



2014002878Z



(2014)国认监认字(347)号

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检测
TESTING
CNAS L1020

实验室名称: 国家电器产品质量监督检验中心

Lab Name: China National Center for Quality Supervision
and Test of Electrical Apparatus Products

№ 17M1019-S

检验 (试验) 报告 Test Report

委托单位: Siemens Transformer (Wuhan) Co., Ltd.
Client:产品名称: Power transformer
Name of Product:产品型号: TLSN7652
Product Type:检验类别: Commission/Monitoring test
Test Category:

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China National Center for Quality Supervision and Test of Electrical Apparatus Products

Test Report

№: 17M1019-S

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Client	Siemens Transformer (Wuhan) Co., Ltd.	Test category	Commission/Monitoring test
Manufacturer	Siemens Transformer (Wuhan) Co., Ltd.	Date of sample receiving	Aug. 05, 2017
Name of sample	Power transformer	Type of sample	TLSN7652
Address of manufacturer	No. 1, Jin Yang Avenue, Yangluo Economic Development Zone, Xinzhou District, Wuhan	Original number or date of production	V101019
Date of test	From Aug. 14, 2017 to Aug. 26, 2017	Number of sample	1 set
Test items	Routine test Type test Measurement of bushing capacitances and dielectric dissipation factor ($\tan\delta$) Calculation of the winding hot-spot temperature-rise Measurement of zero-sequence impedances on three-phase transformers Measurement of the harmonics of the no-load current Measurement of frequency response Short-circuit withstand test Chopped wave lightning impulse test Switching impulse test	Test standards	IEC 60076-1:2011 IEC 60076-2:2011 IEC 60076-3:2013 IEC 60076-5:2006 IEC 60076-10:2001 Commission requirements
Test conclusion	The test results of routine test, type test, measurement of bushing capacitances and dielectric dissipation factor ($\tan\delta$), calculation of the winding hot-spot temperature-rise, measurement of zero-sequence impedances on three-phase transformers, measurement of the harmonics of the no-load current, measurement of frequency response, short-circuit withstand test, chopped wave lightning impulse test and switching impulse test of power transformer (type: TLSN7652) are in accordance with test standards and commission requirements. The sample has passed the above tests. Signing and issuing date: 2017.09.26 Period of validity: 5 years Note: the conclusion is valid only for the inspected and tested sample.		
Remarks	The out-of-tank inspection before and after short-circuit test was monitored in Siemens Transformer (Wuhan) Co., Ltd.		

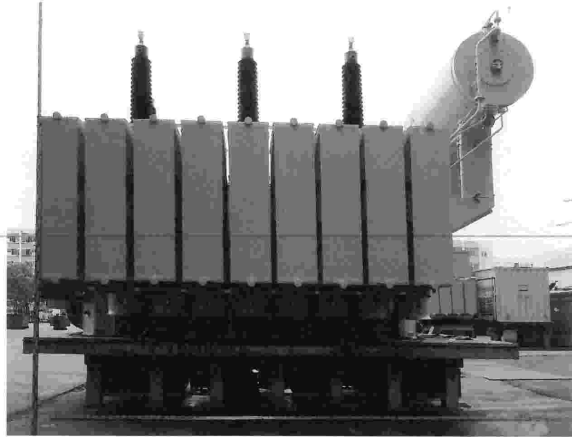
Compiled by: 李洪

Checked by: 李洪

Reviewed by: 郭建华

Approved by: 李明智

Test Report	China National Center for Quality Supervision and Test of Electrical Apparatus Products			№: 17M1019-S Total 83 Page 02
1. Sample parameters				
Rated power : 40000/40000+13400kVA				
Rated voltage : 132/12+12kV				
Rated current : 175.0/1924.5+644.7A				
Rated frequency : 50Hz				
Number of phases: 3				
Tapping ranges: 132±12×1.25%				
Connection symbol : YNyn0+d11				
Cooling method: ONAN/ONAF (78.75%/100%)				
Class of insulation and heat-resistant : /				
Insulation level: h.v. Line terminal LI/AC 650/275 kV				
h.v. Neutral terminal LI/AC 650/275 kV				
l.v. Line terminal LI/AC 125/50kV				
l.v. Neutral terminal LI/AC 125/50kV				
t.v. Line terminal LI/AC 125/50kV				
2. Test standards				
IEC 60076-1:2011 <i>Power transformers—Part 1: General</i>				
IEC 60076-2:2011 <i>Power transformers—Part 2: Temperature rise for liquid-immersed transformers</i>				
IEC 60076-3:2013 <i>Power transformers—Part 3: Insulation levels, dielectric tests and external clearances in air</i>				
IEC 60076-5:2006 <i>Power transformers—Part 5: Ability to withstand short circuit</i>				
IEC 60076-10:2001 <i>Power transformers—Part 10: Determination of sound levels</i>				
Commission requirements				
3. Sample description				
The power transformer is for outdoor use, and the structure of the coil is rotundate concentric type coil.				
External photos of the sample have been attached.				

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Photos of the sample		
		

Test Report		China National Center for Quality Supervision and Test of Electrical Apparatus Products				№: 17M1019-S Total 83 Page 04	
Summary of test results							
No	Test items	Specified value	Measured value				Concl- usion
		Standards (commission requirements)	Before short-circuit test		After short-circuit test		
1	Measurement of d.c. insulation resistance windings-to-earth and between windings (routine test)	Providing value of insulation resistance Providing absorption ratio Providing polarity index	See 4.1		See 4.22.4.1		/
2	Check of core and frame insulation for liquid-immersed transformers with core or frame insulation (routine test)	Providing value of insulation resistance	See 4.2		See 4.22.4.2		/
3	Measurement of dissipation factor (tanδ) of the insulation system capacitances (routine test)	Providing value of capacitance Providing dielectric dissipation factor tanδ	See 4.3		See 4.22.4.3		/
4	Determination of capacitances windings-to-earth and between windings (routine test)	Providing value of capacitance	See 4.4		See 4.22.4.4		/
5	Measurement of bushing capacitances and dielectric dissipation factor (tanδ) (commission test)	Providing value of capacitance Providing dielectric dissipation factor tanδ	See 4.5		See 4.22.4.5		/
6	Measurement of voltage ratio and check of phase displacement (routine test)	Voltage ratio tolerance of principal tapping: obtaining the lower of the following values between ±0.5% of declared ratio and ±1/10 of the actual percentage impedance Connection symbol : YNyn0+d11	0.06%~0.11% YNyn0		0.10%~0.22% YNyn0		PASS
7	Measurement of winding resistance (routine test)	Providing measured value	See 4.7		See 4.22.4.7		/
8	Separate-source AC withstand voltage test (routine test)	HV and neutral point: 275kV 60s LV and neutral point: 50kV 60s Stabilivolt: 50kV 60s Wiring for auxiliary power and control circuitry: 2kV 60s	275.0kV 60s 50.0kV 60s 50.0kV 60s 2.0kV 60s	275.0kV 60s 50.0kV 60s 50.0kV 60s 2.0kV 60s	275.0kV 60s 50.0kV 60s 50.0kV 60s 2.0kV 60s	PASS	

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No	Test items	Specified value	Measured value		Concl- usion		
		Standards (commission requirements)	Before short-circuit test	After short-circuit test			
9	Induced AC withstand voltage test with partial discharge measurement (routine test)	Frequency (Hz): >50	200		PASS		
		0.4Ur (kV)	4.847	4.847			
		Duration (min): /	/	/			
		Discharge magnitude ≤50pC	A:<1 B:<1 C:<1	A:<1 B:<1 C:<1			
		1.2Ur (kV)	14.462	14.462			
		Duration (min): 1	1	1			
		Discharge magnitude ≤100pC	A:<5 B:<2 C:<3	A:<5 B:<5 C:<5			
		1.58Ur (kV)	18.969	18.969			
		Duration (min): 5	5	5			
		Discharge magnitude ≤250pC	A:<10 B:<15 C:<5	A:<15 B:<15 C:<15			
		2Ur (kV)	24.126	24.213			
		Duration (min): 0.5	0.5	0.5			
		1.58Ur (kV)	18.996~19.196	18.968~18.968			
		Duration (min): 60	60	60			
		Discharge magnitude ≤250pC	A:<25 B:<30 C:<25	A:<35 B:<35 C:<36			
		1.2Ur (kV)	14.495	14.513			
		Duration (min): 1	1	1			
		Discharge magnitude ≤100pC	A:<10 B:<1 C:<1	A:<10 B:<10 C:<10			
		0.4Ur (kV)	4.898	4.912			
		Duration (min): /	/	/			
		Discharge magnitude ≤50pC	A:<1 B:<1 C:<1	A:<5 B:<5 C:<5			

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No	Test items	Specified value	Measured value		Concl- usion
		Standards (commission requirements)	Before short-circuit test	After short-circuit test	
10	Check of the ratio and polarity of built-in current transformers (routine test)	Providing measured value of ratio and polarity relation	See 4.10	See 4.22.4.10	/
11	Measurement of no-load loss and current (routine test)	100% I_0 (%): 0.20 +0% Ur P_0 (kW): 25.000 +0%	0.09 23.650	0.09 23.351	PASS
		90% I_0 (%): measured Ur P_0 (kW): measured	0.06 17.132	0.06 16.951	/
		95% I_0 (%): measured Ur P_0 (kW): measured	0.06 19.774	0.06 19.415	
		105% I_0 (%): measured Ur P_0 (kW): measured	0.24 29.825	0.22 29.023	
		110% I_0 (%): measured Ur P_0 (kW): measured	0.74 37.442	0.79 32.915	
		After induced AC withstand voltage test:			
12	Measurement of short-circuit impedance and load loss (routine test)	100% I_0 (%): 0.20 +0% Ur P_0 (kW): 25.000 +0%	0.07 22.410	0.09 22.951	PASS
		t: 75°C Z (%): 20.4 ±7.5% P_k (kW): 190.000 +0% P_{total} (kW): 215.000 +0%	19.83 182.896 206.546	19.85 183.141 206.492	PASS
13	Insulating liquid test, measurement of dissolved gasses in dielectric liquid from each separate oil compartment except diverter switch compartment (routine test)	Breakdown voltage (kV): ≥70 tanδ (90°C): ≤0.25% Water content (mg /L): ≤10	See 4.13	See 4.22.4.13	PASS
		Providing gas chromatograph analysis: Hydrogen : <30μL /L Acetylene : 0 Total hydrocarbon: <20μL /L			
14	Leak testing with pressure for liquid-immersed transformers (routine test)	Applied pressure (kPa): 30 Duration (h): 24 No oil leakage or damage	30 24 No oil leakage or damage		PASS
15	Tests on on-load tap-changers (routine test)	Number of cycles: 8 times/1 time/ 1 time/10 times Without failure	8 times/1 time/ 1 time/10 times Without failure	8 times/1 time/ 1 time/10 times Without failure	PASS

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No	Test items	Specified value	Measured value		Concl- usion
		Standards (commission requirements)	Before short-circuit test	After short-circuit test	
16	Temperature-rise test (type test) Calculation of the winding hot-spot temperature-rise (special test)	Cooling method: ONAN Top oil temperature-rise limits (K): 45 Winding temperature-rise limits (K): 50 Winding hot-spot temperature-rise limits (K): 63	Top oil temperature-rise: 34.4 HV winding temperature-rise: 38.6 LV winding temperature-rise: 41.2 HV winding hot-spot temperature-rise: 52.3 LV winding hot-spot temperature-rise: 55.7		PASS
		Cooling method: ONAF Top oil temperature-rise limits (K): 45 Winding temperature-rise limits (K): 50			
		Winding hot-spot temperature-rise limits (K): 63			
17	Determination of sound levels (type test)	Cooling method: ONAN Sound pressure level L_{pA} dB(A): <65 Sound power level L_{WA} dB(A): Cooling method: ONAF Sound pressure level L_{pA} dB(A): <65 Sound power level L_{WA} dB(A):	58 78 56 79		PASS
18	Measurement of zero-sequence impedances on three-phase transformers (special test)	Providing zero-sequence impedances values (Ω)	See 4.18		/
19	Measurement of the harmonics of the no-load current (commission test)	Providing harmonics of the no-load current of each phase at 100%Ur	Harmonics of the no-load current of I_1 - I_{20}		/
20	Measurement of frequency response (special test)	Providing frequency response characteristic curve	See 4.20		/
21	Measurement of the power taken by the fan and motors (type test)	Providing measured value	See 4.21		/

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No	Test items	Specified value		Measured value	Concl- usion
		Standards (commission requirements)			
22	Short-circuit withstand test (special test)	Test times of each phase: 3 times Duration (s): 0.25±10% The test oscillogram shall be normal. The reactance tolerance of phase before and after the test is not more than 2%. The out-of-tank inspection does not reveal any obvious defects. Routine retests shall be passed after short-circuit test.		3 times 0.258~0.258 Without abnormality The maximum reactance tolerance of phase: 0.13 % Without obvious defects. Routine retests are passed.	PASS
23	Lightning impulse test (routine test, special test)	HV	Line terminal:		PASS
			Full wave (kV): 650 ±3%	642.183~654.733	
			Chopped wave (kV): 715 ±3%	709.819~718.174	
			Neutral point:		
		LV	Full wave (kV): 650 ±3%	642.304~654.420	
			Line terminal:		
			Full wave (kV): 125 ±3%	122.350~126.830	
			Chopped wave (kV): 140 ±3%	137.141~137.812	
			Neutral point:		
			Full wave (kV): 125 ±3%	121.310~125.399	
24	Switching impulse test (special test)	Switching wave (kV): 540 ±3%		531.702~543.098	PASS
Blank below					

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4. Test items and results					
4.1 Measurement of d.c. insulation resistance windings-to-earth and between windings (routine test)					
Test date: Aug. 16, 2017 Relative humidity: 74%; Oil temperature: 22.5℃					
Measured parts	R ₁₅ (GΩ)	R ₆₀ (GΩ)	R ₆₀₀ (GΩ)	Absorption ratio (R ₆₀ /R ₁₅)	Polarity index (R ₆₀₀ /R ₆₀)
HV—LV, stabilivolt and earth	6.78	9.23	17.90	1.36	1.94
Stabilivolt—HV, LV and earth	9.40	13.4	18.3	1.42	1.36
LV—HV, stabilivolt and earth	5.97	8.69	19.1	1.46	2.20
HV, stabilivolt, LV—earth	5.82	7.67	11.4	1.31	1.49
HV, LV—stabilivolt and earth	6.06	7.66	10.7	1.26	1.40
HV, stabilivolt—LV and earth	4.28	6.26	10.2	1.46	1.63
LV, stabilivolt—HV and earth	6.25	8.85	14.7	1.42	1.66
4.2 Check of core and frame insulation for liquid-immersed transformers with core or frame insulation (routine test)					
Test date: Aug. 16, 2017					
Measured parts	Applied voltage (kV)	R ₆₀ (GΩ)	Corrected insulation resistance at 20℃ (GΩ)		
Core—earth	2.5	8.13	9.07		
Frame—earth	2.5	6.78	7.56		
4.3 Measurement of dissipation factor (tanδ) of the insulation system capacitances (routine test)					
Test date: Aug. 16, 2017 Relative humidity: 72%; Oil temperature: 22.7℃					
Measured parts	Dielectric dissipation factor tanδ (%)		Capacitance (pF)		
HV—LV, stabilivolt and earth	0.23		8404		
Stabilivolt—HV, LV and earth	0.28		16090		
LV—HV, stabilivolt and earth	0.23		13540		
HV, stabilivolt, LV—earth	0.35		12680		
HV, LV—stabilivolt and earth	0.25		14180		
HV, stabilivolt—LV and earth	0.27		24290		
LV, stabilivolt—HV and earth	0.33		12250		
4.4 Determination of capacitances windings-to-earth and between windings (routine test)					
Test date: Aug. 16, 2017					
See 4.3					

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4.5 Measurement of bushing capacitances and dielectric dissipation factor (tanδ) (commission test) Test date: Aug. 16, 2017						
Applied voltage	Measured contents	No				
		A	B	C	N	
		1700543	1700541	1700542	1700544	
10kV	tanδ (%)	0.34	0.35	0.34	0.33	
	Capacitance (pF)	535.9	535.0	527.1	533.5	

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4.6 Measurement of voltage ratio and check of phase displacement (routine test)							Test date: Aug. 16, 2017	
HV winding		LV winding		Transformer ratio by calculation	Measured voltage ratio tolerance (%)			Connection symbol
Tapping position	Voltage (kV)	Tapping position	Voltage (kV)		AB/ab	BC/bc	CA/ca	
1	151.800			12.650	0.09	0.11	0.10	
2	150.150			12.513	0.08	0.10	0.10	
3	148.500			12.375	0.08	0.10	0.09	
4	146.850			12.238	0.08	0.10	0.09	
5	145.200			12.100	0.08	0.09	0.09	
6	143.550			11.963	0.07	0.09	0.09	
7	141.900	/	12	11.825	0.07	0.09	0.08	YNyn0
8	140.250			11.688	0.07	0.09	0.08	
9	138.600			11.550	0.07	0.09	0.08	
10	136.950			11.413	0.06	0.09	0.08	
11	135.300			11.275	0.07	0.09	0.08	
12	133.650			11.138	0.07	0.09	0.09	
13B	132.000			11.000	0.07	0.09	0.09	
14	130.350			10.863	0.07	0.09	0.08	
15	128.700			10.725	0.07	0.09	0.09	
16	127.050			10.588	0.07	0.09	0.08	
17	125.400			10.450	0.07	0.09	0.08	
18	123.750			10.313	0.07	0.09	0.08	
19	122.100			10.175	0.07	0.09	0.08	
20	120.450			10.038	0.07	0.09	0.08	
21	118.800			9.900	0.06	0.09	0.08	
22	117.150			9.762	0.06	0.09	0.08	
23	115.500			9.625	0.06	0.09	0.08	
24	113.850			9.487	0.06	0.09	0.07	
25	112.200			9.350	0.06	0.08	0.08	

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4.7 Measurement of winding resistance (routine test)					Test date: Aug. 16, 2017 Oil temperature: 22.5℃
Winding	Tapping position	Measured resistance values (Ω)			Resistance unbalance rate (%)
		A~N a~n	B~N b~n	C~N c~n	
	1	0.95743	0.95787	0.95823	0.08
	2	0.93969	0.94003	0.94029	0.06
	3	0.92202	0.92229	0.92248	0.05
	4	0.90414	0.90440	0.90455	0.05
	5	0.88631	0.88661	0.88667	0.04
	6	0.86844	0.86862	0.86882	0.04
HV	7	0.85063	0.85077	0.85102	0.05
	8	0.83261	0.83283	0.83318	0.07
	9	0.81494	0.81518	0.81536	0.05
	10	0.79695	0.79725	0.79744	0.06
	11	0.77930	0.77961	0.77964	0.04
	12	0.76130	0.76164	0.76170	0.05
	13B	0.74268	0.74231	0.74147	0.16
	14	0.83852	0.83919	0.83941	0.11
	15	0.82083	0.82137	0.82149	0.08
	16	0.80287	0.80348	0.80360	0.09
	17	0.78510	0.78568	0.78570	0.08
	18	0.76717	0.76769	0.76789	0.09
	19	0.74945	0.74985	0.75007	0.08
	20	0.73133	0.73189	0.73222	0.12
	21	0.71369	0.71423	0.71442	0.10
	22	0.69567	0.69631	0.69647	0.11
	23	0.67806	0.67867	0.67868	0.09
	24	0.66000	0.66069	0.66070	0.11
	25	0.64175	0.64164	0.64073	0.16
LV	/	5.7224×10 ⁻³	5.6996×10 ⁻³	5.7552×10 ⁻³	0.97
Stabilivolt	/	aw~cw:0.18753	/	/	/

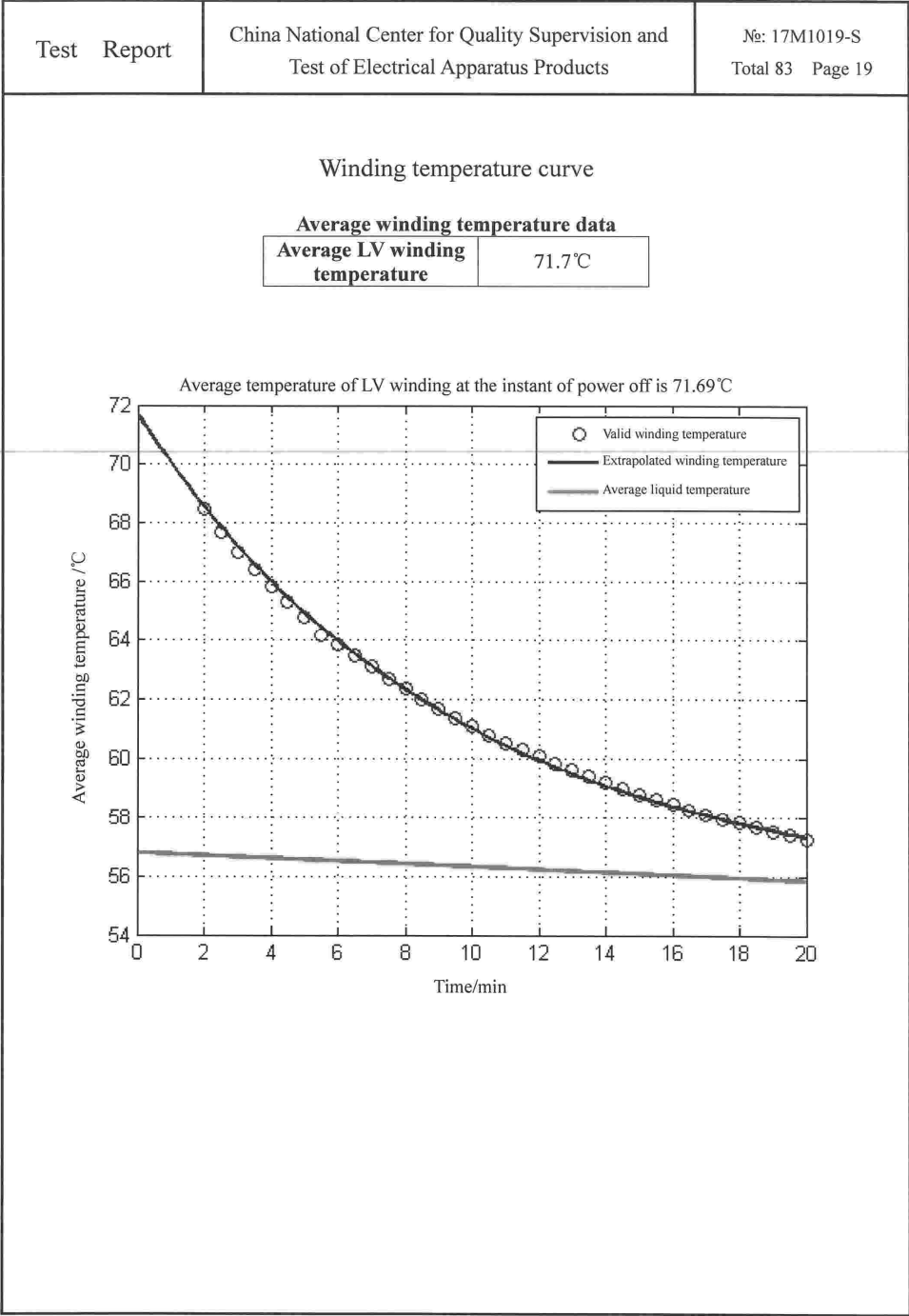
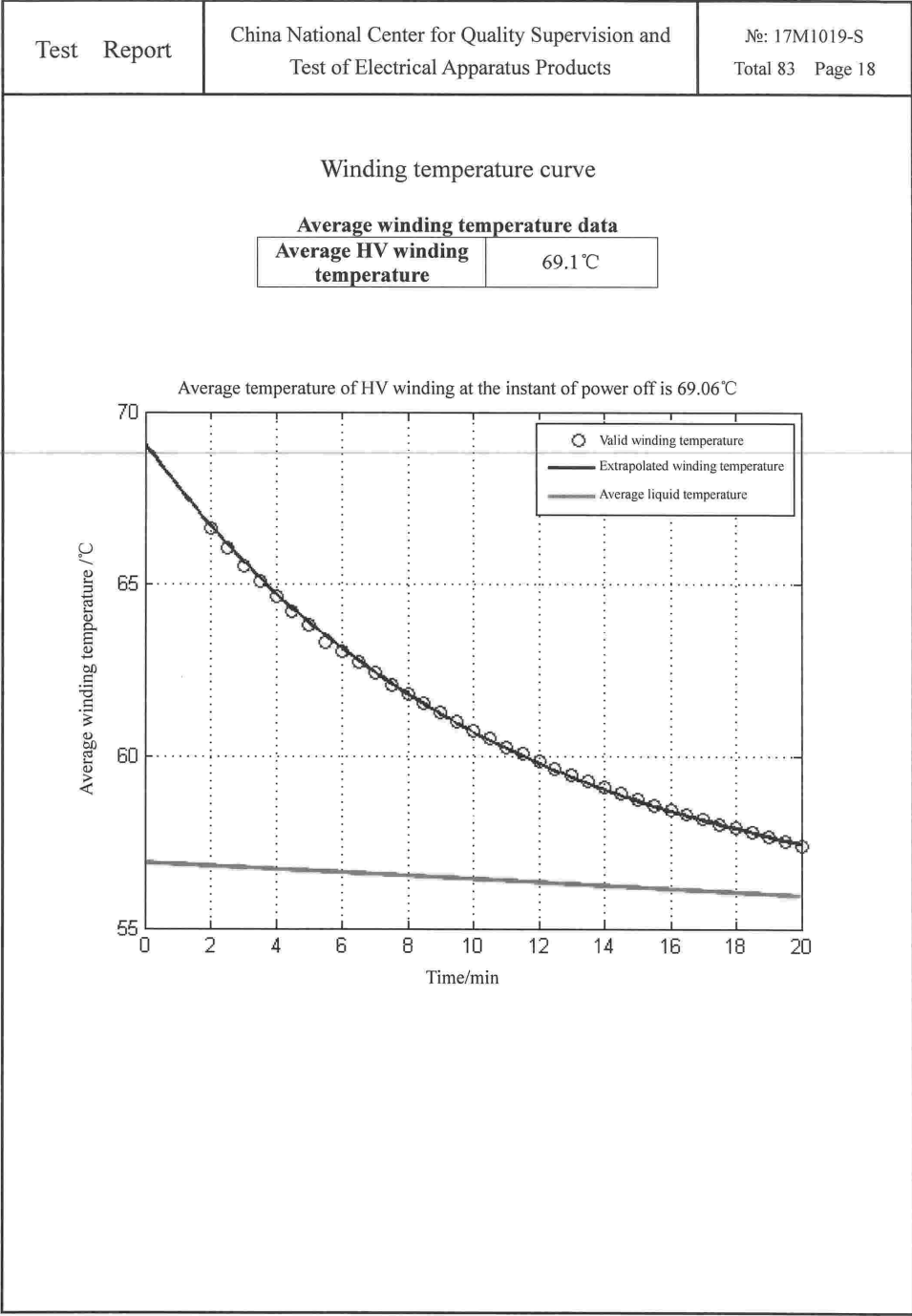
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4.8 Separate-source AC withstand voltage test (routine test) Test date: Aug. 17, 2017 Relative humidity: 66%; Ambient temperature: 21.5℃; Oil temperature: 21.8℃; Air pressure: 101kPa					
Parts of applied voltage		Test voltage (kV)	Duration (s)	Result	
HV and neutral point-stabilivolt, LV and earth		275	60	PASS	
LV and neutral point-HV, stabilivolt and earth		50	60		
Stabilivolt-HV, LV and earth		50	60		
Auxiliary power and control circuitry to earth		2	60		
4.9 Induced AC withstand voltage test with partial discharge measurement (routine test) Test date: Aug. 18, 2017 Relative humidity: 73%; Ambient temperature: 21.5℃; Oil temperature: 22.1℃; Air pressure: 101kPa Tapping position: 13B, frequency: 200Hz.					
Applied voltage		Duration (min)	Partial discharge magnitude (pC)		
Multiple	Voltage between phases (kV)		A	B	C
0.4Ur	4.847	/	<1	<1	<1
1.2Ur	14.462	1	<5	<2	<3
1.58Ur	18.969	5	<10	<15	<5
2.0Ur	24.126	0.5	/	/	/
1.58Ur	18.996	5	<20	<25	<25
	19.166	5	<15	<15	<15
	19.175	5	<25	<25	<25
	19.169	5	<25	<30	<25
	19.196	5	<15	<20	<20
	19.191	5	<15	<15	<15
	19.171	5	<10	<15	<15
	19.182	5	<15	<15	<10
	19.168	5	<15	<10	<10
	19.185	5	<15	<15	<10
	19.178	5	<10	<10	<10
	19.160	5	<10	<10	<10
1.2Ur	14.495	1	<10	<1	<1
0.4Ur	4.898	/	<1	<1	<1
Remarks: Ur=132kV.					

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4.10 Check of the ratio and polarity of built-in current transformers (routine test) Test date: Aug. 17, 2017			
Test windings	Terminals	Current ratio	Polarity
A	1S1-1S2	199.21	-
B	1S1-1S2	200.96	-
	2S1-2S2	115.27	-
C	1S1-1S2	199.50	-
N	1S1-1S2	199.31	-
	2S1-2S2	199.34	-

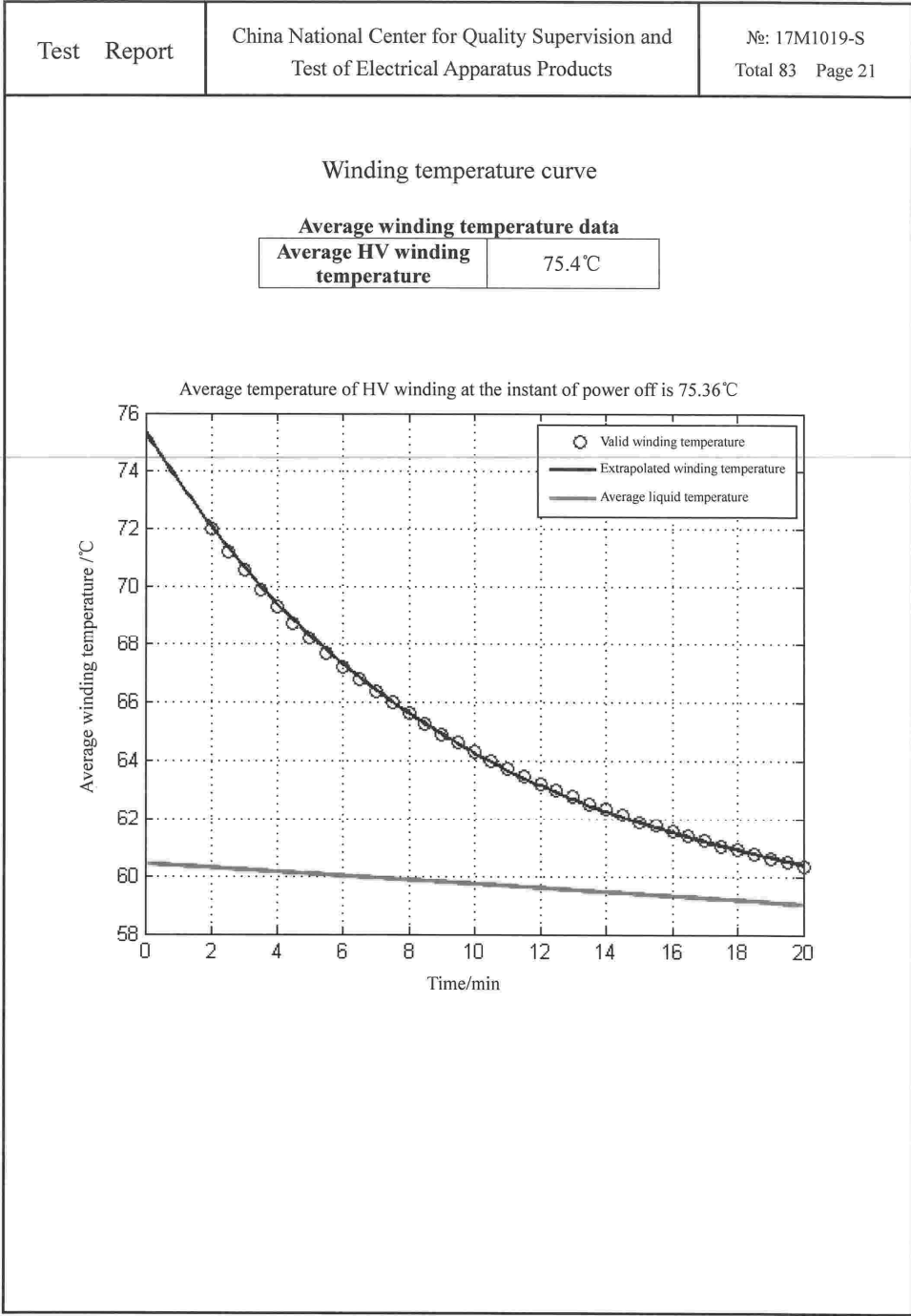
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4.11 Measurement of no-load loss and current (routine test)						Test date: Aug. 17, 2017		
Applied voltage	r.m.s. voltage (kV)		No-load current		No-load loss (kW)			
	Average voltmeter reading	r.m.s. voltmeter reading	(A)	(%)	Measured value	Corrected value		
100%Ur	12.010	12.017	1.68	0.09	23.664	23.650		
90%Ur	10.806	10.815	1.07	0.06	17.147	17.132		
95%Ur	11.412	11.421	1.20	0.06	19.790	19.774		
105%Ur	12.626	12.621	4.67	0.24	29.814	29.825		
110%Ur	13.203	13.158	14.30	0.74	37.295	37.442		
Remarks: the difference between r.m.s voltmeter reading and average voltmeter reading is within 3%.								
Secondary no-load test after induced AC withstand voltage test:						Test date: Aug. 18, 2017		
Applied voltage	r.m.s. voltage (kV)		No-load current		No-load loss (kW)			
	Average voltmeter reading	r.m.s. voltmeter reading	(A)	(%)	Measured value	Corrected value		
100%Ur	12.016	11.962	1.43	0.07	22.310	22.410		
Remarks: the difference between r.m.s voltmeter reading and average voltmeter reading is within 3%.								
4.12 Measurement of short-circuit impedance and load loss (routine test)						Test date: Aug. 18, 2017 Oil temperature: 21.7℃		
Winding	Tapping position	Applied current I		Measured voltage (kV)	Short-circuit impedance (for each phase)		Load loss (kW)	Total loss (kW)
		(A)	I/Ir (%)		HV impedance (Ω)	(%)	Corrected value	Corrected value
					t=75℃ I=Ir	t=75℃ I=Ir	t=75℃ I=Ir	t=75℃ I=Ir
HV LV	1	80.15	52.68	17.751	127.88	22.20	191.266	214.916
	13B	96.38	55.09	14.415	86.37	19.83	182.896	206.546
	25	117.08	56.88	11.745	57.91	18.40	195.737	219.387

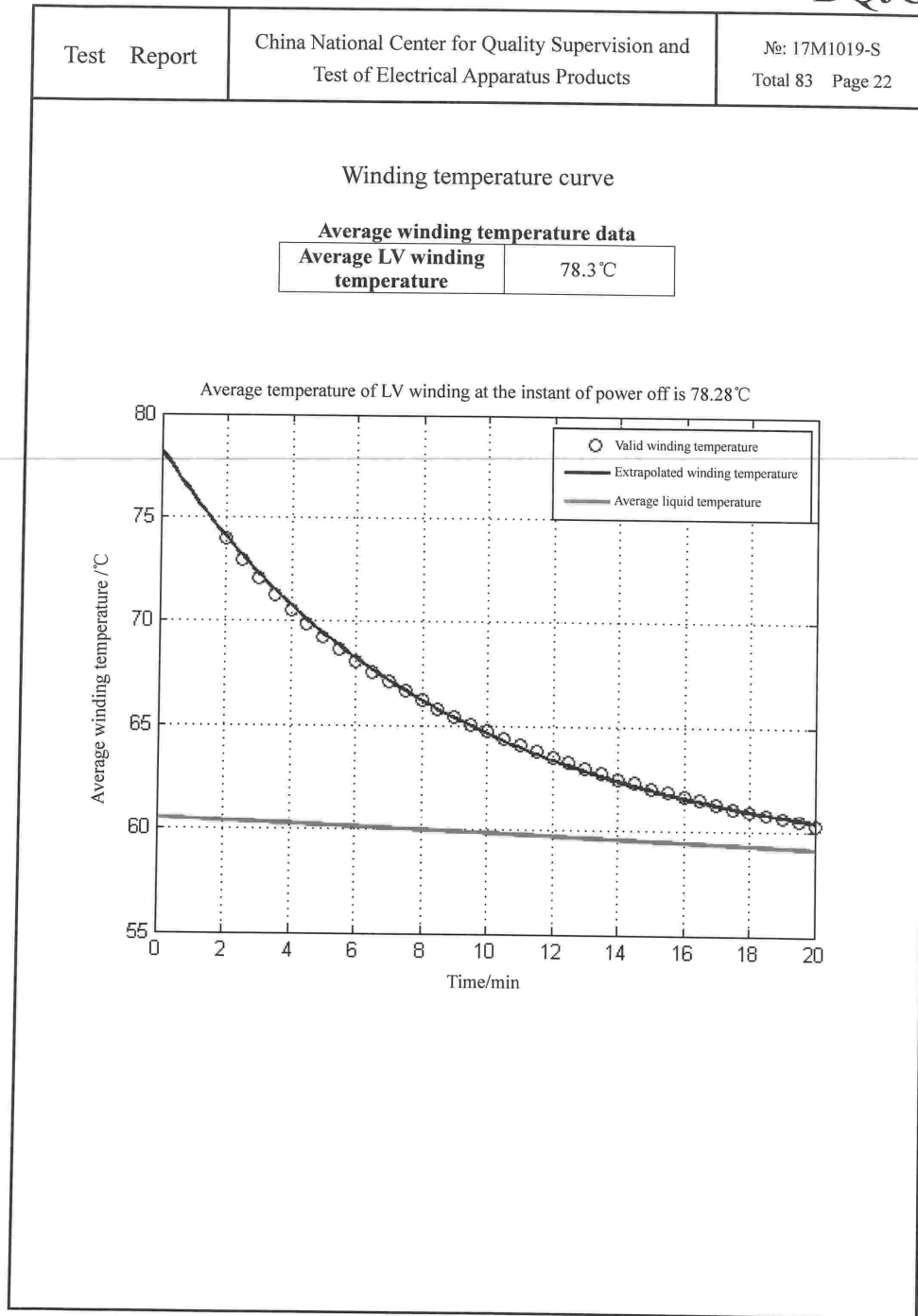
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4.13 Insulating liquid test, measurement of dissolved gasses in dielectric liquid from each separate oil compartment except diverter switch compartment (routine test)								Test date: Aug. 14, 2017
Dielectric dissipation factor (90℃)		Breakdown voltage (kV)			Water content (mg/L)			
0.12%		72.0			9.0			
Gas chromatograph analysis (before all tests) Test date: Aug. 14, 2017								μL/L
H ₂	CO	CO ₂	CH ₄	C ₂ H ₆	C ₂ H ₄	C ₂ H ₂	Total hydrocarbon	
0.00	0.89	29.73	0.00	0.00	0.00	0.00	0	
Gas chromatograph analysis (after dielectric tests, before short-circuit test) Test date: Aug. 18, 2017								μL/L
H ₂	CO	CO ₂	CH ₄	C ₂ H ₆	C ₂ H ₄	C ₂ H ₂	Total hydrocarbon	
0.53	5.07	32.48	0.08	0.00	0.00	0.00	0.08	
Gas chromatograph analysis (after short-circuit test, before dielectric retests) Test date: Aug. 20, 2017								μL/L
H ₂	CO	CO ₂	CH ₄	C ₂ H ₆	C ₂ H ₄	C ₂ H ₂	Total hydrocarbon	
0.71	6.29	27.99	0.14	0.00	0.00	0.00	0.14	
Gas chromatograph analysis (after dielectric retests, before temperature-rise test) Test date: Aug. 25, 2017								μL/L
H ₂	CO	CO ₂	CH ₄	C ₂ H ₆	C ₂ H ₄	C ₂ H ₂	Total hydrocarbon	
0.79	7.13	33.16	0.16	0.00	0.09	0.00	0.16	
Gas chromatograph analysis (after temperature-rise test, after dielectric retests) Test date: Aug. 26, 2017								μL/L
H ₂	CO	CO ₂	CH ₄	C ₂ H ₆	C ₂ H ₄	C ₂ H ₂	Total hydrocarbon	
1.65	12.88	63.57	0.29	0.00	0.00	0.00	0.29	

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4.14 Leak testing with pressure for liquid-immersed transformers (routine test) Test date: from Aug. 15, 2017 to Aug. 16, 2017											
Test method		Applied pressure (kPa)		Duration (h)		Results					
Static pressure method		30.0		24		No oil leakage or damage					
Remarks: the product is general tank.											
4.15 Tests on on-load tap-changers (routine test) The following sequence of operations shall be performed Test date: Aug. 16, 2017											
Test conditions		Operation conditions	Results	Test conditions		Operation conditions	Results				
1. with the transformer un-energized		8 operation cycles	Without failure	3. with the transformer energized at rated voltage and frequency at no load		1 operation cycle	Without failure				
2. with the transformer un-energized, and with the operating voltage reduced to 85% of its rated value		1 operation cycle	Without failure	4. with one winding short-circuited and rated current in the tapped winding		10 tap conversions	Without failure				
4.16 Temperature-rise test (type test) Test date: from Aug. 25, 2017 to Aug. 26, 2017											
4.16.1 Cooling method: ONAN											
The method of temperature rise is the equivalent test in short-circuit connection. The HV (tapping position is 25) supplies power and LV is connected by short-circuit, test duration is 13h, and of which the stabilization time is 3h.											
Measurement of top oil temperature rise: it is required to apply 145.156kW of total loss and 148.616kW is actually applied during testing.											
Measurement of winding temperature rise: 162.095A current is required and 161.848A is actually applied during testing.											
Measured datum											
Top oil temperature-rise and average oil temperature-rise			Measurement of average temperature-rise windings to oil					Ambient temperature (°C)			
Top oil temperature (°C)	Average oil temperature (°C)	Total loss injection/ specified total loss (%)	Current injection/ rated current (%)	Cold resistance (Ω)		Average oil temperature (°C)		Average winding temperature (°C)		Total loss	Measurement of cold resistance
65.8	55.9	102.38	99.85	HV	1.2931	At the instant of power off	55.3	HV	69.1		
				LV	11.398 ×10 ⁻³	At the end of cooling curve	54.4	LV	71.7		
Calculations of temperature-rise											
Top oil temperature-rise (K)				34.4							
Winding temperature-rise (K)				HV		38.6					
				LV		41.2					
Winding hot-spot temperature-rise (K)				HV		52.3					
				LV		55.7					
Remarks: the calculated of temperature-rise are the corrected value under specified total loss and rated current; the winding hot-spot factor is 1.1.											



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4.16.2 Cooling method: ONAF												
The method of temperature rise is the equivalent test in short-circuit connection. The HV (tapping position is 25) supplies power and LV is connected by short-circuit, test duration is 8h, and of which the stabilization time is 3h.												
Measurement of top oil temperature rise: it is required to apply 219.762kW of total loss and 218.767kW is actually applied during testing.												
Measurement of winding temperature rise: 205.84A current is required and 204.81A is actually applied during testing.												
Measured datum												
Top oil temperature-rise and average oil temperature-rise			Measurement of average temperature-rise windings to oil							Ambient temperature (°C)		
Top oil temperature (°C)	Average oil temperature (°C)	Total loss injection/specified total loss (%)	Current injection/rated current (%)	Cold resistance (Ω)		Average oil temperature (°C)		Average winding temperature (°C)		Total loss	Measurement of cold resistance	
72.6	60.8	99.55	99.50	HV	1.293 1	At the instant of power off		60.2	HV	75.4	34.8	27.8
				LV	11.398 ×10 ⁻³	At the end of cooling curve		58.8	LV	78.3		
Calculations of temperature-rise												
Top oil temperature-rise (K)				38.0								
Winding temperature-rise (K)				HV		41.4						
				LV		44.3						
Winding hot-spot temperature-rise (K)				HV		57.9						
				LV		61.7						
Remarks: the calculated of temperature-rise are the corrected value under specified total loss and rated current; the winding hot-spot factor is 1.3.												





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Test date: Aug. 21, 2017

4.17 Determination of sound levels (type test)

4.17.1 Cooling method: ONAN

Measurement of sound pressure level and calculation of sound power level

The transformer is rated excitation; the prescribed contour shall be spaced 0.3m away from the principal radiating surface, the distance between measured points is 0.940m, the number of measured points is 28, the height of measured point 1 is 1.000m and point 2 is 2.000m. The fan is not run.

Measurement of test environment

The total area of the surface of the test room S_v (m ²)	The average acoustic absorption coefficient α	The amount of acoustic absorption A (m ²)	Distance from the principal radiating surface (m)	The area of the measurement surface S (m ²)	Environmental correction K (dB)
3293.2	0.15	494.0	0.3	99.0	2.6

Measured values (dB)

Status of cooling device	Average of background noise		Average noise value of transformer $\overline{L}_{pA0}$	A weighted sound pressure level	A weighted sound power level
	Before the test	After the test		$\overline{L}_{pA} = 10 \lg(10^{0.1\overline{L}_{pA0}} - 10^{0.1\overline{L}_{bgA}}) - K$	$L_{wA} = \overline{L}_{pA} + 10 \lg(S/S_0)$
ONAN	43.9	43.8	60.7	58	78

Remarks: $\overline{L}_{pA0}$: the uncorrected average A-weighted sound pressure level; $\overline{L}_{pA0} = 10 \lg(\frac{1}{N} \sum_{i=1}^N 10^{0.1L_{pAi}})$

$\overline{L}_{bgA}$: the lower of the two calculated average A weighted background noise pressure level.

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4.17.2 Cooling method: ONAF							
Measurement of sound pressure level and calculation of sound power level							
The transformer is rated excitation; the prescribed contour shall be spaced 2m away from the principal radiating surface, the distance between measured points is 0.970m, the number of measured points is 38, the height of measured point 1 is 1.000m and point 2 is 2.000m. The fan is in the service condition.							
Measurement of test environment							
The total area of the surface of the test room Sv (m ²)	The average acoustic absorption coefficient α		The amount of acoustic absorption A (m ²)	Distance from the principal radiating surface (m)	The area of the measurement surface S (m ²)	Environmental correction K (dB)	
3293.2	0.15		494.0	2.0	185.2	4.0	
Measured values (dB)							
Status of cooling device	Average of background noise		Average noise value of transformer $\overline{L}_{pA0}$	A weighted sound pressure level $\overline{L}_{pA} = 10 \lg(10^{0.1\overline{L}_{pA0}} - 10^{0.1\overline{L}_{bgA}}) - K$	A weighted sound power level $L_{WA} = \overline{L}_{pA} + 10 \lg(S/S_0)$		
	Before the test	After the test					
ONAF	43.9	43.8	60.6	56	79		
Remarks: $\overline{L}_{pA0}$: the uncorrected average A-weighted sound pressure level; $\overline{L}_{pA0} = 10 \lg(\frac{1}{N} \sum_{i=1}^N 10^{0.1L_{pAi}})$ $\overline{L}_{bgA}$: the lower of the two calculated average A weighted background noise pressure level.							
4.18 Measurement of zero-sequence impedances on three-phase transformers (special test) Test date: Aug. 21, 2017							
Connection symbol	Power supply terminal	Open-circuit terminal	Short-circuit terminal	Tapping positions	Applied current (A)	Test voltage (V)	Impedance (Ω)
YNyn	ABC-O	/	abc-O	1	53.43	2067	116.06
				13B	90.98	2415	79.63
				25	69.53	1251	53.98
	ABC-O	abc-O	/	1	53.65	2766	154.67
				13B	65.88	2399	109.25
				25	72.57	1836	75.90
	abc-O	/	ABC-O	1	150.28	9.054	0.18
				13B	162.03	9.519	0.18
				25	173.40	9.990	0.17
	abc-O	ABC-O	/	1	188.65	14.506	0.23
				13B	171.12	13.159	0.23
				25	171.56	13.191	0.23

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4.19 Measurement of the harmonics of the no-load current (commission test)					Test date: Aug. 21, 2017		
4.19.1 Applied 100%Ur							
No	CH-A THD =47.55		CH-B THD =76.07		CH-C THD =50.99		
	In (A)	In/I1 (%)	In (A)	In/I1 (%)	In (A)	In/I1 (%)	
01	1.51	100.00	0.80	100.00	1.51	100.00	
02	0.00	0.00	0.00	0.00	0.00	0.00	
03	0.25	16.37	0.46	57.03	0.29	18.95	
04	0.00	0.00	0.00	0.00	0.00	0.00	
05	0.54	35.87	0.30	37.95	0.58	38.60	
06	0.00	0.00	0.00	0.00	0.00	0.00	
07	0.36	23.78	0.21	26.50	0.37	24.73	
08	0.00	0.00	0.00	0.00	0.00	0.00	
09	0.05	3.44	0.12	14.94	0.07	4.73	
10	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.14	9.56	0.09	10.92	0.14	8.98	
12	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.08	5.31	0.04	5.46	0.08	5.51	
14	0.00	0.00	0.00	0.00	0.00	0.00	
15	0.01	0.96	0.02	3.12	0.01	0.76	
16	0.00	0.00	0.00	0.00	0.00	0.00	
17	0.04	2.65	0.02	3.06	0.03	2.31	
18	0.00	0.00	0.00	0.00	0.00	0.00	
19	0.02	1.04	0.01	0.90	0.01	0.77	

Test Report		China National Center for Quality Supervision and Test of Electrical Apparatus Products				№: 17M1019-S Total 83 Page 26	
4.19.2 Applied 90%Ur							
№	CH-A THD =21.83		CH-B THD =34.30		CH-C THD =19.06		
	In (A)	In/I1 (%)	In (A)	In/I1 (%)	In (A)	In/I1 (%)	
01	1.05	100.00	0.64	100.00	1.14	100.00	
02	0.00	0.00	0.00	0.00	0.00	0.00	
03	0.18	16.88	0.21	32.76	0.13	11.63	
04	0.00	0.00	0.00	0.00	0.00	0.00	
05	0.13	12.30	0.04	6.41	0.16	13.71	
06	0.00	0.00	0.00	0.00	0.00	0.00	
07	0.06	5.67	0.04	6.19	0.06	5.54	
08	0.00	0.00	0.00	0.00	0.00	0.00	
09	0.01	1.07	0.02	3.42	0.02	1.48	
10	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.02	2.14	0.01	2.28	0.03	2.22	
12	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.01	0.99	0.01	1.27	0.01	0.93	
14	0.00	0.00	0.00	0.00	0.00	0.00	
15	0.00	0.00	0.00	0.31	0.00	0.00	
16	0.00	0.00	0.00	0.00	0.00	0.00	
17	0.01	1.29	0.01	2.27	0.01	1.20	
18	0.00	0.00	0.00	0.00	0.00	0.00	
19	0.00	0.29	0.00	0.58	0.00	0.23	

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4.19.3 Applied 110%Ur							
No	CH-A THD =80.43		CH-B THD =112.62		CH-C THD =81.74		
	In (A)	In/I1 (%)	In (A)	In/I1 (%)	In (A)	In/I1 (%)	
01	13.00	100.00	7.64	100.00	12.86	100.00	
02	0.00	0.00	0.00	0.00	0.00	0.00	
03	2.75	21.17	5.67	74.20	2.85	22.18	
04	0.00	0.00	0.00	0.00	0.00	0.00	
05	8.39	64.55	5.21	68.23	8.43	65.54	
06	0.00	0.00	0.00	0.00	0.00	0.00	
07	5.43	41.78	3.50	45.77	5.43	42.25	
08	0.00	0.00	0.00	0.00	0.00	0.00	
09	0.55	4.22	1.07	14.06	0.51	3.93	
10	0.00	0.00	0.00	0.00	0.00	0.00	
11	1.14	8.79	1.02	13.32	1.15	8.96	
12	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.17	1.30	0.40	5.17	0.21	1.66	
14	0.00	0.00	0.00	0.00	0.00	0.00	
15	0.23	1.74	0.38	4.99	0.17	1.31	
16	0.00	0.00	0.00	0.00	0.00	0.00	
17	0.33	2.52	0.06	0.75	0.29	2.29	
18	0.00	0.00	0.00	0.00	0.00	0.00	
19	0.22	1.70	0.08	1.02	0.19	1.51	

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4.20 Measurement of frequency response (special test)			Test date: Aug. 18, 2017	
For winding frequency response curves before and after short-circuit test, see P ₆₅₋₆₈ .				
4.21 Measurement of the power taken by the fan and motors (type test)			Test date: Aug. 26, 2017	
No	Voltage (kV)	Current (A)	Power (kW)	
17267	0.4017	0.93	0.273	
17266	0.4017	0.98	0.273	
17263	0.4014	0.92	0.280	
17259	0.3994	0.94	0.282	
17260	0.3999	0.90	0.277	
17264	0.3992	0.93	0.269	
17262	0.3992	0.92	0.268	
17261	0.3995	0.90	0.262	
17268	0.4007	0.91	0.269	
17265	0.4015	0.92	0.266	

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4.22 Short-circuit withstand test (special test)					
					Test date: Aug. 19, 2017
Single-phase supply should be used, and test voltage shall be supplied between one line terminal and the other two line terminals connected together. During the test, the single-phase voltage is $\sqrt{3}/2$ times of voltage between phases of three-phase test. The test oscillogram shall be normal. For the test oscillogram, see P ₃₃₋₄₁ . The percentages of peak current and symmetrical current are the ratio of applied current to calculated current.					
4.22. 1 Current calculation of short-circuit test (reference temperature 75°C)					
Tapping position	Symmetrical current value of phase		Peak current value of phase		Peak coefficient ($K\sqrt{2}$)
	HV (A)	LV (A)	HV (A)	LV (A)	
1	679	8590	1731	21900	2.55
13B	871	9580	2221	24430	2.55
25	1097	10260	2797	26160	2.55

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4.22.2 Current injection of short-circuit test														
Tapping position	Phase of peak current injection	Times	Measurement of current						U (kV)	Itank (A)	Duration (s)	Oscillogram No		
			Symmetrical current value of phase			Peak current value of phase								
			Measured value (A)		U (%)		Measured value (A)						U (%)	
			HV (A)	LV (A)	HV	LV	HV (A)	LV (A)					HV	LV
1	A	1	668.3	8161	98.42	95.01	21618	101.50	98.71	124.6	0	0.258	17M1019-S -T001	
		2	656.1	8173	96.63	95.15	21569	100.12	98.49	123.8	0	0.258	17M1019-S -T002	
		3	673.2	8182	99.15	95.25	21732	102.08	99.23	125.5	0	0.258	17M1019-S -T003	
		Measurement of reactance												
		Reactance variation of phase (%)												
1	A	Times	Reactance values of phase (Ω)			Reactance variation of phase (%)								
		A		B		C		A		B		C		
		Before tests		125.46		128.92		126.02		/		/		
		1		125.49		128.85		126.12		0.02		-0.05		
		2		125.51		128.87		126.17		0.04		-0.04		
3		125.48		128.87		126.14		0.02		-0.04				
The maximum reactance variation of phase is 0.12%.														

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13B	Phase of peak current injection	Times	Measurement of current												
			Symmetrical current value of phase			Peak current value of phase			U (kV)	Itank (A)	Duration (s)	Oscillogram No			
													Measured value (A)		
			HV (A)		LV (A)		HV (A)		LV (A)		HV (A)		LV (A)		
	1	839.5	9018	23734	2189	23734	98.56	97.15	107.7	0	0.258	17M1019-S -T004			
	2	858.8	9333	24347	2245	24347	101.08	99.66	107.6	0	0.258	17M1019-S -T005			
	3	849.5	9212	24187	2235	24187	100.63	99.01	108.1	0	0.258	17M1019-S -T006			
	A	Times	Measurement of reactance												
			Reactance values of phase (Ω)						Reactance variation of phase (%)						
			A		B		C		A		B		C		
Before tests			85.295		86.771		85.609		/		/				
1			85.389		86.771		85.703		0.11		0.00		0.11		
2			85.405		86.755		85.719		0.13		-0.02		0.13		
3		85.405		86.755		85.719		0.13		-0.02		0.13			
The maximum reactance variation of phase is 0.13%.															

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Tapping position	Phase of peak current injection	Times	Symmetrical current value of phase				Measurement of current				U (kV)	Itank (A)	Duration (s)	Oscillogram No					
			Measured value (A)		Peak current value of phase		Measured value (A)		Peak current value of phase										
			HV (A)	LV (A)	HV (A)	LV (A)	HV (A)	LV (A)	HV (A)	LV (A)									
			1	1045	9707	95.26	94.61	2787	25768	99.64					98.50	90.2	0	0.258	17M1019-S -T007
			2	1066	9832	97.17	95.83	2833	26044	101.29					99.56	90.6	0	0.258	17M1019-S -T008
			3	1072	9947	97.72	95.95	2821	26037	100.86					99.53	90.4	0	0.258	17M1019-S -T009
Measurement of reactance																			
25	A	Times	Reactance values of phase (Ω)						Reactance variation of phase (%)										
			A		B		C		A		B		C						
			Before tests		57.421		58.128		57.578		/		/						
			1		57.468		58.144		57.625		0.08		0.03		0.08				
			2		57.484		58.143		57.641		0.11		0.03		0.11				
			3		57.476		58.151		57.633		0.10		0.04		0.10				
The maximum reactance variation of phase is 0.11%.																			
4.22.3 The out-of-tank inspection The out-of-tank inspection does not reveal any obvious distortion and displacement of coil, lead and supporting structures after the short-circuit test and no traces of discharge are found. For the pictures before and after the short-circuit test, see P ₇₃ -P ₇₄ .																			

SJJJ-YB011

(11)

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Oscillogram

The oscilloscope displays four waveforms over a time interval from 2.35 s to 2.80 s. The vertical axis for all waveforms ranges from -1.5 MV to 1.5 MV. The horizontal axis is labeled with time in seconds (s) from 2.35 to 2.80. The waveforms are: U (voltage), IH (current), IL (current), and Itank (current). The U waveform is a high-frequency sine wave with an amplitude of approximately 1.2 MV. The IH waveform is a high-frequency sine wave with an amplitude of approximately 1.2 kV. The IL waveform is a high-frequency sine wave with an amplitude of approximately 1.2 kV. The Itank waveform is a high-frequency sine wave with an amplitude of approximately 1.2 kV.

17M1019-S-T001

U (kV) 124.6

IHp (A) 1757

IH (A) 668.3

ILp (A) 21618

IL (A) 8161

Itank (A) 0

T(ms) 258

扫描编号: 1

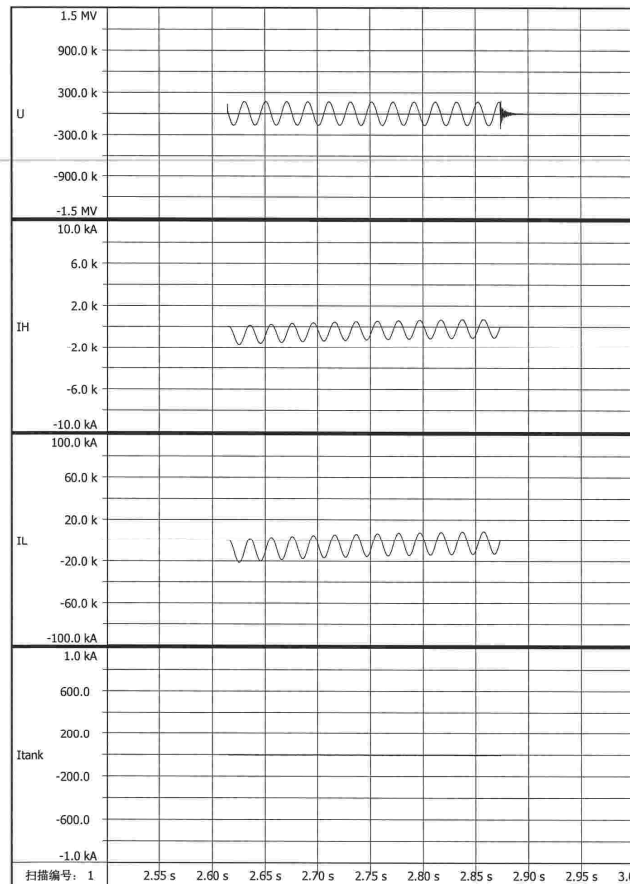
2.35 s 2.40 s 2.45 s 2.50 s 2.55 s 2.60 s 2.65 s 2.70 s 2.75 s 2.80

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Oscillogram

17M1019-S-T002



U (kV) 123.8

I_{Hp} (A) 1733I_H (A) 656.1I_{Lp} (A) 21569I_L (A) 8173I_{tank} (A) 0

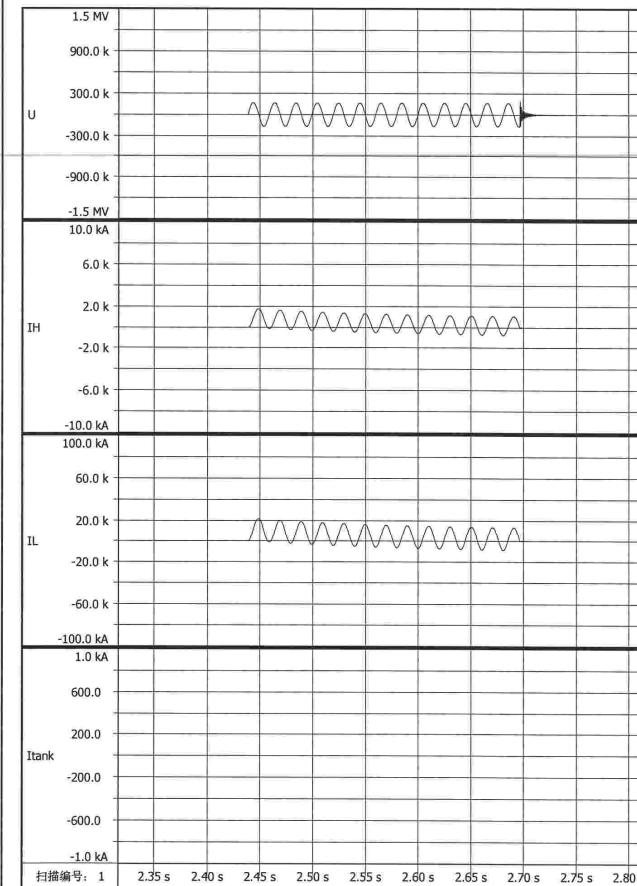
T(ms) 258

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Oscillogram

17M1019-S-T003



U (kV) 125.5

I_{Hp} (A) 1767I_H (A) 673.2I_{Lp} (A) 21732I_L (A) 8182I_{tank} (A) 0

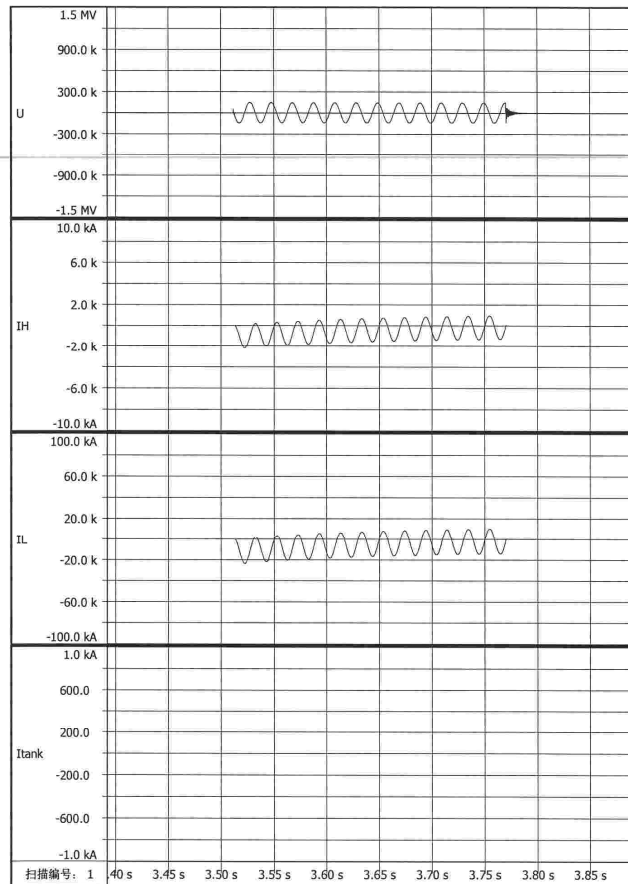
T(ms) 258

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Oscillogram

17M1019-S-T004



U (kV) 107.7

IH_p (A) 2189

IH (A) 839.5

IL_p (A) 23734

IL (A) 9018

Itank (A) 0

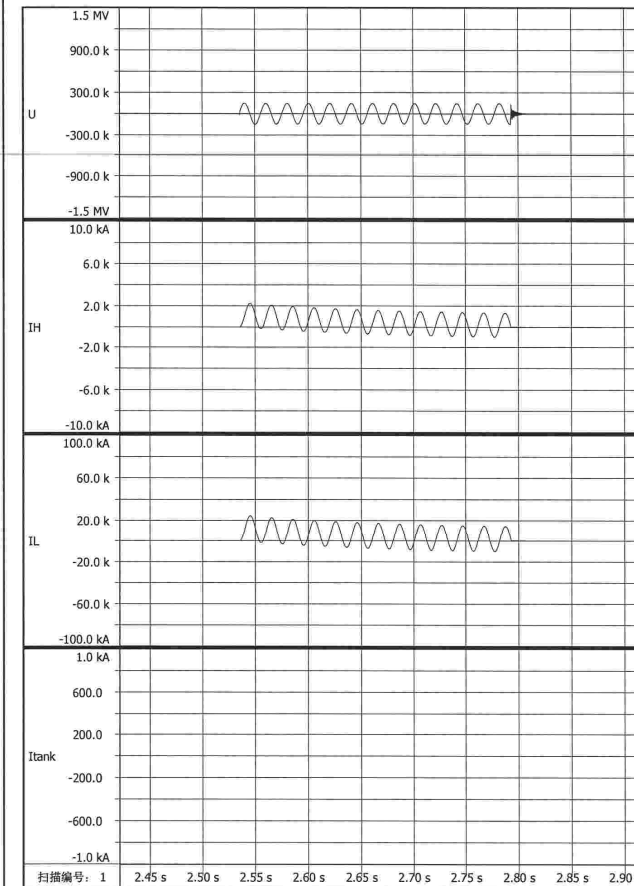
T(ms) 258

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Oscillogram

17M1019-S-T005



U (kV) 107.6

IH_p (A) 2245

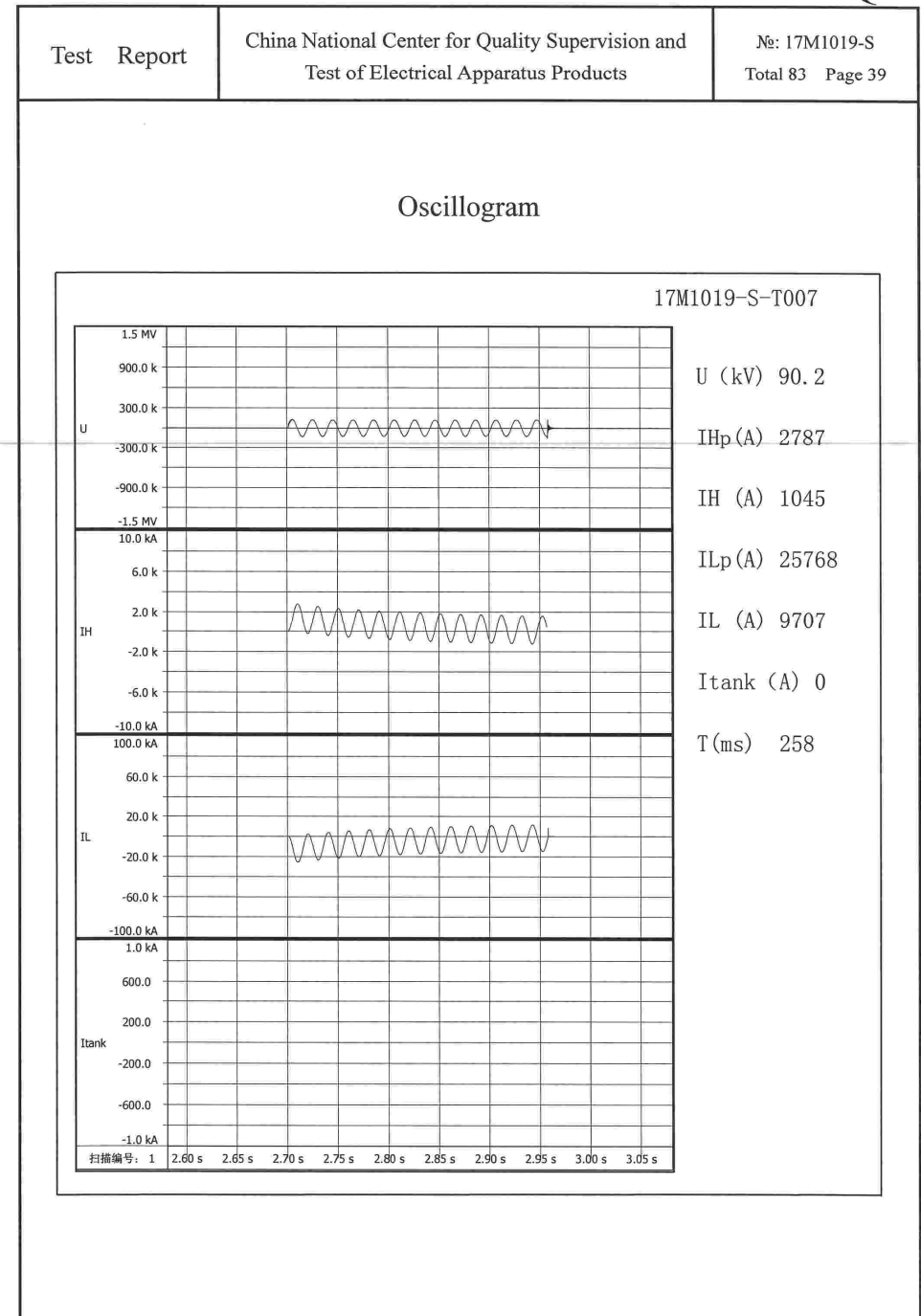
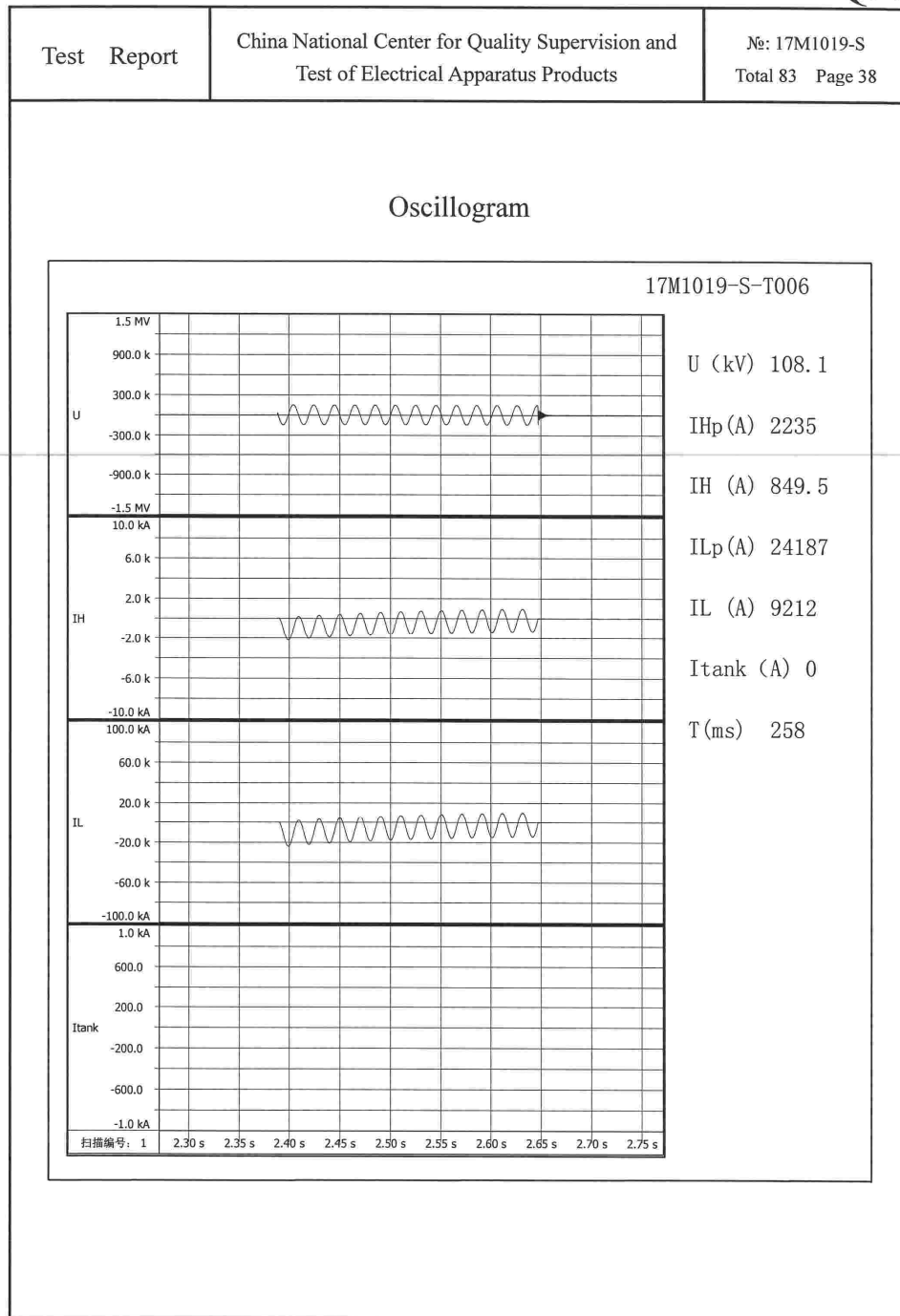
IH (A) 858.8

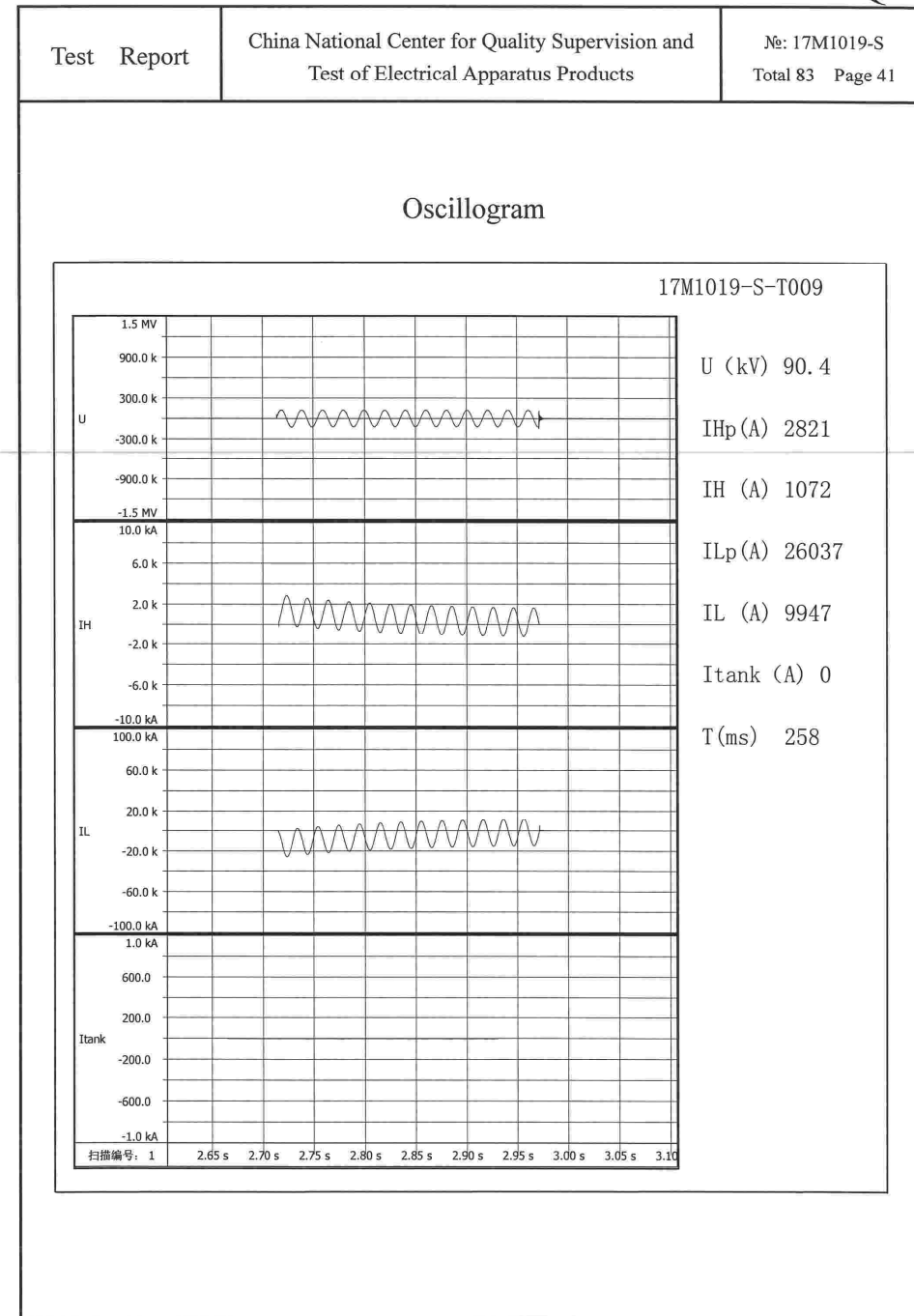
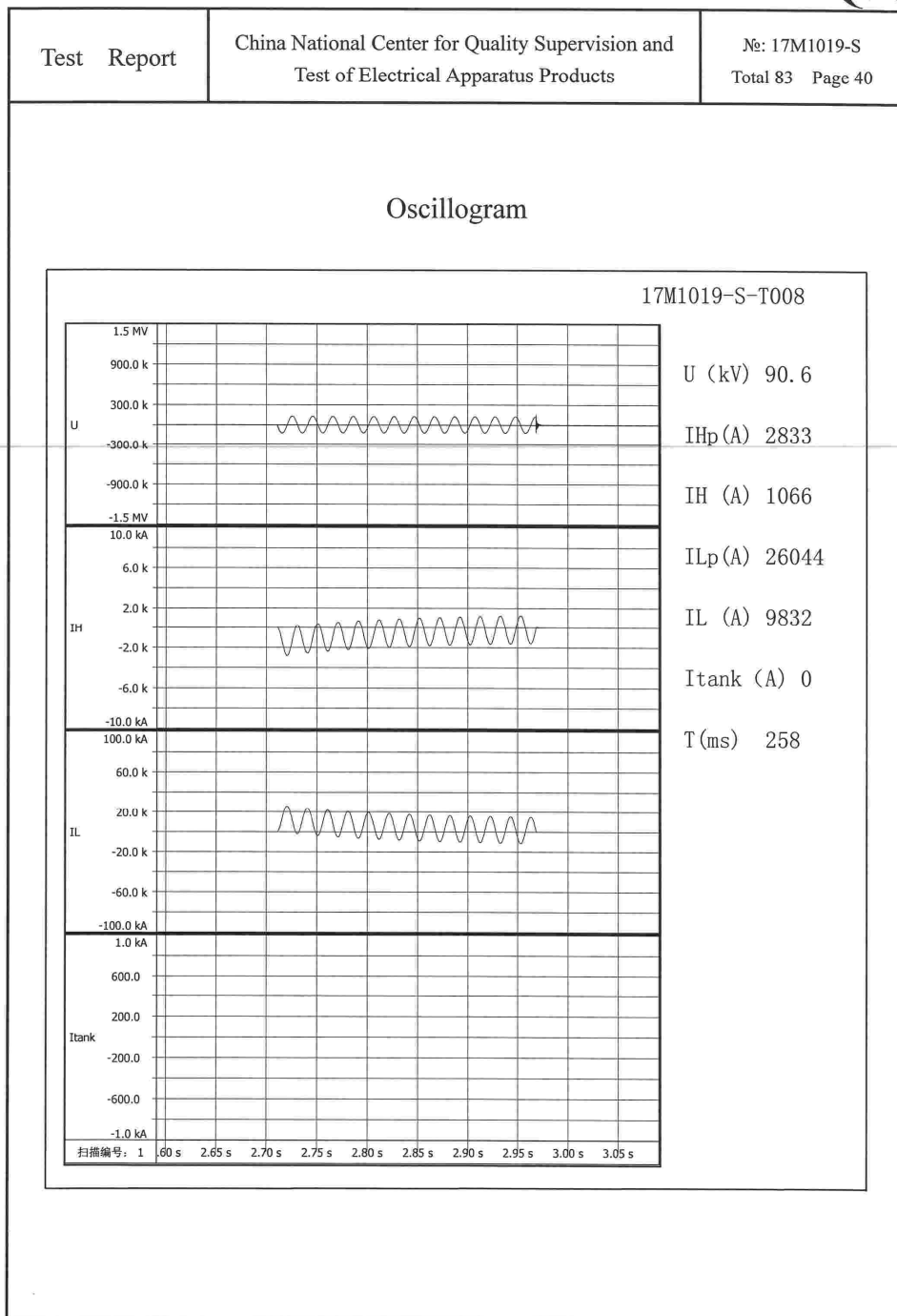
IL_p (A) 24347

IL (A) 9333

Itank (A) 0

T(ms) 258





Test Report	China National Center for Quality Supervision and Test of Electrical Apparatus Products			№: 17M1019-S Total 83 Page 42	
4.22.4 Routine retests					
4.22.4.1 Measurement of d.c. insulation resistance windings-to-earth and between windings (routine test)					
Test date: Aug. 20, 2017 Relative humidity: 58%; Oil temperature: 26.0°C					
Measured parts	R ₁₅ (GΩ)	R ₆₀ (GΩ)	R ₆₀₀ (GΩ)	Absorption ratio (R ₆₀ /R ₁₅)	Polarity index (R ₆₀₀ /R ₆₀)
HV—LV, stabilivolt and earth	6.01	10.45	19.40	1.74	1.86
Stabilivolt—HV, LV and earth	4.83	13.42	32.3	2.78	2.41
LV—HV, stabilivolt and earth	4.39	10.68	27.00	2.43	2.53
HV, stabilivolt, LV—earth	6.22	10.78	15.45	1.73	1.43
HV, LV—stabilivolt and earth	6.49	11.25	15.82	1.73	1.41
HV, stabilivolt—LV and earth	4.99	7.76	13.55	1.56	1.75
LV, stabilivolt—HV and earth	6.77	14.22	25.6	2.10	1.8
4.22.4.2 Check of core and frame insulation for liquid-immersed transformers with core or frame insulation (routine test)					
Test date: Aug. 20, 2017					
Measured parts	Applied voltage (kV)		R ₆₀ (GΩ)	Corrected insulation resistance at 20°C (GΩ)	
Core—earth	2.5		7.08	11.06	
Frame—earth	2.5		5.77	8.92	
4.22.4.3 Measurement of dissipation factor (tanδ) of the insulation system capacitances (routine test)					
Test date: Aug. 20, 2017 Relative humidity: 78%; Oil temperature: 31.0°C					
Measured parts	Dielectric dissipation factor tanδ (%)			Capacitance (pF)	
HV—LV, stabilivolt and earth	0.19			8379	
Stabilivolt—HV, LV and earth	0.22			16070	
LV—HV, stabilivolt and earth	0.21			13510	
HV, stabilivolt, LV—earth	0.30			12650	
HV, LV—stabilivolt and earth	0.22			14160	
HV, stabilivolt—LV and earth	0.21			24260	
LV, stabilivolt—HV and earth	0.29			12220	
4.22.4.4 Determination of capacitances windings-to-earth and between windings (routine test)					
Test date: Aug. 20, 2017					
See 4.22.4.3					

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4.22.4.5 Measurement of bushing capacitances and dielectric dissipation factor (tanδ) (routine test) Test date: Aug. 20, 2017					
Applied voltage	Measured contents	No			
		A	B	C	N
		1700543	1700541	1700542	1700544
10kV	tanδ (%)	0.31	0.30	0.29	0.29
	Capacitance (pF)	536.6	535.9	526.8	534.3

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4.22.4.6 Measurement of voltage ratio and check of phase displacement (routine test) Test date: Aug. 20, 2017								
HV winding		LV winding		Transformer ratio by calculation	Measured voltage ratio tolerance (%)			Connection symbol
Tapping position	Voltage (kV)	Tapping position	Voltage (kV)		AB/ab	BC/bc	CA/ca	
1	151.800			12.650	0.22	0.18	0.19	
2	150.150			12.513	0.22	0.19	0.19	
3	148.500			12.375	0.22	0.19	0.19	
4	146.850			12.238	0.21	0.19	0.19	
5	145.200			12.100	0.17	0.15	0.16	
6	143.550			11.963	0.18	0.15	0.15	
7	141.900	/	12	11.825	0.17	0.14	0.14	YNyn0
8	140.250			11.688	0.17	0.15	0.15	
9	138.600			11.550	0.16	0.15	0.16	
10	136.950			11.413	0.16	0.13	0.15	
11	135.300			11.275	0.16	0.14	0.14	
12	133.650			11.138	0.15	0.13	0.15	
13B	132.000			11.000	0.15	0.13	0.14	
14	130.350			10.863	0.16	0.13	0.14	
15	128.700			10.725	0.16	0.13	0.14	
16	127.050			10.588	0.16	0.13	0.14	
17	125.400			10.450	0.14	0.12	0.12	
18	123.750			10.313	0.16	0.14	0.14	
19	122.100			10.175	0.15	0.13	0.13	
20	120.450			10.038	0.16	0.13	0.13	
21	118.800			9.900	0.14	0.11	0.12	
22	117.150			9.762	0.14	0.12	0.12	
23	115.500			9.625	0.14	0.10	0.11	
24	113.850			9.487	0.15	0.13	0.14	
25	112.200			9.350	0.13	0.12	0.12	

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4.22.4.7 Measurement of winding resistance (routine test)					Test date: Aug. 20, 2017 Oil temperature: 31.0°C
Winding	Tapping position	Measured resistance values (Ω)			Resistance unbalance rate (%)
		A~N a~n	B~N b~n	C~N c~n	
	1	0.9863	0.9868	0.9871	0.08
	2	0.9680	0.9684	0.9687	0.07
	3	0.9496	0.9500	0.9503	0.07
	4	0.9312	0.9316	0.9318	0.06
	5	0.9128	0.9132	0.9134	0.07
	6	0.8944	0.8947	0.8950	0.07
HV	7	0.8759	0.8762	0.8766	0.08
	8	0.8574	0.8579	0.8582	0.09
	9	0.8391	0.8396	0.8399	0.10
	10	0.8204	0.8212	0.8214	0.12
	11	0.8027	0.8029	0.8030	0.04
	12	0.7841	0.7844	0.7845	0.05
	13B	0.7649	0.7645	0.7637	0.16
	14	0.8636	0.8640	0.8646	0.12
	15	0.8453	0.8456	0.8461	0.09
	16	0.8269	0.8276	0.8277	0.10
	17	0.8085	0.8092	0.8092	0.09
	18	0.7901	0.7907	0.7909	0.10
	19	0.7717	0.7722	0.7725	0.10
	20	0.7532	0.7534	0.7541	0.12
	21	0.7349	0.7353	0.7358	0.12
	22	0.7164	0.7168	0.7172	0.11
	23	0.6982	0.6986	0.6989	0.10
	24	0.6797	0.6804	0.6804	0.10
	25	0.6609	0.6608	0.6599	0.15
	LV	/	5.899×10 ⁻³	5.874×10 ⁻³	5.934×10 ⁻³
Stabilivolt	/	aw~cw:0.19337	/	/	/

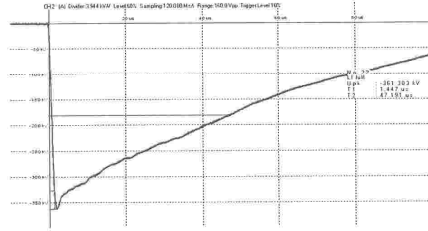
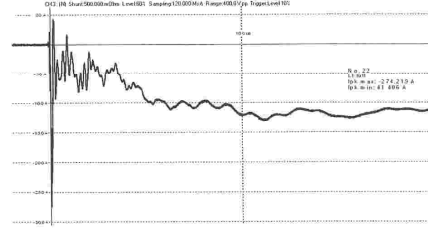
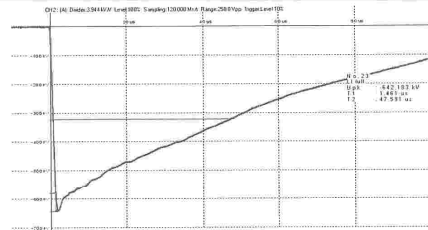
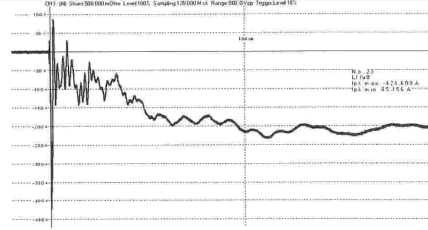
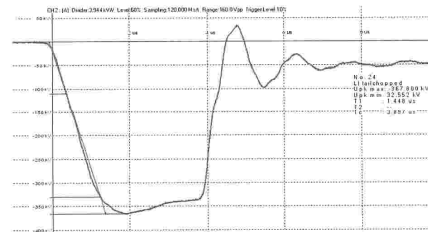
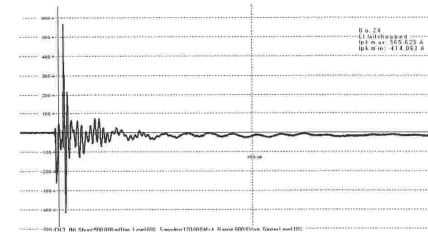
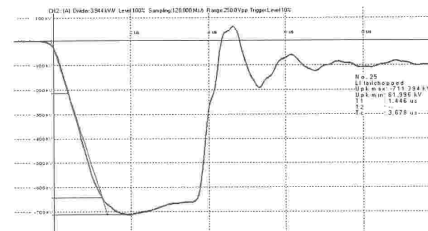
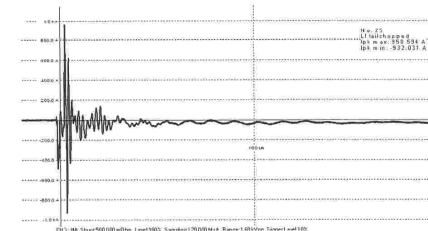
Test Report		China National Center for Quality Supervision and Test of Electrical Apparatus Products		№: 17M1019-S Total 83 Page 46	
4.22.4.8 Separate-source AC withstand voltage test (routine test) Test date: Aug. 24, 2017 Relative humidity: 75%; Ambient temperature: 26.5°C; Oil temperature: 25.8°C; Air pressure: 101kPa					
Parts of applied voltage		Test voltage (kV)	Test date (s)	result	
HV and neutral point - stabilivolt, LV and earth		275	60	PASS	
LV and neutral point - HV, stabilivolt and earth		50	60		
Stabilivolt - HV, LV and earth		50	60		
Wiring for auxiliary power and control circuitry		2	60		
4.22.4.9 Induced AC withstand voltage test with partial discharge measurement (routine test) Test date: Aug. 24, 2017 Relative humidity: 69%; Ambient temperature: 27.2°C; Oil temperature: 32.3°C; Air pressure: 101kPa Tapping position: 13B, frequency200Hz.					
Applied voltage		Duration (min)	Partial discharge magnitude (pC)		
Multiple	Voltage between phases (kV)		A	B	C
0.4Ur	4.847	/	<1	<1	<1
1.2Ur	14.462	1	<5	<5	<5
1.58Ur	18.969	5	<15	<15	<15
2.0Ur	24.213	0.5	/	/	/
1.58Ur	18.983	5	<35	<35	<35
	18.968	5	<35	<35	<35
	18.971	5	<35	<35	<36
	18.983	5	<20	<20	<20
	18.984	5	<20	<20	<20
	18.982	5	<15	<15	<15
	18.983	5	<10	<10	<10
	18.981	5	<10	<10	<10
	18.993	5	<15	<15	<15
	18.997	5	<10	<10	<10
	18.998	5	<10	<10	<10
	18.988	5	<10	<10	<10
1.2Ur	14.513	1	<10	<10	<10
0.4Ur	4.912	/	<5	<5	<5
Remarks: Ur=132kV.					

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4.22.4.10 Check of the ratio and polarity of built-in current transformers (routine test) Test date: Aug. 26, 2017			
Test windings	Terminals	Current ratio	Polarity
A	1S1-1S2	199.28	-
B	1S1-1S2	200.87	-
	2S1-2S2	115.23	-
C	1S1-1S2	199.63	-
N	1S1-1S2	199.42	-
	2S1-2S2	199.31	-

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4.22.4.11 Measurement of no-load loss and current (routine test)						Test date: Aug. 21, 2017		
Applied voltage	r.m.s. voltage (kV)		No-load current		No-load loss (kW)			
	Average voltmeter reading	r.m.s. voltmeter reading	(A)	(%)	Measured value	Corrected value		
100%Ur	12.008	12.016	1.68	0.09	23.367	23.351		
90%Ur	10.822	10.831	1.06	0.06	16.965	16.951		
95%Ur	11.401	11.410	1.19	0.06	19.427	19.415		
105%Ur	12.599	12.594	4.59	0.22	29.011	29.023		
110%Ur	13.195	13.149	15.177	0.79	32.081	32.915		
Remarks: the difference between r.m.s voltmeter reading and average voltmeter reading is within 3%.								
Secondary no-load test after induced AC withstand voltage test:						Test date: Aug. 26, 2017		
Applied voltage	r.m.s. voltage (kV)		No-load current		No-load loss (kW)			
	Average voltmeter reading	r.m.s. voltmeter reading	(A)	(%)	Measured value	Corrected value		
100%Ur	11.99	12.008	1.67	0.09	22.968	22.951		
Remarks: the difference between r.m.s voltmeter reading and average voltmeter reading is within 3%.								
4.22.4.12 Measurement of short-circuit impedance and load loss (routine test)						Test date: Aug. 21, 2017 Oil temperature: 28.3℃		
Winding	Tapping position	Applied current I		Measured voltage (kV)	Short-circuit impedance (for each phase)		Load loss (kW)	Total loss (kW)
		(A)	I/Ir (%)		IIV impedance (Ω)	(%)	Corrected value	Corrected value
					t=75℃ I=Ir	t=75℃ I=Ir	t=75℃ I=Ir	t=75℃ I=Ir
HV LV	1	77.38	50.86	17.116	127.72	22.17	191.797	215.148
	13B	95.56	54.62	14.308	86.47	19.85	183.141	206.492
	25	109.45	53.17	11.001	58.03	18.44	196.411	219.762

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4.22.4.13 Insulating liquid test, measurement of dissolved gasses in dielectric liquid from each separate oil compartment except diverter switch compartment (routine test) Test date: Aug. 20, 2017					
Dielectric dissipation factor (90℃)		Breakdown voltage (kV)		Water content (mg/L)	
0.22%		72.4		9.8	
For gas chromatograph analysis, see 4.13.					
4.22.4.14 Tests on on-load tap-changers (routine test) Test date: Aug. 20, 2017					
Test conditions	Operation conditions	Results	Test conditions	Operation conditions	Results
1. with the transformer un-energized	8 operation cycles	Without failure	3. with the transformer energized at rated voltage and frequency at no load	1 operation cycle	Without failure
2. with the transformer un-energized, and with the operating voltage reduced to 85% of its rated value	1 operation cycle	Without failure	4. with one winding short-circuited and rated current in the tapped winding	10 tap conversions	Without failure

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4.23 Lightning impulse test (routine test, special test)			Test date: Aug. 22, 2017/ Aug. 23, 2017
Atmospheric conditions of test: Relative humidity: 69%; Ambient temperature: 23.1℃; Oil temperature: 23.0℃; Air pressure: 101 kPa. Relative humidity: 73%; Ambient temperature: 20.6℃; Oil temperature: 20.4℃; Air pressure: 101 kPa.			
Test items and voltage			
Withstand terminals	Rated withstand voltage (kV)		Tapping position
	Lightning full wave	Lightning chopped wave	
A, B, C	650	715	A:25; B:13B; C:1
a, b, c	125	140	/
N	650	/	/
n	125	/	/
Test sequence: Line terminal: One negative reduced level full impulse; One negative rated level full impulse; One negative reduced level chopped impulse; Two negative rated level chopped impulse; Two negative rated level full impulse. Neutral point: One negative reduced level full impulse; Three negative rated level full impulse. Test waveform records: T1: wave front time; T2: time to half of peak value; Tc: chopped wave time; Upk: peak voltage. For waveform diagram, see P ₅₁ ~P ₆₄ . Voltage ranges of oscillograms are as below:			
Withstand terminals	Full wave (kV)	Chopped wave (kV)	
A, B, C	642.183~654.733	709.819~718.174	
a, b, c	122.350~126.830	137.141~137.812	
N	642.304~654.420	/	
n	121.310~125.399	/	

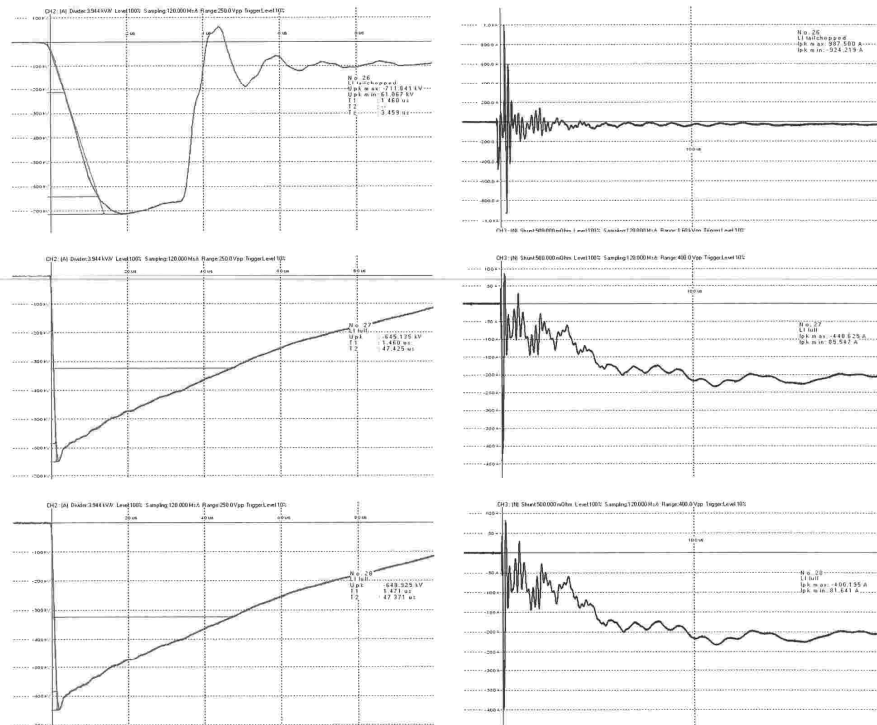
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Tested terminal: A Test polarity: negative Channel 1: voltage wave Channel 2: current wave			
			
			
			
			

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Tested terminal: A Test polarity: negative Channel 1: voltage wave Channel 2: current wave

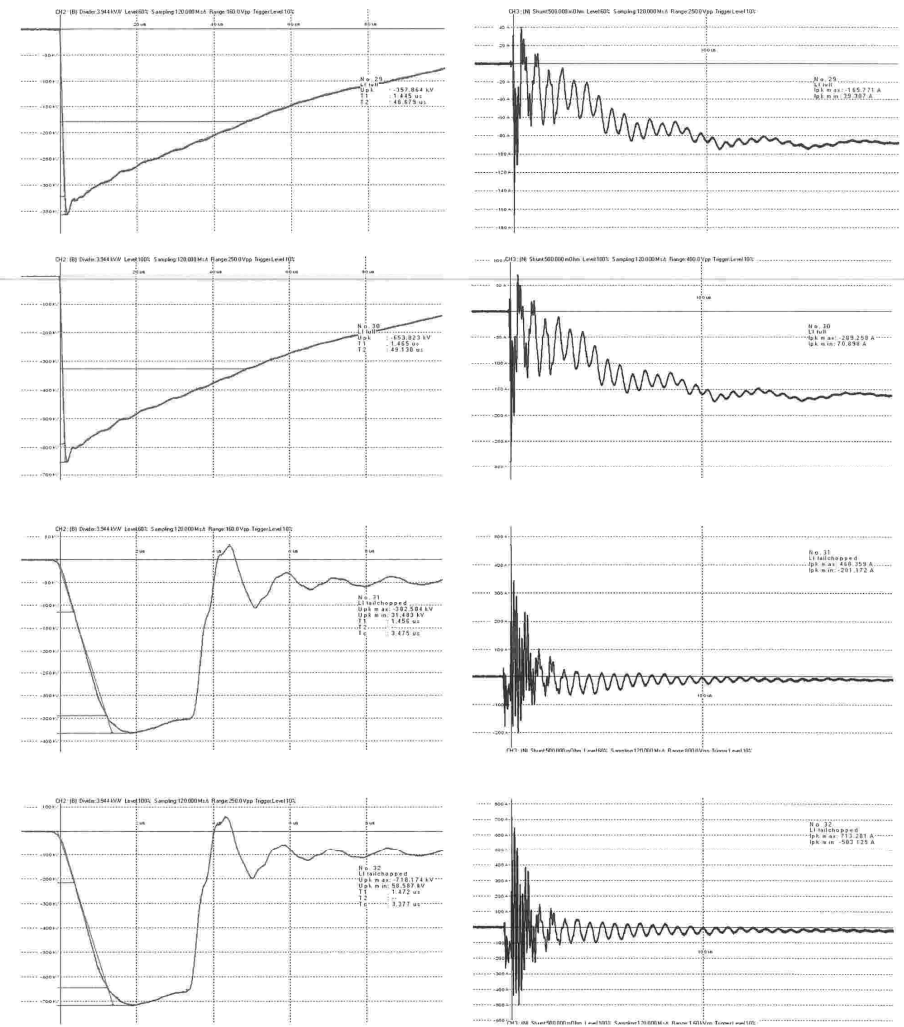


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Tested terminal: B Test polarity: negative Channel 1: voltage wave Channel 2: current wave

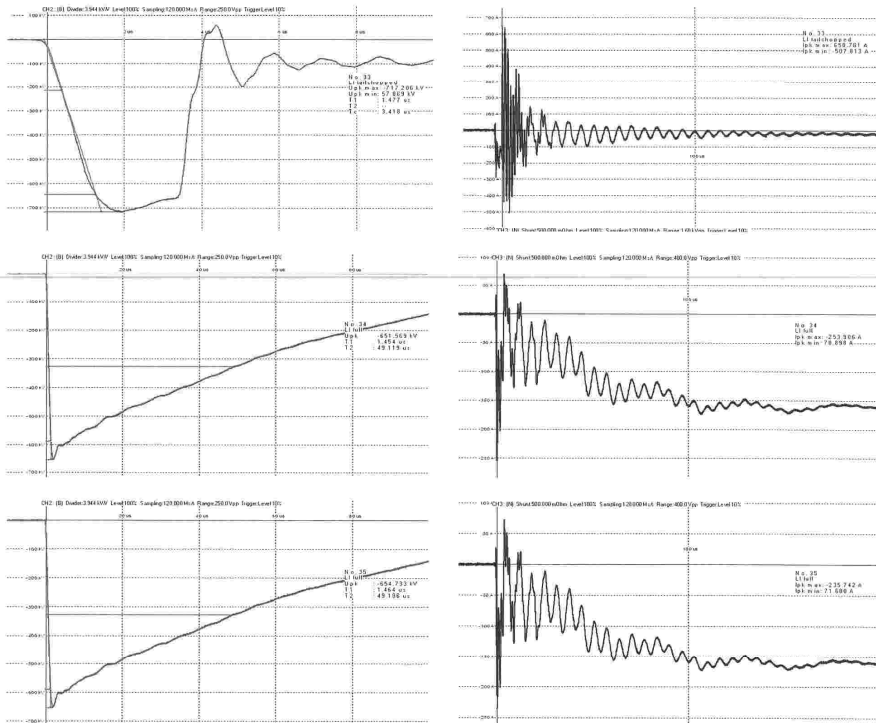


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Tested terminal: B Test polarity: negative Channel 1: voltage wave Channel 2: current wave

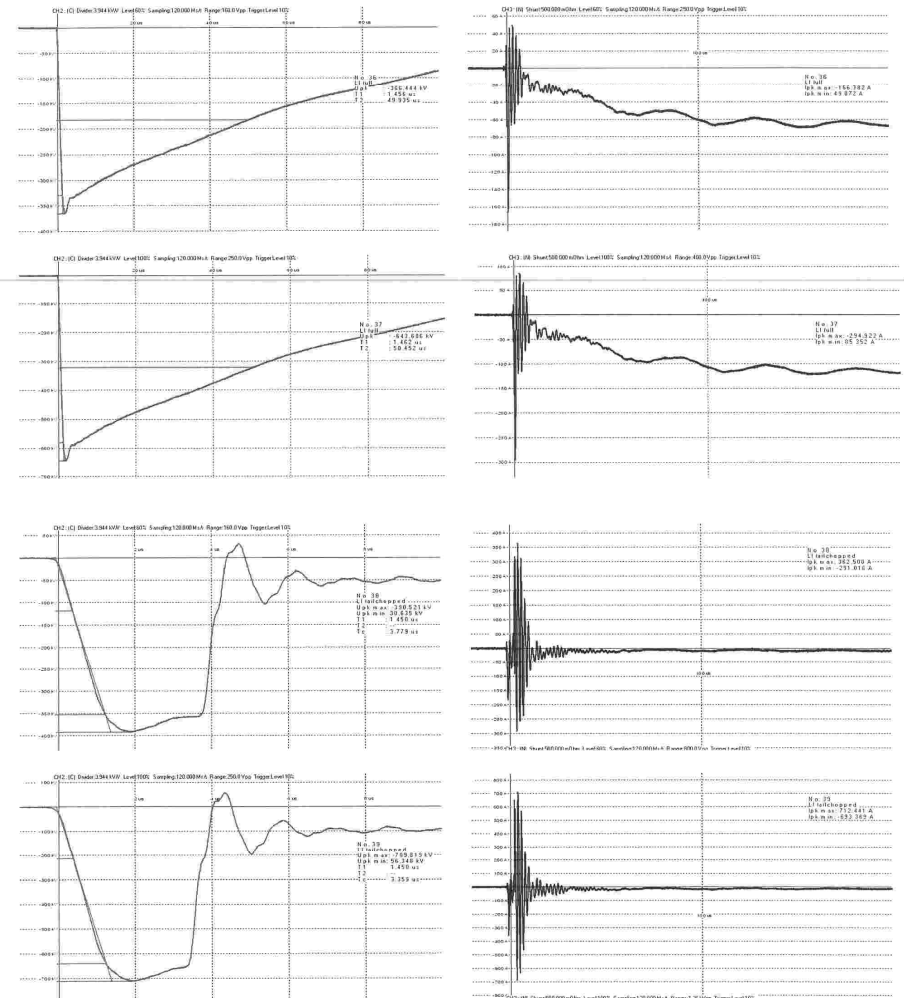


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Tested terminal: C Test polarity: negative Channel 1: voltage wave Channel 2: current wave

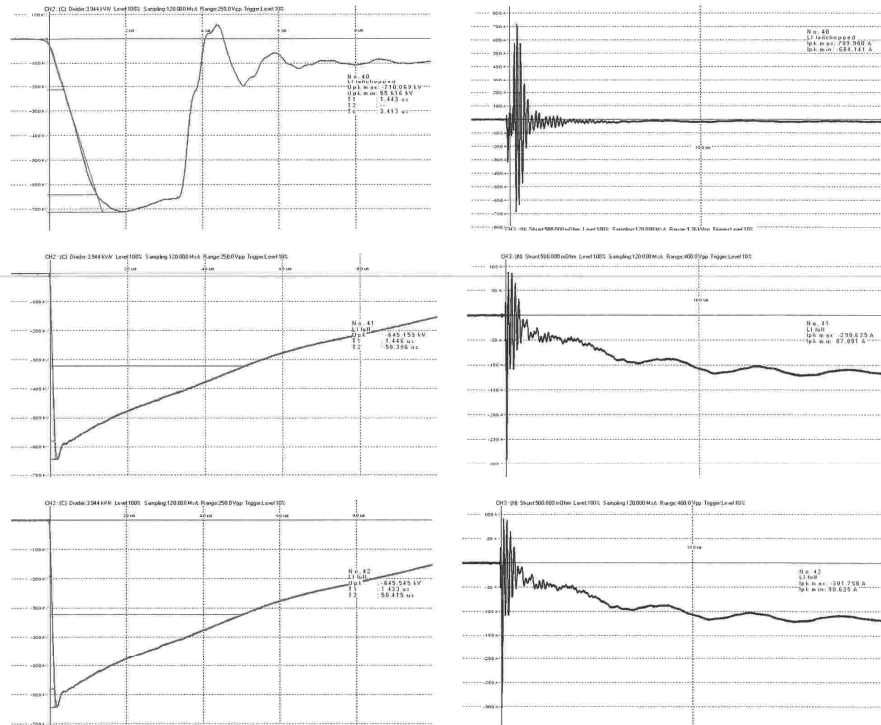


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Tested terminal: C Test polarity: negative Channel 1: voltage wave Channel 2: current wave

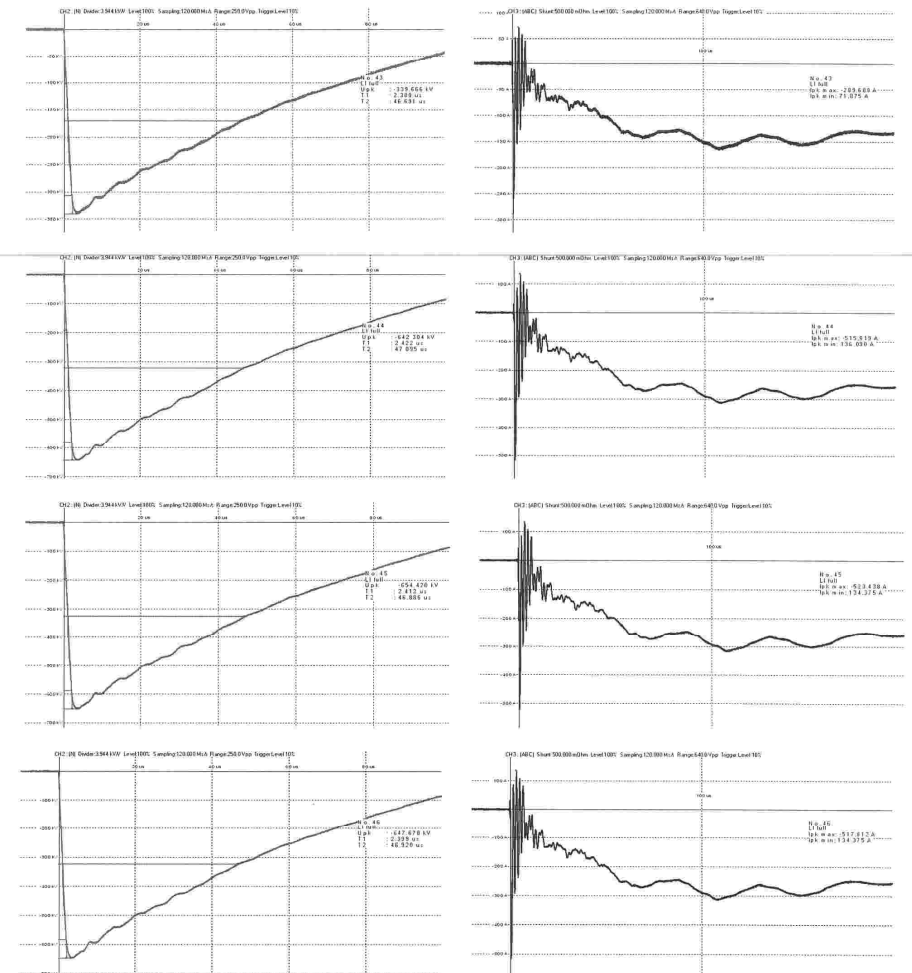


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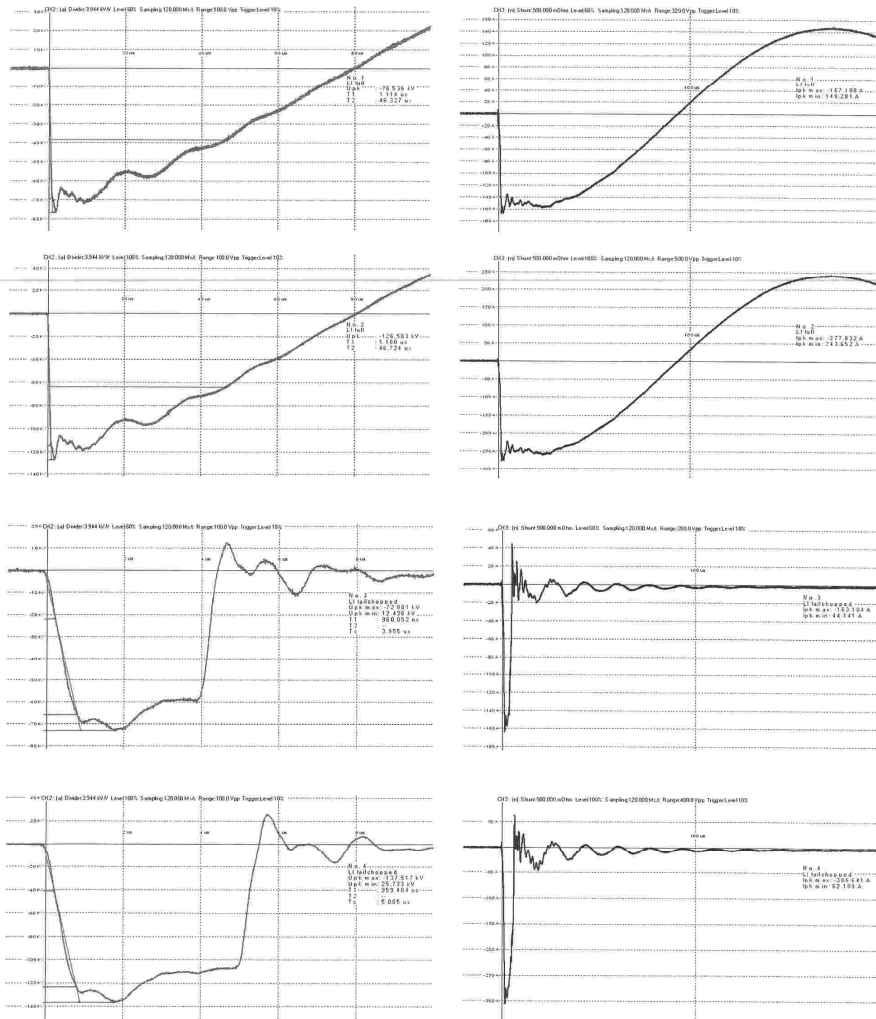
Tested terminal: N Test polarity: negative Channel 1: voltage wave Channel 2: current wave



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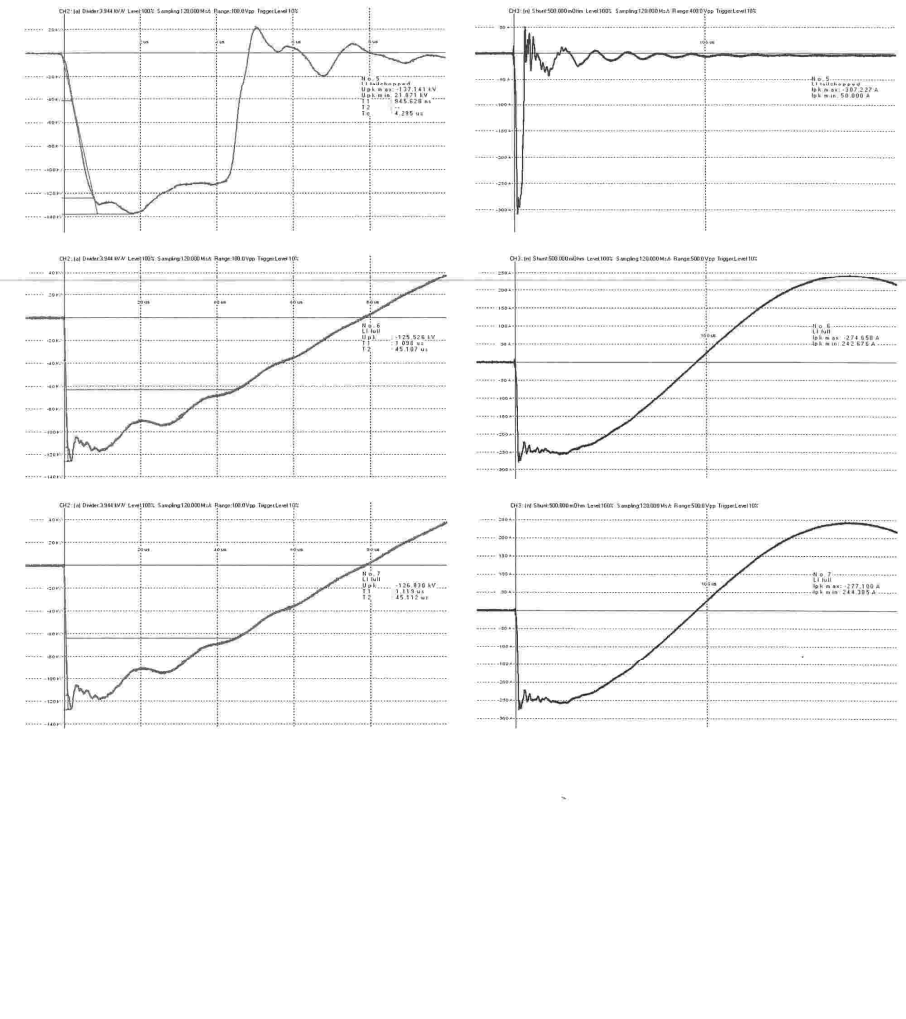
Tested terminal: a Test polarity: negative Channel 1: voltage wave Channel 2: current wave



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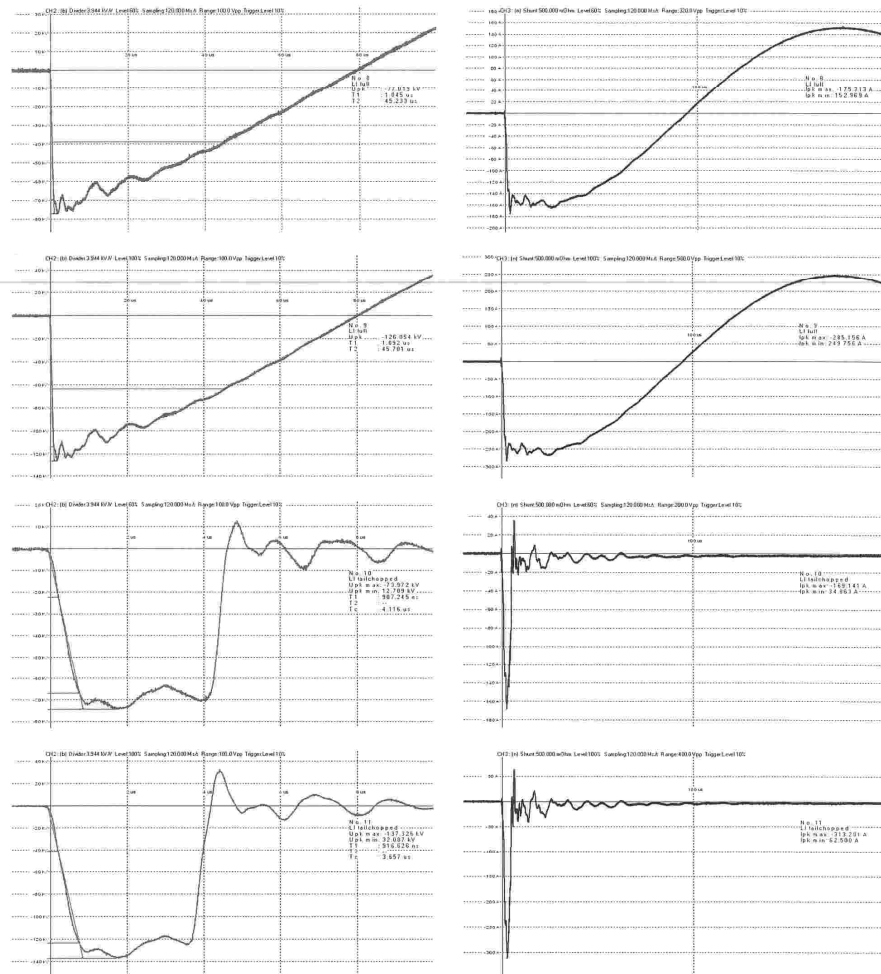
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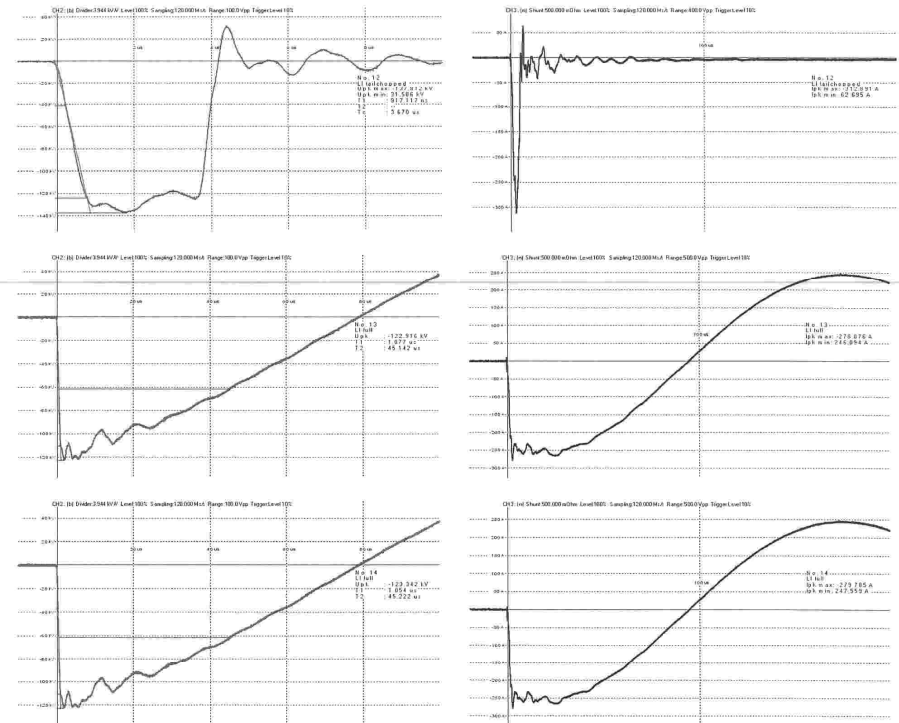
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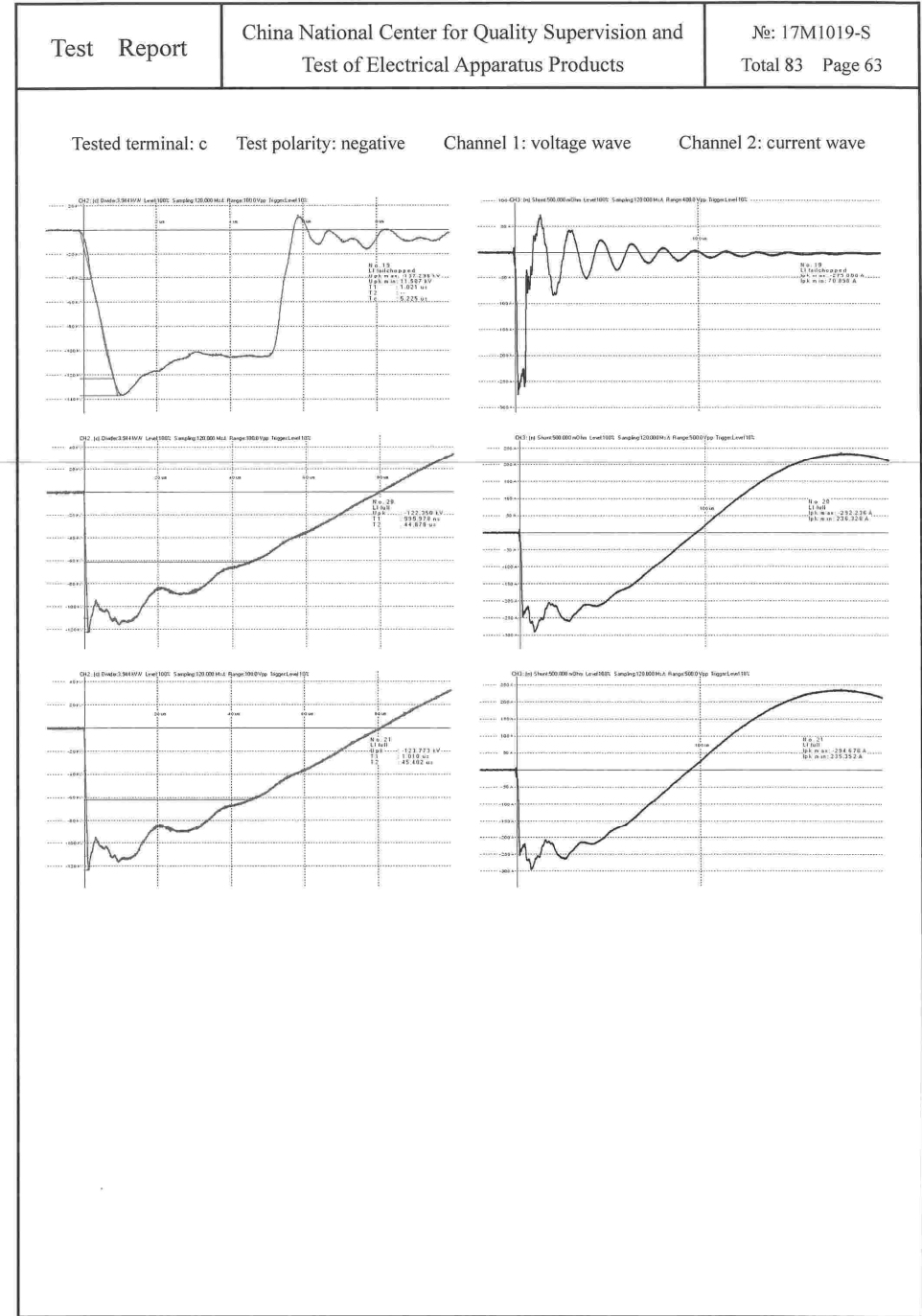
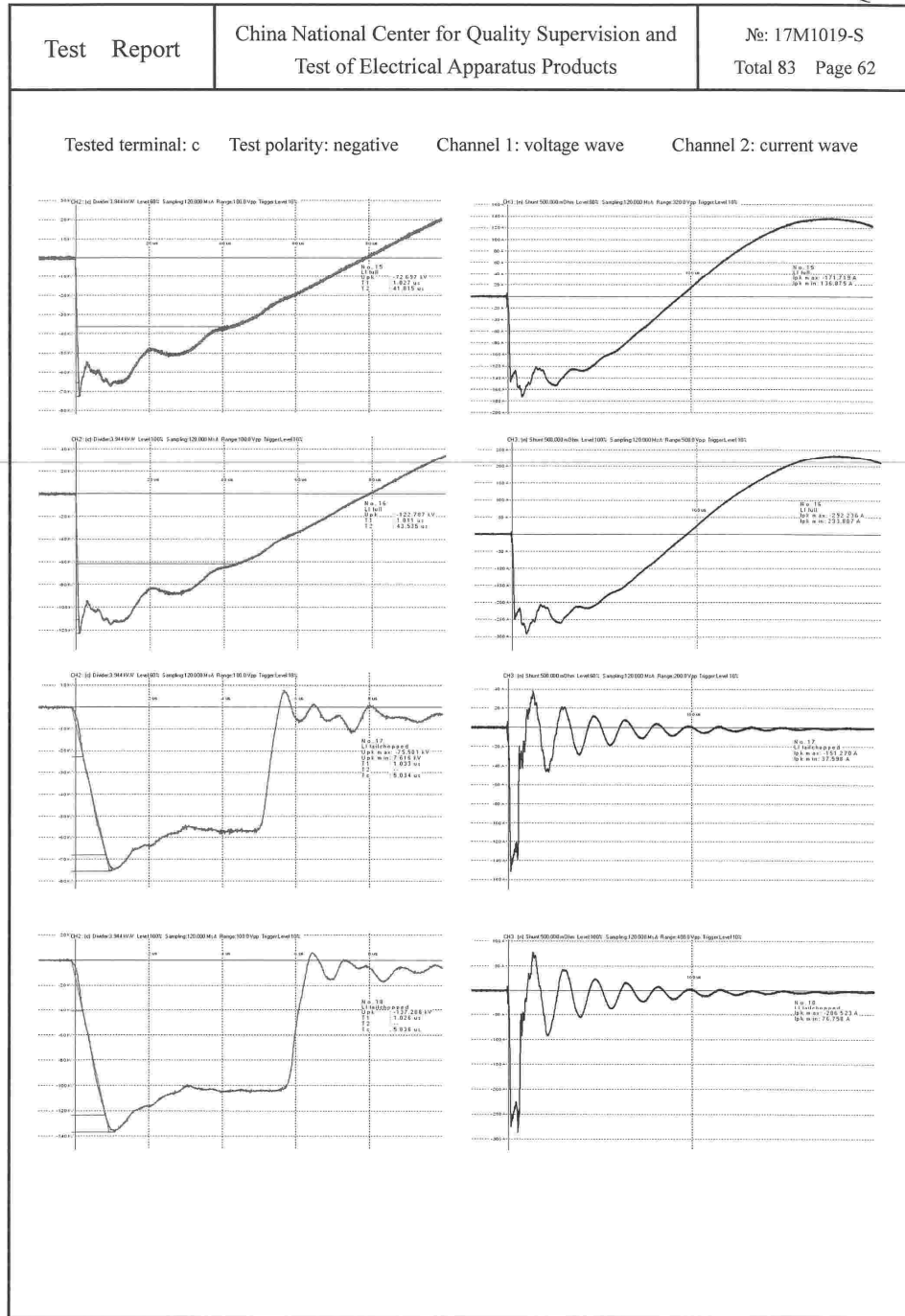


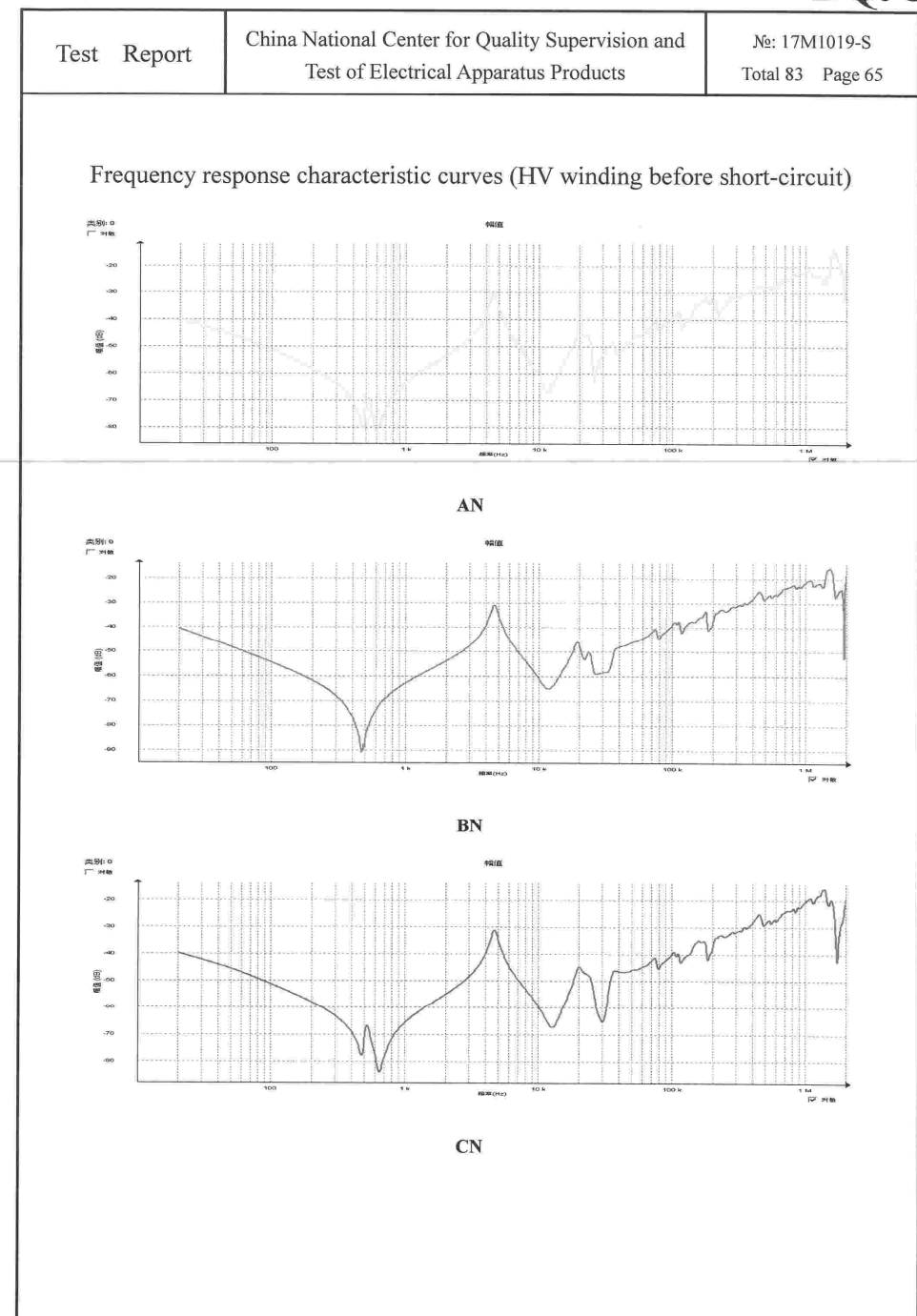
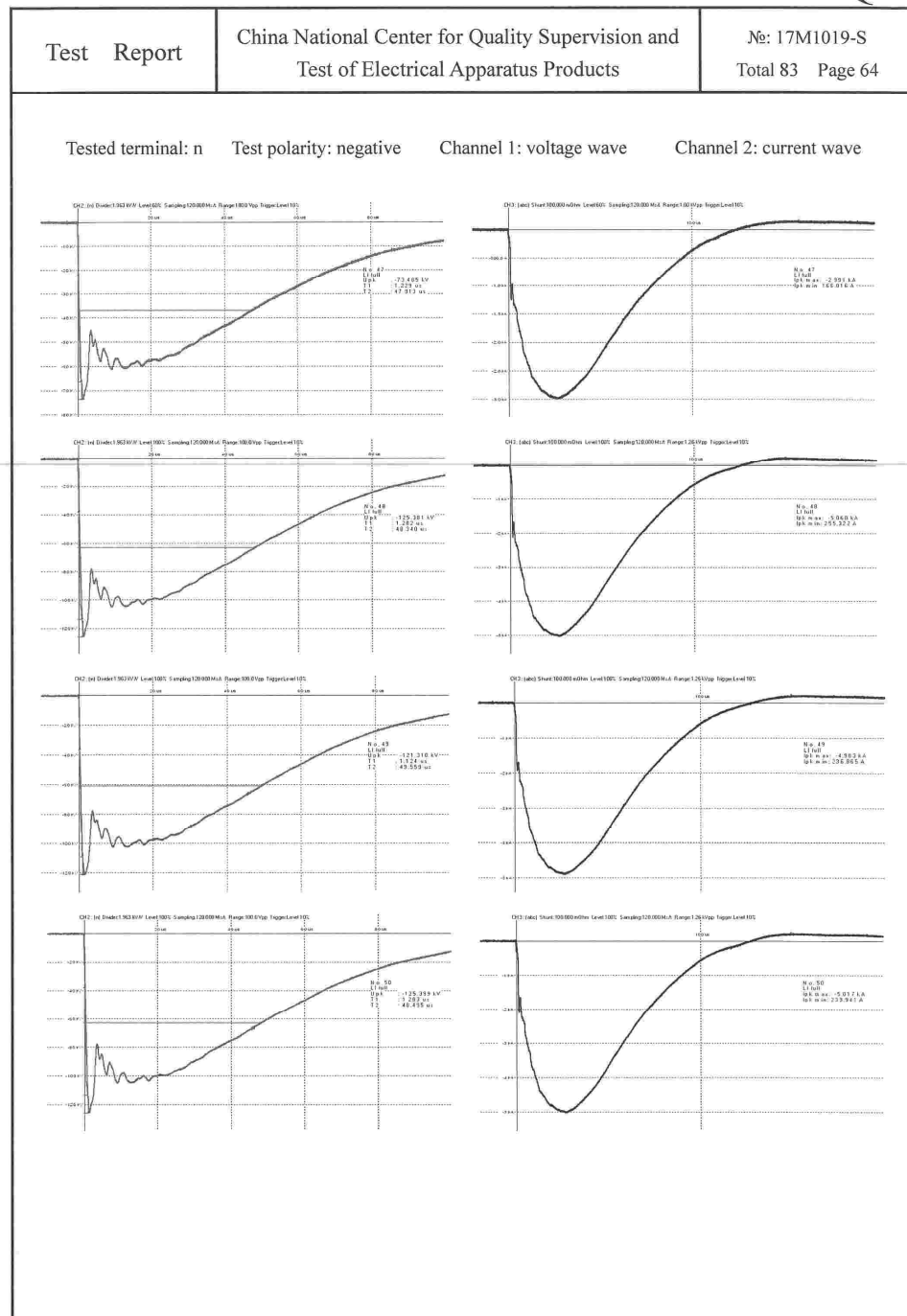
Test Report

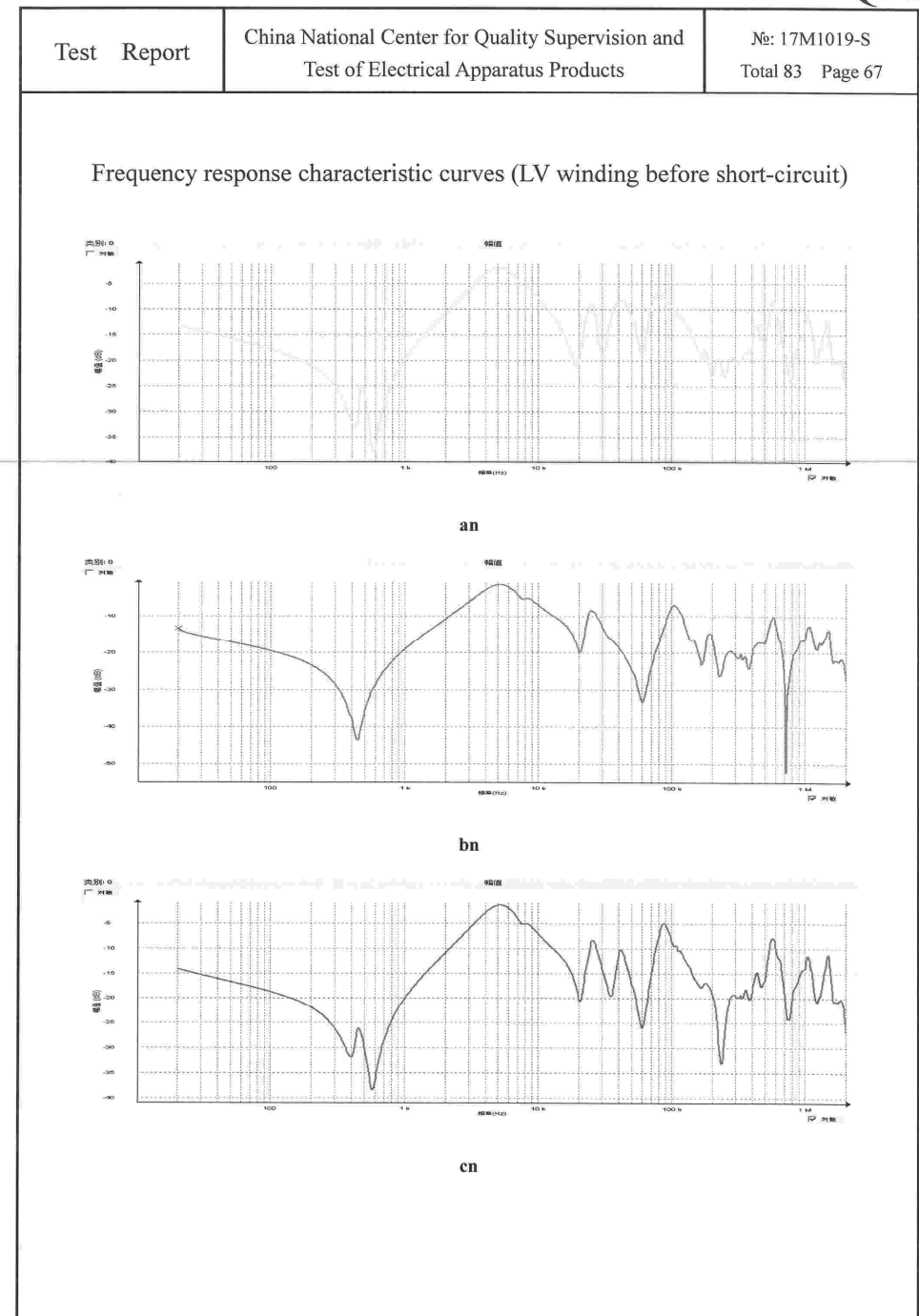
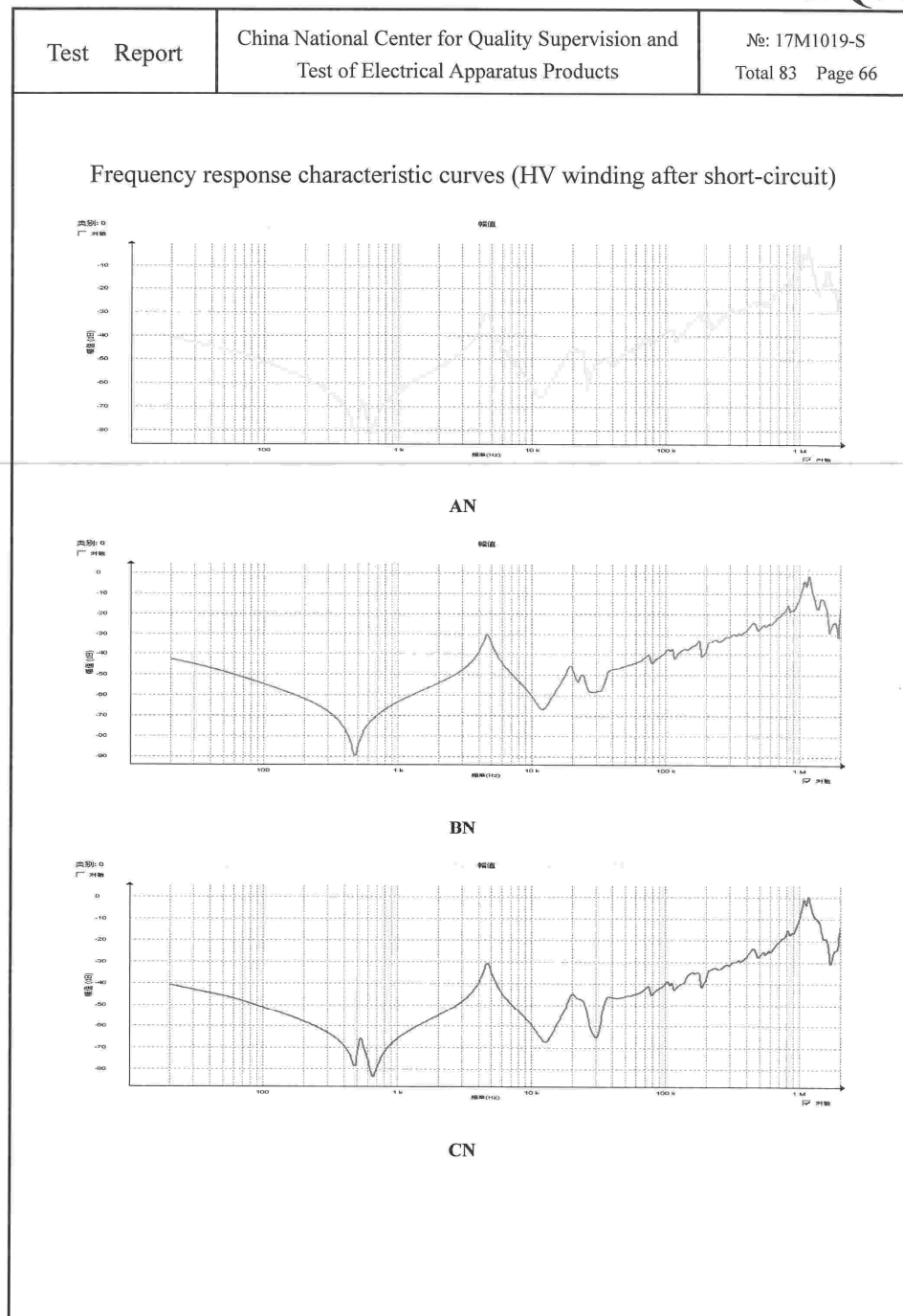
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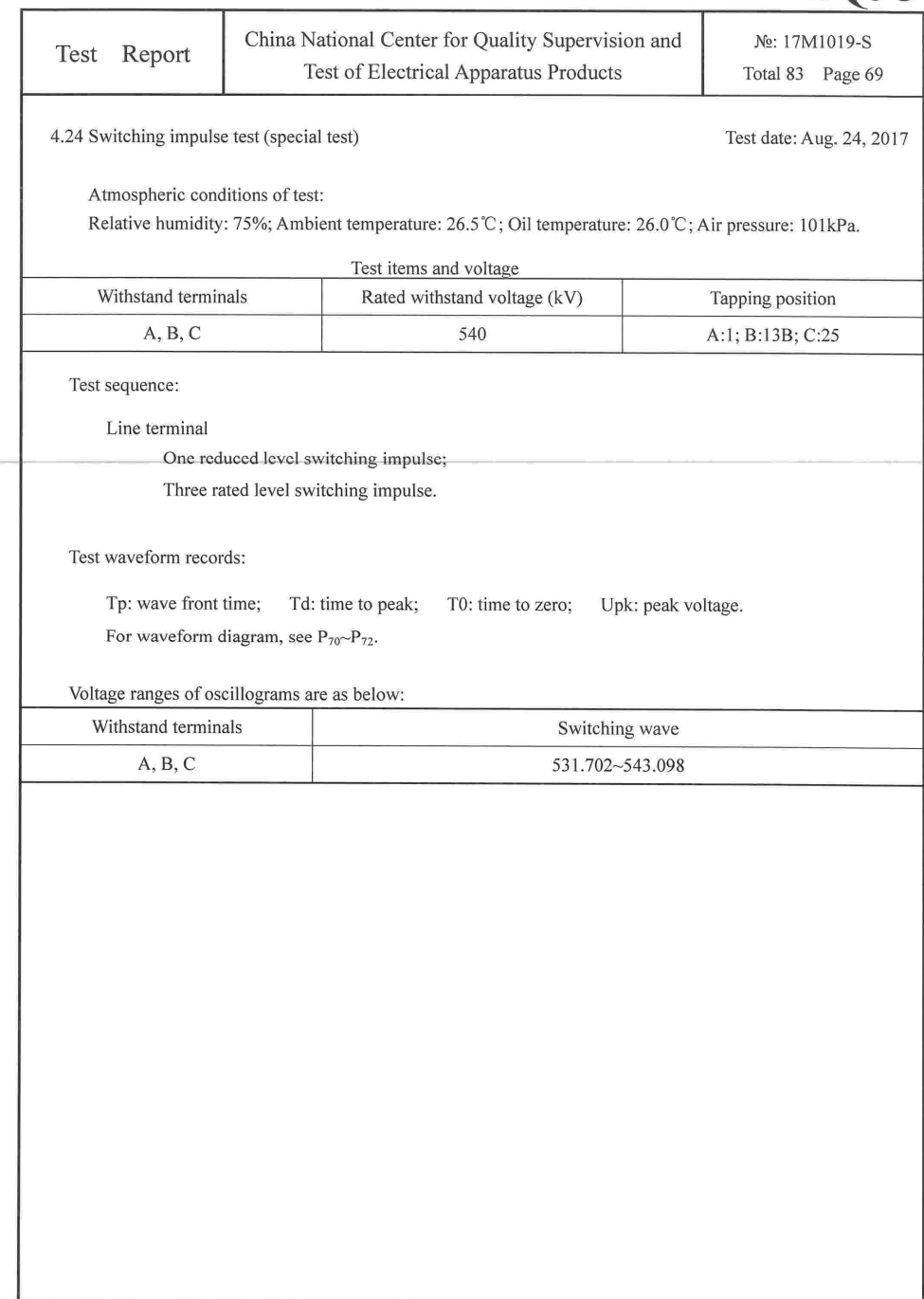
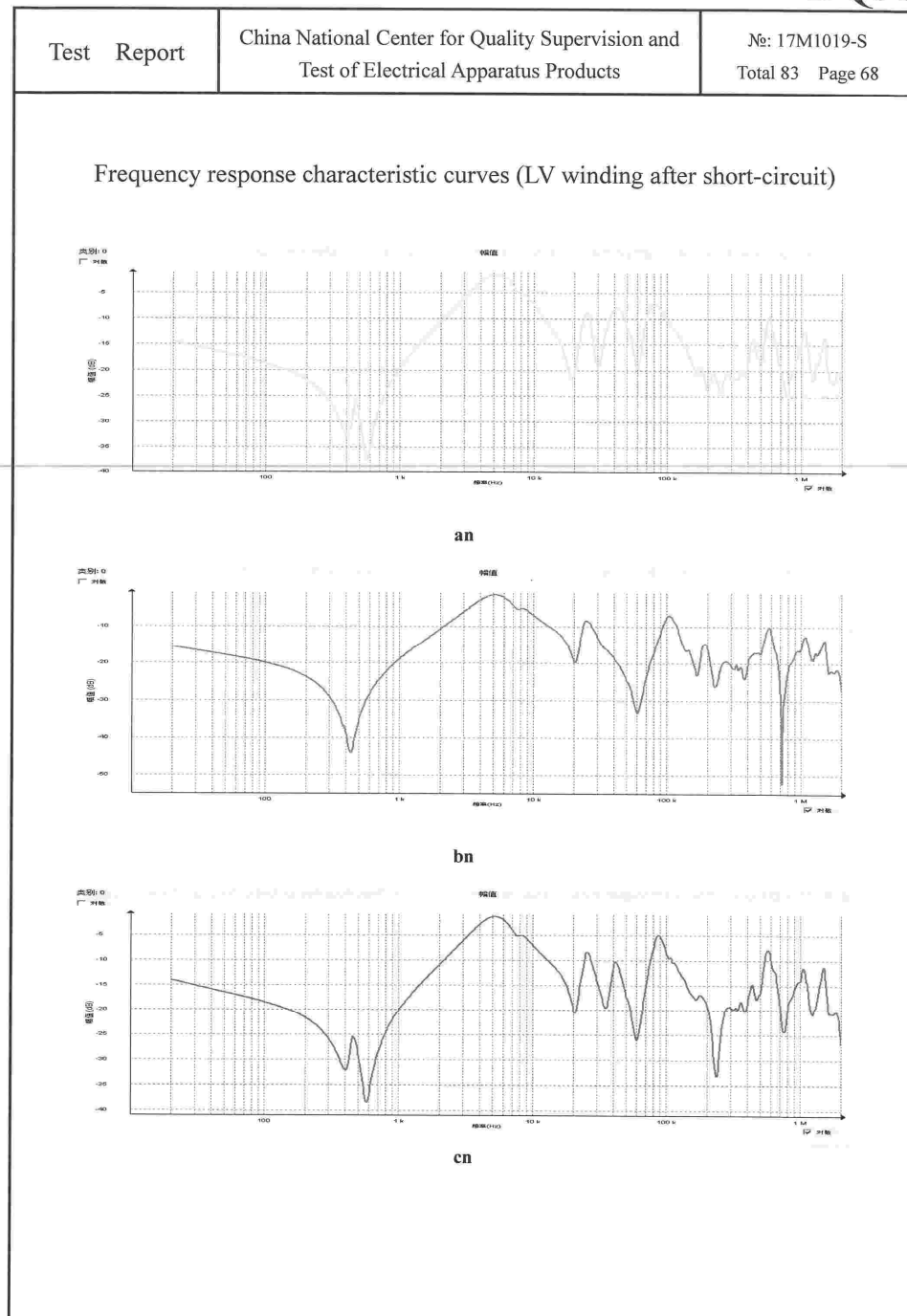
Tested terminal: b Test polarity: negative Channel 1: voltage wave Channel 2: current wave









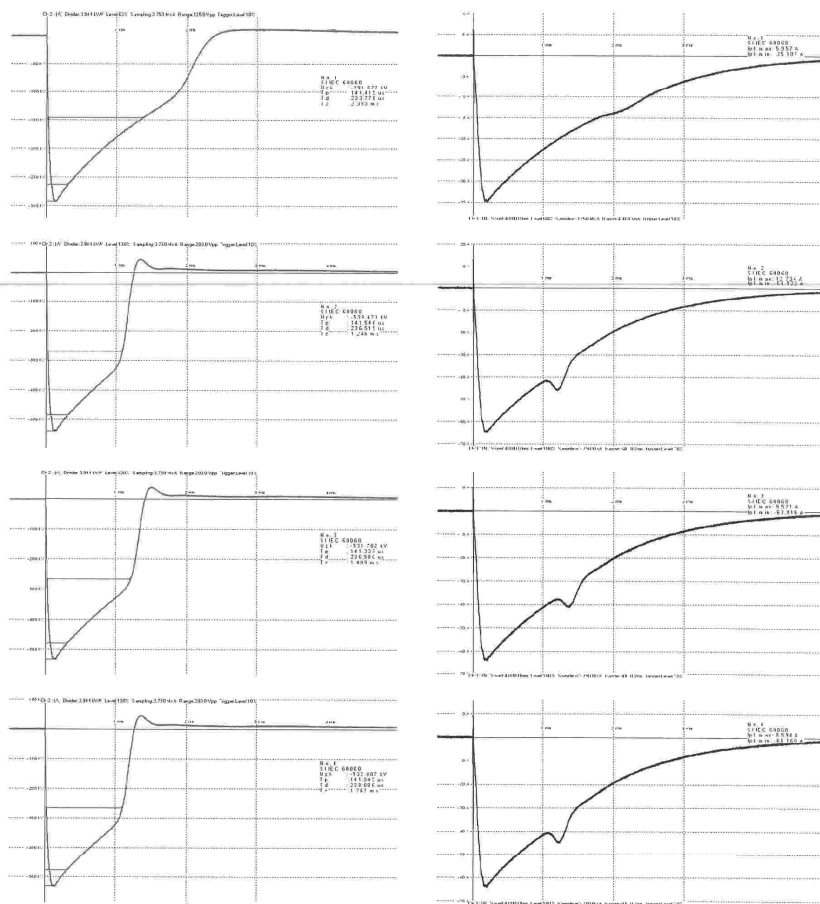


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Tested terminal: A Test polarity: negative Channel 1: voltage wave Channel 2: current wave

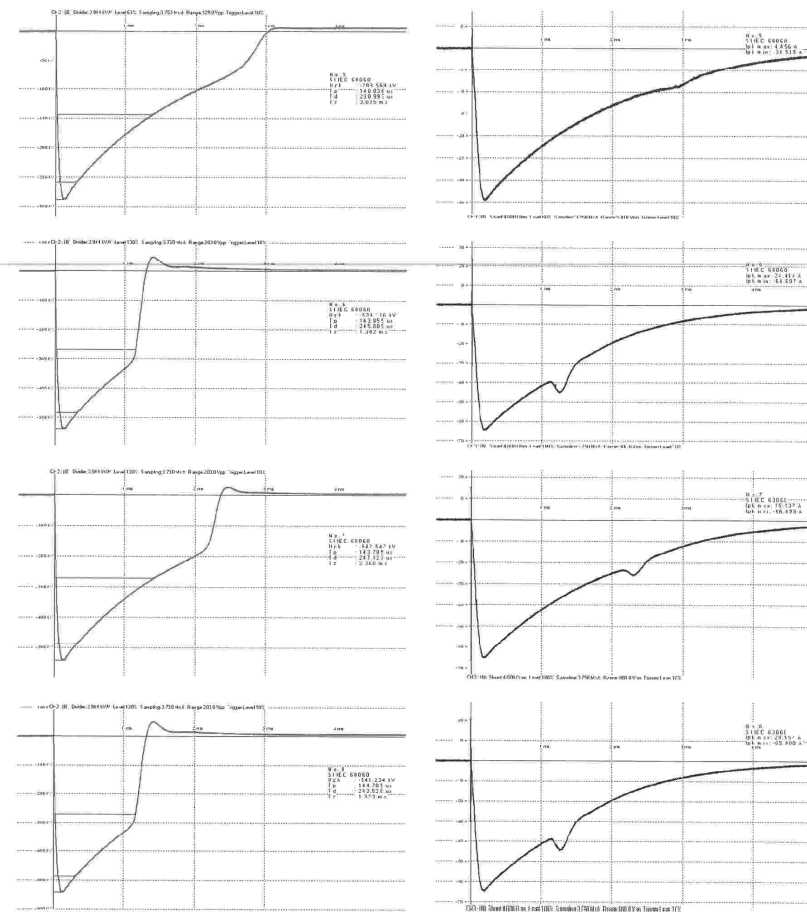


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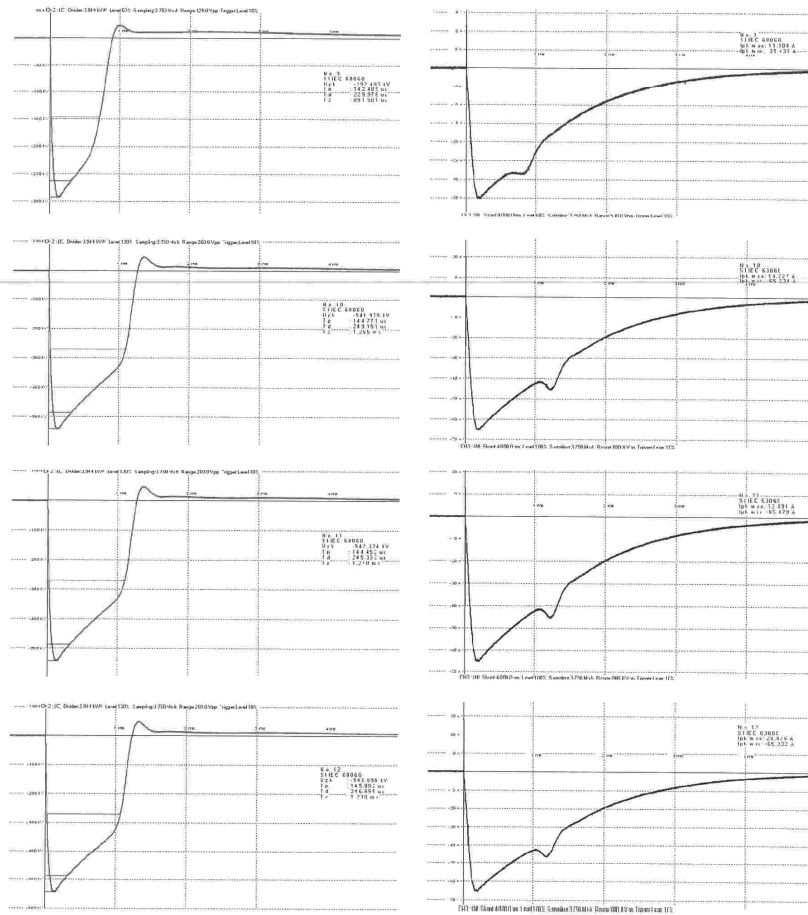
Tested terminal: B Test polarity: negative Channel 1: voltage wave Channel 2: current wave



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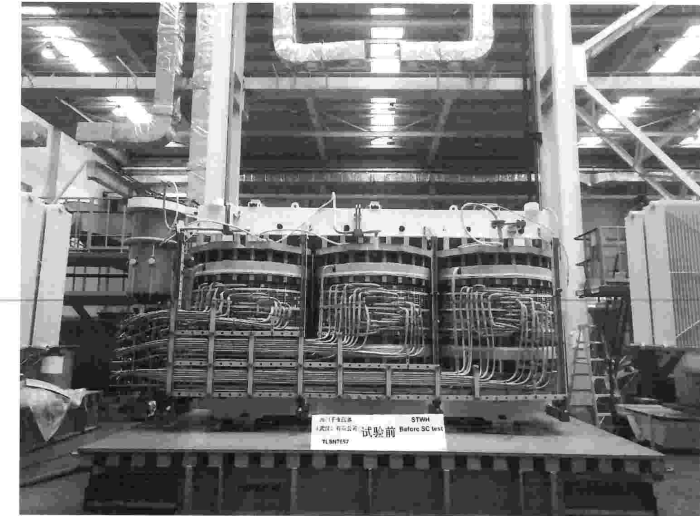
Tested terminal: C Test polarity: negative Channel 1: voltage wave Channel 2: current wave



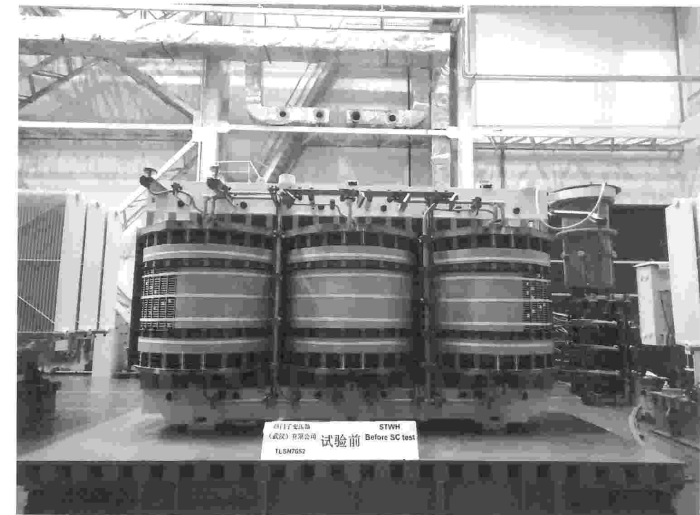
Test Report

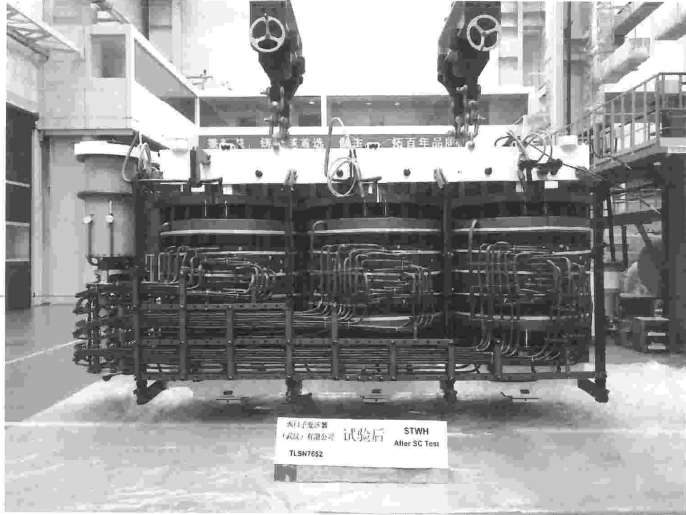
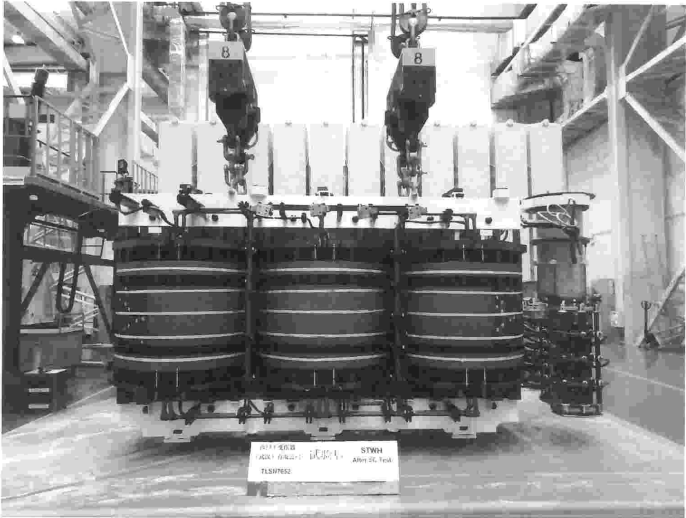
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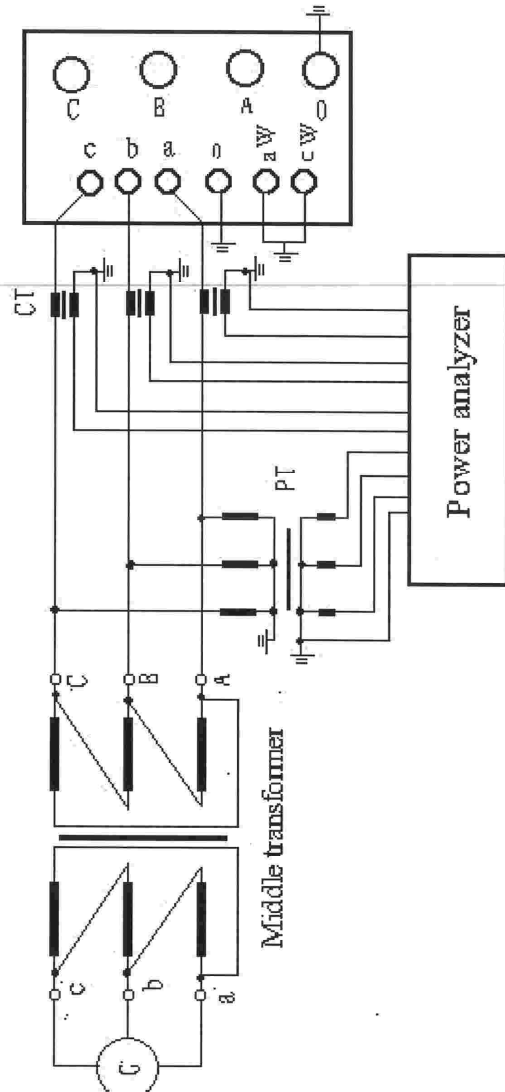
HV side before short-circuit:

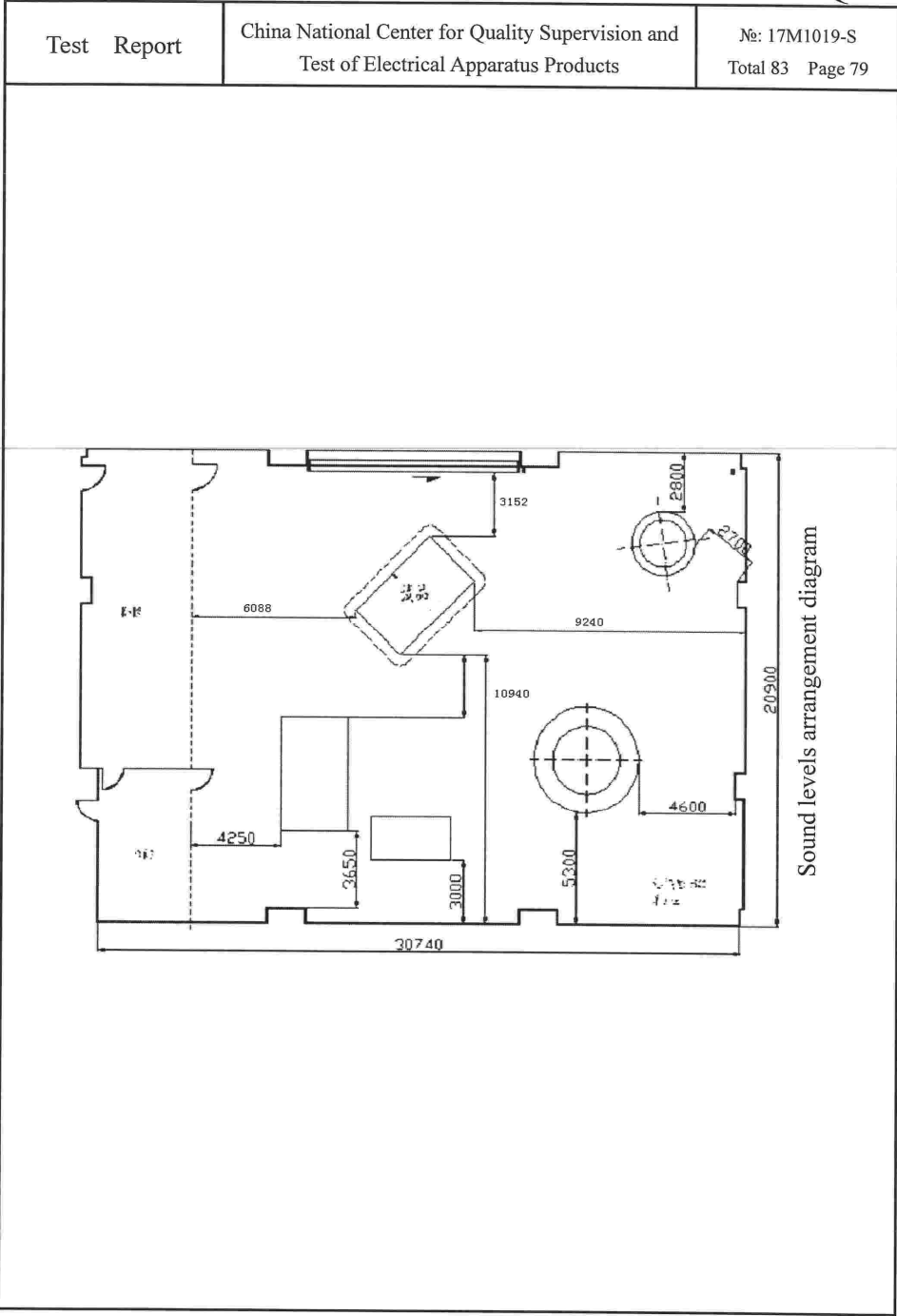
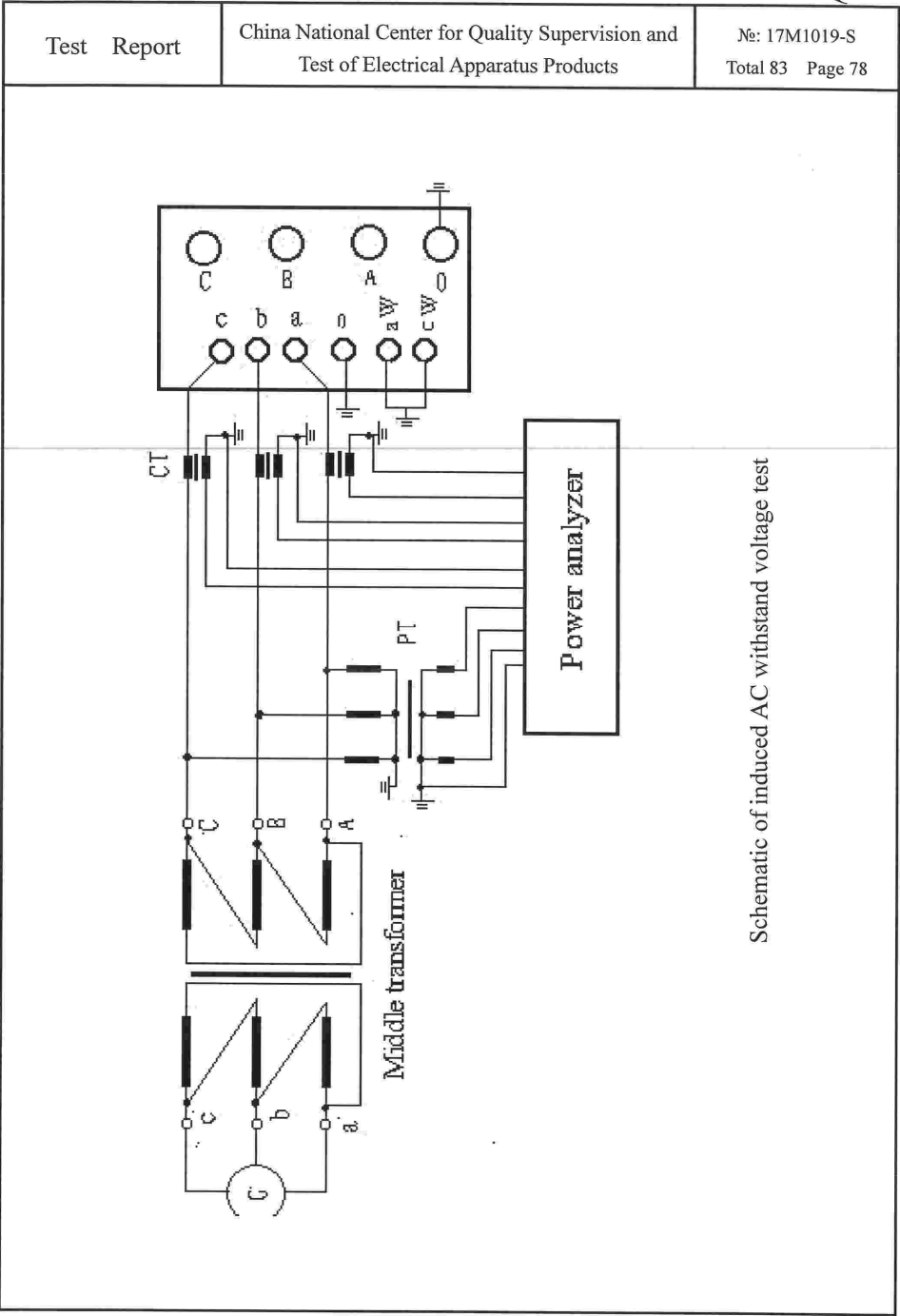


LV side before short-circuit:



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HV side after short-circuit:  LV side after short-circuit: 		

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 Schematic of no-load test		



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Instruments used in the test					
No	Test items	Name & type of instrument	Number & validity		Accuracy level
1	Insulating liquid test, Measurement of dissolved gasses in dielectric liquid from each separate oil compartment except diverter switch compartment	Oil voltage withstand tester BA100	ER18-006	2018-01-09	±3%
		High precision full-automatic capacitance, inductance and dielectric loss measuring bridge 2840-Combi	ER18-003	2018-08-07	±0.02%rdg±0.01pF; ±0.5%rdg±1×10 ⁻⁵
		Gas chromatogram analyzer 7890B	749-1732	2018-12-21	/
		Moisture analyzer CA-200	CA02-002	2018-07-19	±3μg (water for 10μg to 1mg or above) RSD 0.3% or under (water for 1mg or above)
2	Measurement of d.c. insulation resistance windings-to-earth and between windings	Digital mega-ohm meter F1550C	ER17-008	2018-04-21	200k~5/10/20/50/ 100GΩ class 5, other class 20
3	Check of core and frame insulation for liquid-immersed transformers with core or frame insulation				
4	Measurement of dissipation factor (tanδ) of the insulation system capacitances	Movable insulation diagnostic and analysis system MIDAS2880	ER19-003	2017-10-11	Capacitance: ±0.3%rdg±0.3pF Inductance: ±0.5%rdg±0.5mH
5	Measurement of bushing capacitances and dielectric dissipation factor (tanδ)				
6	Determination of capacitances windings-to-earth and between windings				
7	Measurement of winding resistance	DC resistance tester 2293	ER16-013	2018-03-02	0.1μΩ~300μΩ: 0.1%±0.5μΩ 300.1μΩ~30kΩ: 0.1% 30.01kΩ~300kΩ: 1%
8	Measurement of voltage ratio and check of phase displacement	Full-automatic transformer ratio tester TTR2796	RI15-014	2017-10-07	±0.1mA, ±0.05°
9	Measurement of zero-sequence impedances on three-phase transformers	Transformer power loss test system TMS580-200-4000	749-1237	2017-09-27	Voltage range: 100V~200kV, accuracy; 0.12% Current range: 1A~4000A, accuracy; 0.15%
10	Measurement of short-circuit impedance and load loss				
11	Measurement of no-load loss and current				
12	Measurement of the harmonics of the no-load current				
13	Tests on on-load tap-changers				

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Instruments used in the test					
No	Test items	Name & type of instrument	Number & validity		Accuracy level
14	Check of the ratio and polarity of built-in current transformers	Full-automatic transformer ratio tester BZC	RI15-002 2018-07-20		1~1000: class 0.2 1000~1000: class 0.5
15	Separate-source AC withstand voltage test	Assemblies equipment of power-frequency partial discharge-free testYDTW-300/300	745-051 2018-07-11		/
		Capacitance voltage divider TAWF-400/300	745-051-1 2018-07-11		/
		Power-frequency partial discharge-free test transformer YDTCW-1000kVA/1000kV	745-034 2018-10-17		/
		Capacitance voltage divider TRF1000-0.0005	745-034-1 2018-10-17		/
		Power-frequency withstand voltage tester PFT6-5	745-083 2017-12-28		/
16	Induced AC withstand voltage test with partial discharge measurement	Transformer power loss test system TMS580-200-4000	749-1237 2017-09-27		Voltage range: 100V~200kV, accuracy; 0.12% Current range: 1A~4000A, accuracy; 0.15%
		HV FILTER LBH-150	749-1222-1/2/3		/
		Partial discharge tester DDX 9121b	745-077 2018-03-11		/
17	Temperature-rise test, measurement of winding hot-spot temperature-rise	Transformer power loss test system TMS580-200-4000	749-1237 2017-09-27		Voltage range: 100V~200kV, accuracy; 0.12% Current range: 1A~4000A, accuracy; 0.15%
		Thermocouple Type T	TT33-129/130/131/132/133/134 2018-03-17		/
		Data acquisition/switch unit 34970A	TT11-065 2018-03-17		V±5.25%, A±1.5%, T±1℃, Ω±0.81%
		DC resistance tester JYR(50C)	ER16-016 2018-02-11		0.2%±0.2μΩ
		DC resistance tester JYR(50C)	ER16-006 2017-09-14		0.2%±0.2μΩ
		Electronic stopwatch PC396	HT15-010 2018-04-24		/
18	Leak testing with pressure for liquid-immersed transformers	Intelligent pressure transmitter SY-PGD101-2.5MPa-GH	FP87-039 2018-04-06		/

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Instruments used in the test					
No	Test items	Name & type of instrument	Number & validity		Accuracy level
19	Determination of sound levels	Transformer power loss test system TMS580-200-4000	749-1237	2017-09-27	Voltage range: 100V~200kV, accuracy; 0.12% Current range: 1A~4000A, accuracy; 0.15%
		Precision sound level meter HS5661A	SP01-008	2018-05-18	Clas 1
		Sound level calibrator HS6021	SP01-007	2018-05-20	94dB±0.2dB, 114dB±0.5dB
		Steel tapeline	LS05-032	2018-05-15	/
20	Short-circuit withstand test	Voltage transformer TEMP-1000HU	EH112-001	2017-11-10	/
		Voltage transformer VEOS525	EH111-002	2018-10-20	/
		Voltage transformer VEOS525	EH111-003	2018-10-20	/
		Current transformer AGU-550	EH165-001	2018-02-21	/
		LCR automatic tester XC2819	ER16-022	2017-11-23	/
		Data collector 1-GEN16T-2	EI56-019	2018-02-05	/
		Standard current diverter FL-10/10K	EI31-056	2018-01-25	/
		Current divider FLT1-30/2.5	EI30-016	2017-11-20	/
		Current divider FLT1-30/2.5	EI30-017	2017-11-20	/
		Current divider FLT1-30/2.5	EI30-018	2017-11-20	/

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Instruments used in the test					
No	Test items	Name & type of instrument	Number & validity		Accuracy level
21	Measurement of d.c. insulation resistance windings-to-earth and between windings	Insulation resistance tester S1-1068	ER86-003	2018-06-01	/
22	Check of core and frame insulation for liquid-immersed transformers with core or frame insulation				
23	Measurement of dissipation factor (tanδ) of the insulation system capacitances				Dielectric loss: ± (1% reading +0.0004)
24	Measurement of bushing capacitances and dielectric dissipation factor (tanδ)	HV frequency conversion anti-jamming dielectric dissipation tester HV9003	ER19-004	2018-05-03	Capacitance : ± (1% reading +1pF) Transformer ratio: ±0.5% Phase: ±0.02°
25	Determination of capacitances windings-to-earth and between windings				
26	Measurement of voltage ratio and check of phase displacement	Transformer ratio tester BBC6638	RI15-032	2018-05-12	1~1000: + (0.1%*K+2 characters) 1000~5000: ± (0.2%*K+2 characters)
27	Measurement of the power taken by the fan and motors	Transformer no-load and load characteristic tester JYW6100	RI15-025	2018-01-09	/
28	Lightning impulse test	Assemblies testing equipment of impulse voltage generator CJDY-2400kV/360kJ	750-008	2018-08-12	/
		Weakly damped capacitance voltage divider DDF-2400/400	750-008-1	2018-08-12	/
29	Switching impulse test	Assemblies testing equipment of impulse voltage generator CJDY-2400kV/360kJ	750-008	2018-08-12	/
		Weakly damped capacitance voltage divider DDF-2400/400	750-008-1	2018-08-12	/
30	Measurement of frequency response	Transformer windings deformation tester FRAX99	ER16-021	2018-02-05	/
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DECLARATION

1. The report is invalid without special seal for testing and page combining seal on the report;
2. The report is invalid if altered;
3. The report is invalid without signatures of persons for drawing up,
proof-reading, reviewing and approval;
4. The report is valid only for the inspected and tested samples.

NOTICE

1. In case there is any objection to this report, please raise it to the laboratory within fifteen days starting from the date of receiving the report. Thank you for your cooperation.
2. In case there is no objection, please take back the samples within one month starting from the date of receiving the report, when the manufacturer is going to take back the samples, certificate for sample taking and along with the written approval for the report should be brought in presence, only then the samples could be taken back. On time due, the samples will be in the laboratory's own disposal.

The test report is in total 83 pages including 39 figures and 3 photos

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