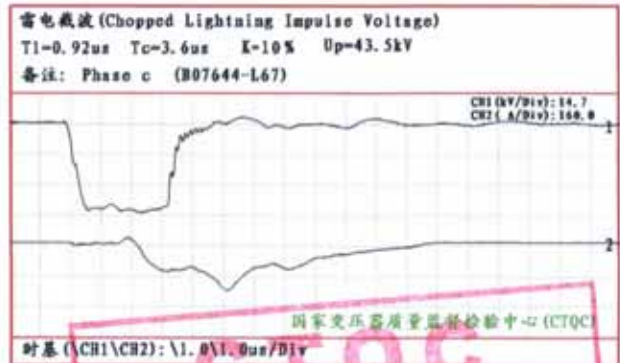
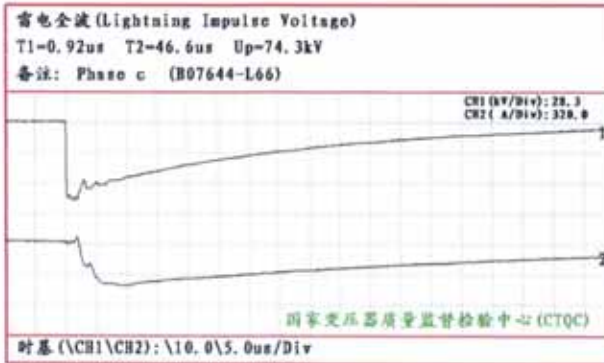
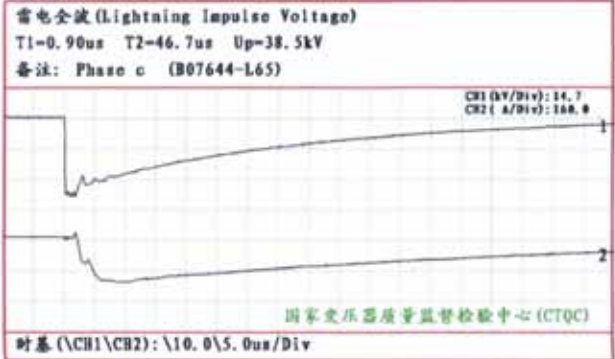
CTQC

国家变压器质量监督检验中心

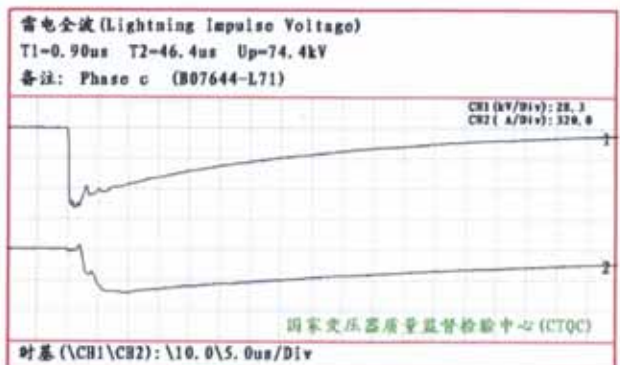
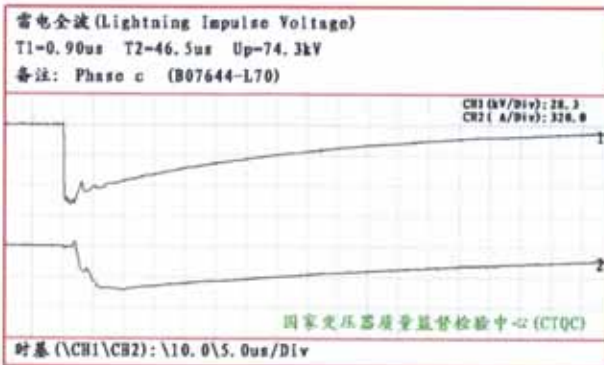
Tested terminal: b
 Test polarity: Negative
 CH1. Voltage records
 CH2. Neutral current records



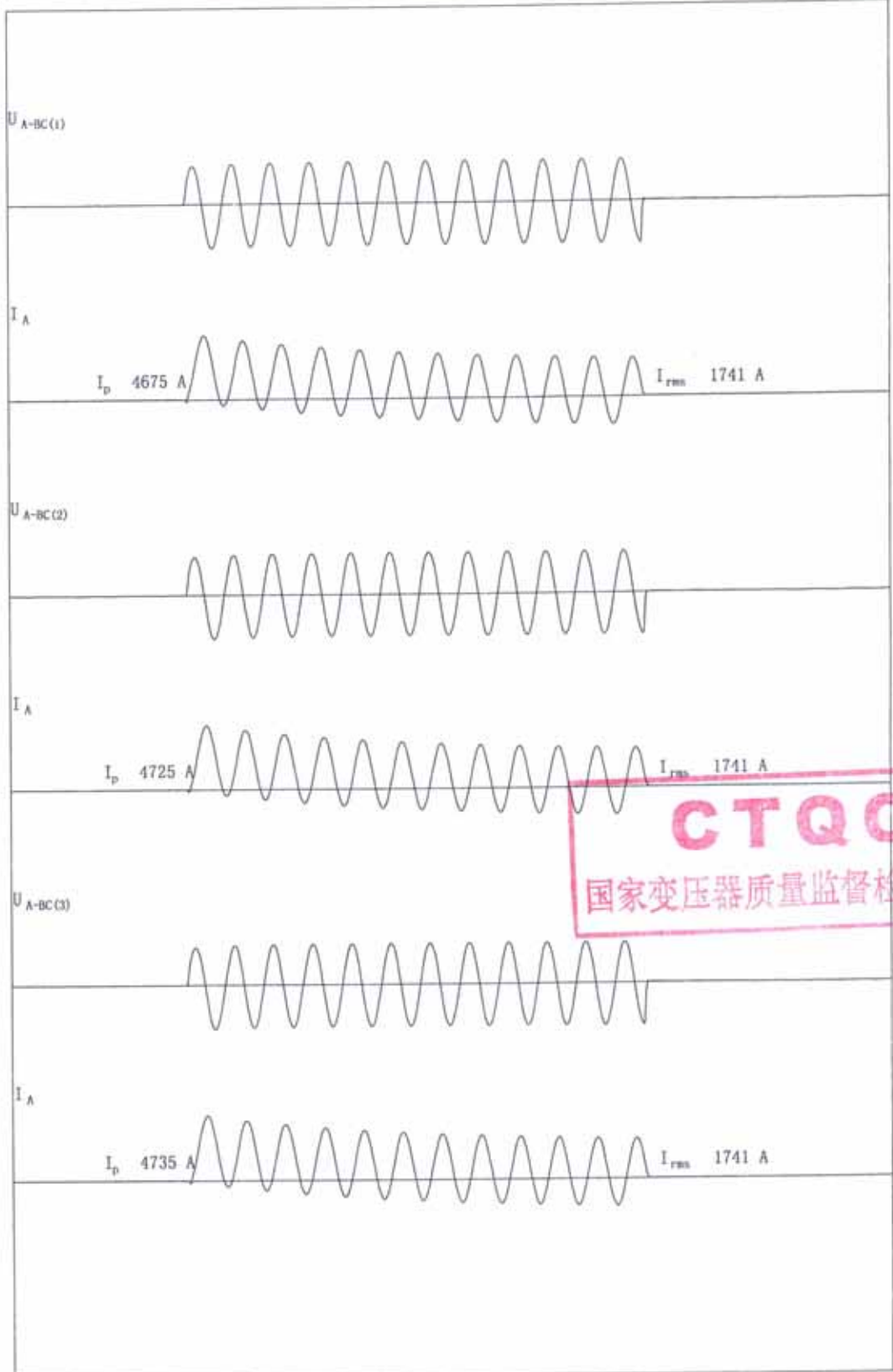
Tested terminal: c
 Test polarity: Negative
 CH1. Voltage records
 CH2. Neutral current records



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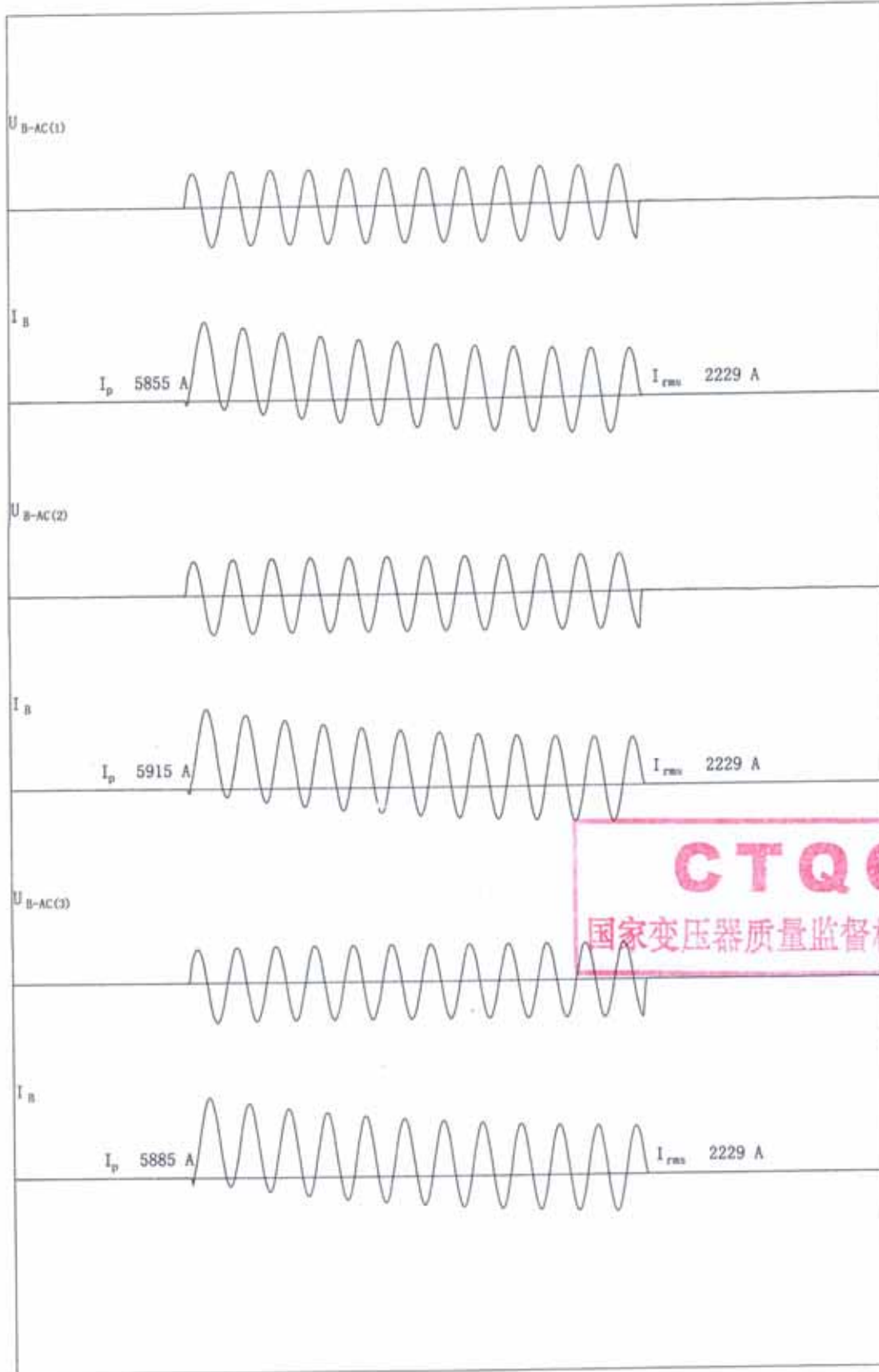


Test Report	China National Transformer Quality Supervision Testing Center	No.: CTQC/B-07.644 Total 50 Page 43
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CTQC
 国家变压器质量监督检验中心

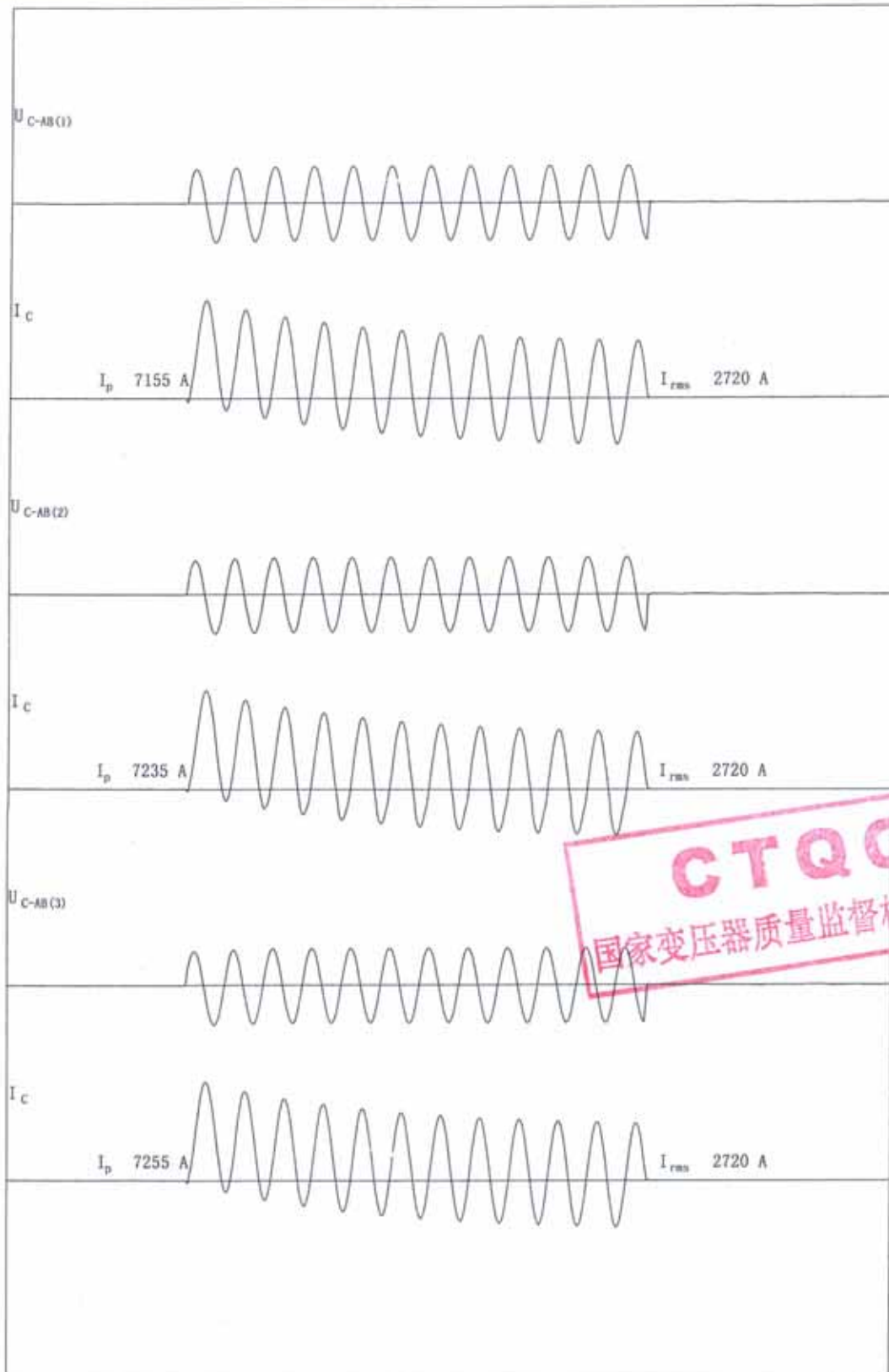
B07644-S04



CTQC
国家变压器质量监督检验中心

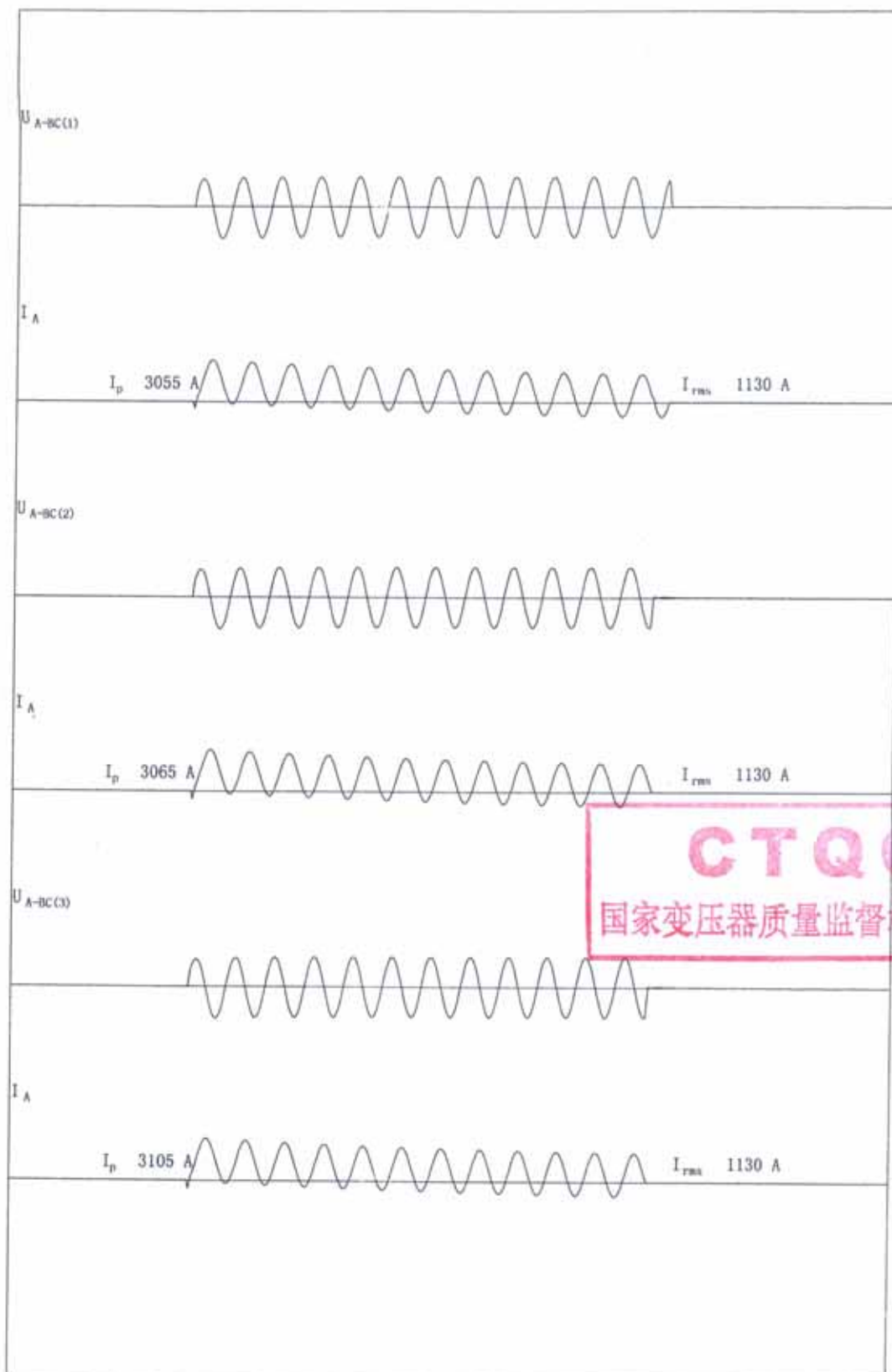
B07644-S05

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B07644-S06

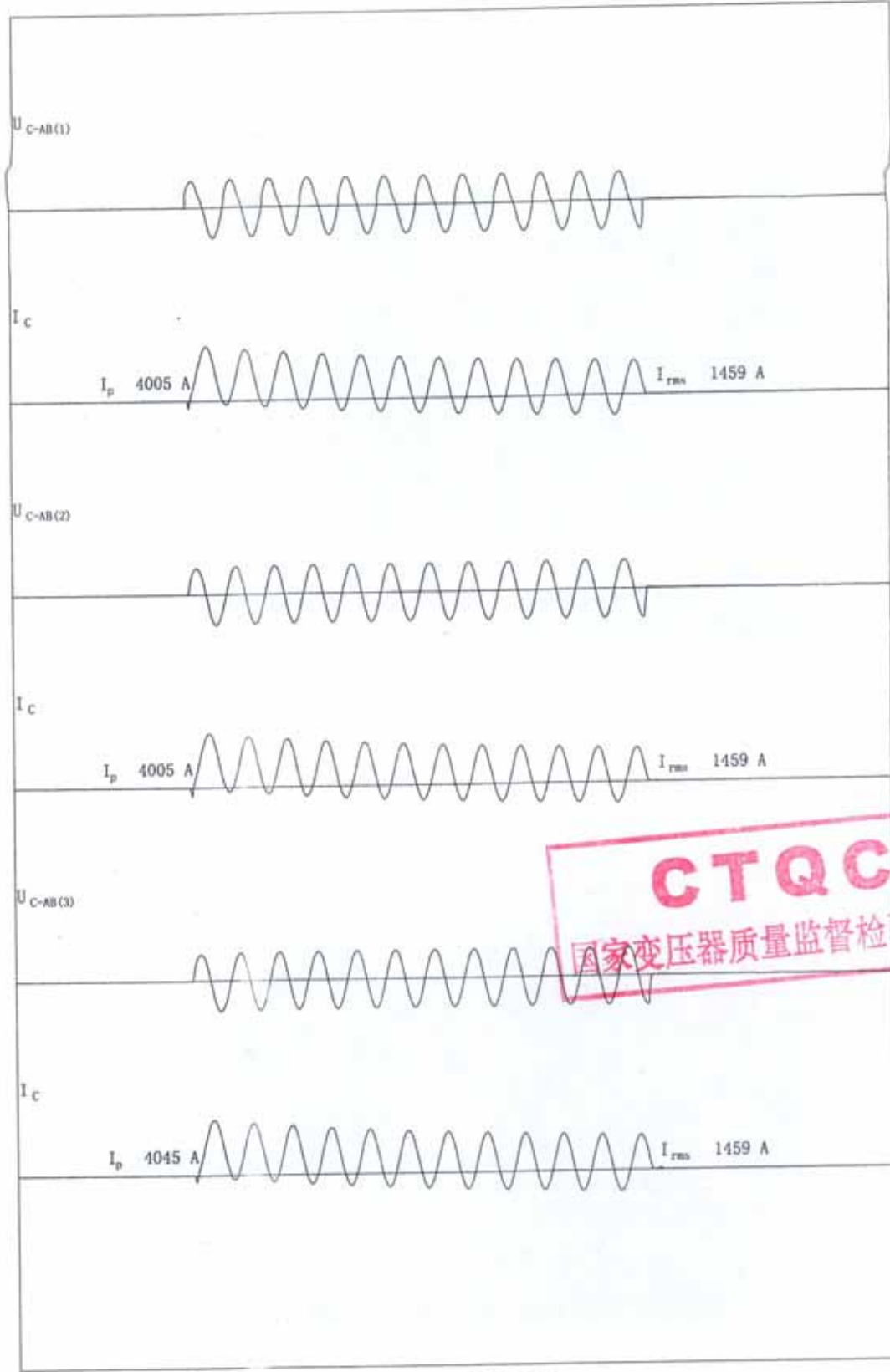
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