INSPECTION REPORT

Report number	70450007-TDT 04-42066A
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 January 5 and January 10, 2004
Place	Shenyang, China
Object	Power Transformer 1600 kVA
Manufacturer	Hangzhou Qianjiang 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.

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This B-report consists of:
17 pages
4 annexes
1 appendix (31 pages)

Arnhem, May 14, 2004

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MATERIAL DATA

Manufacturer	Hangzhou Qianjiang Electric Group Co., Ltd.
Type	S11-1600/10
Serial number	0307510001
Rated power	1600 kVA
Rated voltages	10 / 0.4 kV
Rated current	92.4/2309.4 A
Rated frequency	50 Hz
Number of phases	3
Tapping range	+5%, -5%
Number of steps/ tapping step	3 / 5%
Vector group	Yyn0
Cooling method	ONAN
Temperature class of insulation	A
Insulation levels	H.V. LI/LIC/AC – 75 / 85 / 35 kV
	L.V. AC – 5 kV
Short-circuit impedance	4.5%
Total mass	4680 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 number CTQC/B-04.001.
The SVET.CTQC test report regarding tests, oscillograms, curves, lists of test equipments, test circuits and manufacturer drawings are enclosed in this report as appendix A.

TEST PROGRAMME

		kind of test *	standard/ specification	clause
0	INSPECTION OF THE TEST SET-UP			
1	ROUTINE-, SPECIAL- AND TYPE TESTS BEFORE SHORT-CIRCUIT TEST			
1.1	Separate source AC withstand voltage test	R	IEC 60076-3	5,11
1.2	Short-duration induced AC withstand voltage test	R	IEC 60076-3	5,12
1.3	Measurement of insulation resistances	S	IEC 60076-1	10.1
1.4	Measurement of winding resistance	R	IEC 60076-1	10.2
1.5	Measurement of voltage ratio and check of voltage vector relationship	R	IEC 60076-1	10.3
1.6	Measurement of load loss and short-circuit impedance	R	IEC 60076-1	10.4
1.7	Measurement of zero sequence impedance	S	IEC 60076-1	10.7
1.8	Measurement of no-load loss and current	R	IEC 60076-1	10.5
1.9	Measurement of the harmonics of the no-load current	S	IEC 60076-1	10.6
1.10	Temperature-rise test	T	IEC 60076-2	
1.11	Determination of sound levels	S	IEC 60076-10	
1.12	Test on transformer oil			
2	SHORT-CIRCUIT TEST	S	IEC 60076-5	
3	REPEAT OF ROUTINE TESTS, SPECIAL- AND TYPE TESTS			
3.1	Separate source AC withstand voltage test	R	IEC 60076-3	5, 11
3.2	Short-duration induced AC withstand voltage test	R	IEC 60076-3	5, 12
3.3	Measurement of insulation resistances	S	IEC 60076-1	10.1
3.4	Measurement of winding resistance	R	IEC 60076-1	10.2
3.5	Measurement of voltage ratio and check of voltage vector relationship	R	IEC 60076-1	10.3
3.6	Measurement of no load loss and current	R	IEC 60076-1	10.5
3.7	Measurement of load loss and impedance	R	IEC 60076-1	10.4
3.8	Lightning impulse test (including chopped)	T	IEC 60076-3	13
3.9	Test on transformer oil			
3.10	Inspection of the active part	S	IEC 60076-5	4.2

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 A.B. Hofstee	KEMA Nederland B.V.
Mr G.J Veldscholten	KEMA Nederland B.V.

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

1.1 Separate source AC withstand voltage test

The tests were carried in accordance with IEC 60076-3 clause 11.
The high voltage winding was tested with 35 kV, 50 Hz for 1 minute. The low voltage winding was tested with 5 kV, 50 Hz for 1 minute.

Results

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

1.2 Short-duration induced AC withstand voltage test

The test was carried out in accordance with IEC 60076-3 clause 12.
A three-phase power-frequency voltage of 200 Hz was applied to the low-voltage winding during 30 seconds in order to induce 200% Un. The tapping position during the test was 2 (10000/400 V).

Results

No collapse of the test voltages occurred.

1.3 Measurement of insulation resistances

Measured was the insulation resistance between the mutual windings and between the winding and ground with a d.c. voltage of 5 kV. The measured values are shown in annex 1.

Results

The measured values do not give rise to remarks.

1.4 Measurement of winding resistance

The measurement was carried out in accordance with IEC 60076-1 clause 10.2.
The d.c. resistance of the windings was determined with equipment, measuring voltages and currents and calculating the measured resistance. The resistances of the h.v. winding were measured in all positions of the tap-changer. The results of the measurements are represented in annex 1.

Results

The measured values do not give rise to remarks.

1.5 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.
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 given in annex 1.

Results

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

1.6 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. The measurements took place in all tapping positions. The l.v. winding was short-circuited. The measuring results were recalculated to 75 °C winding temperature and are given in annex 1.

Results

The measured values were within the specified tolerance.

1.7 Measurement of zero sequence impedance

The measurement was carried out in accordance with IEC 60076-1, clause 10.7, measured in tapping position 2. There is no value specified for this impedance. The measured values are given in annex 3.

Results

The measured values do not give rise to remarks.

1.8 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 low voltage side with rated voltage. The results in comparison with the specified values are given in annex 1.

Results

The measured values were within the specified tolerance.

1.9 Measurement of the harmonics of the no-load current

The harmonics of the no-load current were measured at nominal voltage. The measured values are given in the SVET.CTQC report, see appendix A.

Results

The measured values don't give rise to remarks.

1.10 Temperature-rise test

The temperature-rise test was carried out in accordance with IEC 60076-2. The transformer was loaded with its total losses (no-load loss and load loss) of tap 2. The measured values, compared with the guaranteed values, are given in annex 2.

Results

The measured temperature-rise values are well below the allowed maximum values.

1.11 Determination of sound levels

The sound level test was carried out in accordance with IEC 60076-10.
Sound level measurement was carried out at 100% of the rated voltage. The measurement was carried out indoors. The measured values are given in annex 3.

Results

The measured values, compared with the guaranteed values, don't give rise to remarks.

1.12 Test on transformer oil

The transformer oil was checked upon breakdown voltage and tan δ at 90 °C.

Results

Breakdown voltage was 55.2 kV, while requirement was higher than 35 kV.
Tan δ was 0.0009 while requirement was less than 0.01.

2 SHORT-CIRCUIT TEST

The short-circuit test was carried out in accordance with IEC 60076-5. The transformer is of category 1.
Calculations of the short-circuit current were made with a short-circuit rating of 500 MVA and a system voltage of 10 kV.
The test was performed according to the single-phase method. The single-phase supply is provided between one terminal and to the other two terminals connected together. The secondary windings were shorted.
The primary, secondary 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 given in the SVET.CTQC report, see appendix A.

Results

During the test no visible damage could be detected.
The reactance deviations were within the tolerance.
The currents and peak currents were within the tolerances.

3 REPEAT OF ROUTINE TEST

3.1 Separate source AC withstand voltage test

The tests were carried out in accordance with IEC 60076-3 clause 11.
The high voltage winding was tested with 35 kV, 50 Hz for 1 minute. The low voltage winding was tested with 5 kV, 50 Hz for 1 minute.

Results

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

3.2 Short-duration induced AC withstand voltage test

The test was carried out in accordance with IEC 60076-3 clause 12.
A three-phase power-frequency voltage of 200 Hz was applied to the low-voltage winding during 30 seconds in order to induce 200% Un. The tapping position during the test was 2 (10000/400 V).

Results

No collapse of the test voltages occurred.

3.3 Measurement of insulation resistances

Measured was the insulation resistance between the mutual windings and between the winding and ground with a d.c. voltage of 5 kV. The measured values are shown in annex 4.

Results

The measured values do not give rise to remarks.

3.4 Measurement of winding resistance

The measurement was carried out in accordance with IEC 60076-1 clause 10.2.
The d.c. resistance of the windings was determined with equipment, measuring voltages and currents and calculating the measured resistance. The resistances of the h.v. winding were measured in all positions of the tap-changer. The results of the measurements are represented in annex 4.

Results

The measured values do not give rise to remarks.

3.5 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.
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 given in annex 4.

Results

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

3.6 Measurement of no-load loss and current

The measurement was carried out in accordance with IEC 60076-1, clause 10.5.
The no-load loss and no-load currents were measured with supply at the low-voltage side with rated voltage. The results in comparison with the specified values are given in annex 4.

Results

The measured values were within the specified tolerance.

3.7 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. The measurements took place in tap 2. The l.v. winding was short-circuited. The measuring results were recalculated to 75 °C winding temperature and are given in annex 4.

Results

The measured values were within the specified tolerance.

3.8 Lightning impulse test (including chopped)

The test was carried out in accordance with IEC 60076-3, clause 13.
The lightning impulse test voltage was 75 kV and the chopped wave was 85 kV.
The three phases of the high voltage 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 given in the SVET.CTQC report, see appendix A.

Results

The transformer passed the test successfully.

3.9 Test on transformer oil

The transformer oil was checked upon breakdown voltage and tan δ at 90 °C.

Results

Breakdown voltage was 55.12 kV, while requirement was higher than 35 kV.
Tan δ was 0.0012 while requirement was less than 0.01.

3.10 Inspection of the active part

The transformer was untanked and the active part was inspected.

The out-of-tank inspection with respect to displacements, deformations of core and windings, connections and supporting structures or traces of discharges did not reveal any apparent defects.
The drawings and photos made before and after short-circuit test can be found in the SVET.CTQC report, see appendix A.

Results

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

Annex 1

Results of routine tests before the short-circuit tests.

Transformer number: 0307510001.

Insulation impedance

Humidity: 33%, oil temperature 12 °C	
Measurement position	Insulation resistance (GΩ)
H.V. – L.V. & tank to earth	70.1
L.V. – H.V. & tank to earth	35.0
H.V. & L.V. – tank to earth	60.1

Winding resistances

Resistance at 12.0 °C	H.V. voltage (Ω)			L.V. (mΩ)
	Tap 1	Tap 2	Tap 3	
A-B (a-b)	0.3777	0.3584	0.3389	0.7563
B-C (b-c)	0.3773	0.3582	0.3387	0.7549
C-A (c-a)	0.3778	0.3585	0.3390	0.7667

Ratio and connection group

H.V.		L.V.	Ratio	Measured deviation (%)			Connection group
Tap position	Voltage (kV)	Voltage (kV)		AB/ab	BC/bc	CA/ca	
1	10.50	0.40	26.25	0.00	0.00	0.00	Yyno
2	10.00		25.00	0.01	0.01	0.01	
3	9.50		23.75	0.00	0.00	0.01	

No-load loss

Rated no-load voltage	Average current (A)	Average current %)/ guaranteed (%)	No-load loss (W)/ guaranteed
400 V	2.28	0.10 / 0.6	1380 / 1640

Load loss

Values calculated to 145 °C	Tap 1	Tap 2	Tap 3
Load loss (W)/ guaranteed	14520 -	14750/ 14500	15020 -
Impedance (Ω)	3.41	3.05	2.68
Impedance (%)/ guaranteed	4.95 -	4.88/ 4.50	4.76 -

Annex 2

Results of the temperature rise test.

Transformer number: 0307510001.

		required/ [max. allowed]
GENERAL		
Power	kVA	1600
Cooling		ONAN
Position of tap changer		2
Ratio	kV	10/ 0.4
Supplied losses (sum of load and no-load losses at 75 °C)	kW	16.35
RESULTS TEMPERATURE-RISES		
Top-oil	K	47.6 / [55]
Mean oil	K	35.7
Mean high voltage windings	K	52.7 / [65]
Mean low voltage windings	K	59.7 / [65]

Annex 3

Measurement of sound levels.

Transformer number: 0307510001.

Location		Indoor
Excitation	% U_n	100
Cooling method		ONAN
Number of measuring points		
At 1/2 height		10
Measuring distance	m	0.3
Logarithmic mean of		
Measured value	dB_A	41.8
Corrected measuring result	dB_A	41
Calculated sound power	dB_A	54
Guaranteed sound power	dB_A	65

Zero sequence impedance.

Connection group	Applied voltage terminal	Open circuit terminal	Short-circuit terminal	Applied current (A)	Measured voltage (V)	Losses (kW)	Impedance (Ω)
Yyn0	abc - 0	A, B, C	/	461.3	15.6	3.5	0.1015
				922.5	28.8	12.0	0.0937
				1385.0	40.8	26.0	0.0884
				1847.5	52.0	43.0	0.0845
				2310	60.0	67.0	0.0779

Annex 4

Results of routine tests after the short-circuit tests.

Transformer number: 0307510001.

Insulation impedance

Humidity: 28%, oil temperature 11.4 °C	
Measurement position	Insulation resistance (GΩ)
H.V. – L.V. & tank to earth	54.7
L.V. – H.V. & tank to earth	28.1
H.V. & L.V. – tank to earth	47.5

Winding resistances

Resistance at 11.4 °C	H.V. (Ω)			L.V. (mΩ)
	Tap 1	Tap 2	Tap 3	
A-B (a-b)	0.3764	0.3574	0.3383	0.7575
B-C (b-c)	0.3761	0.3572	0.3382	0.7576
C-A (c-a)	0.3764	0.3575	0.3384	0.7688

Ratio and connection group

H.V.		L.V.	Ratio	Measured deviation (%)			Connection group
Tap position	Voltage (kV)	Voltage (kV)		AB/ab	BC/bc	CA/ca	
1	10.50	0.40	26.25	0.00	0.01	0.01	Yyno
2	10.00		25.00	0.01	0.01	0.02	
3	9.50		23.75	0.00	0.01	0.01	

No-load loss

Rated no-load voltage	Average current (A)	Average current %)/ guaranteed(%)	No-load loss (W)/ guaranteed
400 V	2.30	0.10 / 0.6	1390 / 1640

Load loss

Values calculated to 145 °C	Tap 1	Tap 2	Tap 3
Load loss (W)/ guaranteed		14640/ 14500	
Impedance (Ω)		3.04	
Impedance (%)/ guaranteed		4.86/ 4.50	

REPORT OF TESTS WITNESSED

REPORT No.	**4007-04**		
PROJECT No.	**70450007**		
APPARATUS	A power transformer		
DESIGNATION	S11-1600/10	**SERIAL No.** 0307510001	
CLIENT	Hangzhou Quinjiang Electric Group Co. Ltd., Hangzhou, P.R.China		
MANUFACTURER	Hangzhou Quinjiang Electric Group Co. Ltd., Hangzhou, P.R.China		
RATINGS	**Voltage**	10 kV ± 5% / 400	V
	Power	1600	kVA
	Short-circuit impedance	4,5	%
	Connection symbol	Yyn0	
	Cooling method	ONAN	
	Frequency	50	Hz
	Temperature class of insulation	A	

TEST LOCATION	SVET, Shenyang, P.R. China
DATE(S) OF TESTS	4th January 2004
TEST SPECIFICATION	**IEC 60076**

SUMMARY AND CONCLUSION

KEMA has witnessed the tests carried out at the laboratory of SVET:

Routine tests
Type tests
Special tests

The results obtained relate only to the work ordered and to the material inspected. For the points examined the requirements of the standard mentioned were met.

SVET has compiled a document no. CTQC/B-04.001 forming part of this Report of Type Test Witnessed. KEMA has verified that this document is a true record of the tests performed.
The ultimate responsibility for correctness and the accuracy of test results remains with the laboratory.

The report applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designations with that tested, rests with the Manufacturer.

KEMA Nederland B.V.

P.G.A. Bus
Manager High-Power Laboratory

Arnhem, 19th March 2004