KEMA

Report.

70951914-TDT 09-72776A

Type test on deadbreak bolted separable T-connector AQT3 24/630KT

Manufacturer
AMPLE Technology (Shenzhen) Co., Ltd.,
China

Arnhem, 28 January 2010

INSPECTION REPORT

Report number	70951914-TDT 09-72776A
Client	AMPLE Technology (Shenzhen) Co., Ltd. D Building, Henggangxia Industrial Zone Xinqiao Village, Shajing Town, Baoan District Shenzhen City, Guangdong Province, China
Reference	Agreement of 20 October 2009
Concerning	Type tests
Date	17 November until 10 December 2009
Location of tests	Inspection and test center of State Grid Electric Power Research Institute (SGEPRI) Wuhan, China
Object	Screened deadbreak bolted separable T-connector
Type	AQT3 24/630KT
Manufacturer	AMPLE Technology (Shenzhen) Co., Ltd.

REQUIREMENTS
The requirements as mentioned in the standard IEC 60502-4 (2005-02).

TEST PROGRAMME
The programme was specified by the client.
For the programme, reference is made to page 4.

SUMMARY AND CONCLUSION
The test results obtained relate only to the work ordered and to the material tested.
For the test programme listed on page 4, the requirements were met.

KEMA Nederland B.V.

Author R.A.J. Blokhuis

This report consists of:
29 pages incl. 10 annexes (14 pages)

P.G.A. Bus
KEMA T&D Testing Services
Managing Director
Arnhem, 28 January 2010

MATERIAL DATA

SCREENED DEADBREAK BOLTED SEPARABLE T-CONNECTOR

Manufacturer	AMPLE Technology (Shenzhen) Co., Ltd.
Type	AQT3 24/630KT
Meanings of the type code	A: AMPLE Q: front (Qian in Chinese) T: T-type 3: 3rd generation 24: rated voltage 24 kV 630: rated current 630 A K: screened surface (Can in Chinese) T: special (Te in Chinese)

Ratings assigned by the manufacturer

Rated voltages $U_o/U/U_m$	12.7/22/24 kV
Rated frequency	50 Hz
Rated current	630 A
Rated cable conductor cross section	25 to 500 mm^2
AC 5 minute withstand	57 kV
Impulse withstand	125 kV
Partial discharge level	≤ 10 pC at 22 kV (1,73 U_o)

Insulation

Insulating material	EPDM

The manufacturer has guaranteed that the objects submitted to the tests have been manufactured in accordance with the technical data represented before.
The manufacturer is responsible for the correctness of these data.
For pictures of the T-connectors during the type tests reference is made to annex H.
For the drawing and data of the connector reference is made to annex I.
For the installation instructions reference is made to annex J.

PERSONS ATTENDING THE TESTS

Mr. T. Guoqiang	AMPLE Technology (Shenzhen) Co., Ltd.
Mr. M. Fugui	Inspection and test center of State Grid Electric Power Research Institute (SGEPRI) Wuhan, China

THE INSPECTION WAS CARRIED OUT BY

Mr. R. A. J. Blokhuis	KEMA Nederland B.V.

PURPOSE OF THE TESTS

Purpose of the tests was to verify whether the material complies with the specified requirements.

TEST PROGRAMME

		IEC 60502-4 Table 7 Clause
0	INSPECTION OF THE TEST SET-UP	
1	TYPE TESTS ACCORDING TEST SEQUENCE 4.1	
1.1	AC withstand test 57 kV - 5 min.	1
1.2	Partial discharge test at ambient temperature	2
1.3	Impulse test at high temperature	3
1.4	Heating cycles in air	9
1.5	Heating cycles under water	10
1.6	Disconnect / connect	11
1.7	Partial discharge test at high and ambient temperature	12
1.8	Impulse test at ambient temperature	13
1.9	AC withstand test 32 kV 15 min.	14
1.10	Examination	15
2	TYPE TESTS ACCORDING TEST SEQUENCE 4.3	
2.1	Thermal short circuit test on the conductor	7
2.2	Dynamic short circuit test	8
2.3	Disconnect / connect	11
2.4	Impulse test at ambient temperature	13
2.5	AC withstand test 32 kV 15 min.	14
2.6	Examination	15
3	TYPE TESTS ON SEPARATE CONNECTORS	
3.1	Screen resistance test	17
3.2	Screen leakage current test	18
4	IDENTIFICATION OF THE CABLE USED FOR THE TYPE TEST	
4.1	Check of the construction	clause 6.1.1

DESCRIPTION OF THE TESTS

0 INSPECTION OF THE TEST SET-UP

The tests were carried out in the laboratory of the Inspection and test center of State Grid Electric Power Research Institute (SGEPRI) in Wuhan, China.
This laboratory is therefore jointly responsible for the correctness of the results obtained.
The measuring devices and the test set-up were checked by KEMA and were necessary calibrated.

Result

The inspection did not give rise to remarks.

1 TYPE TESTS ACCORDING TEST SEQUENCE 4.1

In accordance with test sequence 4.1 of IEC 60502-4, six connectors were mounted on two three core XLPE insulated cables in order to create a test loop. Each three of the two pairs of connectors were connected to each other by means of a bushing.

1.1 AC withstand test in accordance with IEC 60502-4, table 7, clause 1

The voltage test was carried out with an AC voltage of 50 Hz. The connectors were tested with a voltage of at least 57 kV ($4.5xU_o$) during 5 minutes in accordance with the specification.

Result

The test was completed successfully.

1.2 Measurement of partial discharges in accordance with IEC 60502-4, table 7, clause 2

After the voltage test as described under 1.1 the connectors were examined for partial discharges in accordance with IEC 61442, clause 7. The sensitivity of the measuring circuit was checked with a calibrator. Discharges with an intensity of 2 pC could be detected. The voltage was first set to 2 U_o (24 kV) for 10 s and then lowered until 1,73 U_o (22 kV).
At 1,73 U_o the partial discharges were measured.
The results are stated in annex A.

Result

The requirements were met.

1.3 Impulse test at high temperature in accordance with IEC 60502-4, table 7, clause 3

After the above mentioned tests the test set-up was tested with an impulse voltage.
During the test the cable was heated by a current through the conductor until a conductor temperature of at least 95 °C (5 °C to 10 °C above the maximum cable conductor temperature in normal operation) was reached.
The test was performed in accordance with IEC 60442, clause 6.
The test set-up was tested with 10 positive and 10 negative impulses of 125 kV.
The oscillograms of the test are stated in annex B.

Result

The test was completed successfully.

1.4 Thermal cycles in air in accordance with IEC 60502-4, table 7, clause 9

The test was performed in accordance with IEC 60442, clause 9.
The test set-up with the connectors was subjected to a heating cycle of 95 °C (5 °C above the maximum rated temperature). A total of 30 cycles was performed. Each thermal cycle consisted of 8 hours heating with at least 2 hours at a steady temperature, followed by at least 3 hours of natural cooling to within 10 °C of ambient temperature. During this test the set-up was subjected to an AC voltage test of 2,5 U_o (32 kV), 50 Hz.
The results are listed in annex A.

Result

The test was completed successfully.

1.5 Thermal cycles under water in accordance with IEC 60502-4, table 7, clause 10

The test was performed in accordance with IEC 60442, clause 9.
The test set-up with the connectors was subjected to a heating cycle of 95 °C (5 °C above the maximum rated temperature). The height of the water above the upper side of the connectors was 1 metre. A total of 30 cycles was performed. Each thermal cycle consisted of 8 hours heating with at least 2 hours at a steady temperature, followed by at least 3 hours of natural cooling to within 10 °C of ambient temperature. During this test the set-up was subjected to an AC voltage test of 2,5 U_o (32 kV), 50 Hz.
The results are listed in annex A.

Result

The test was completed successfully.

1.6 Disconnect / connect in accordance with IEC 60502-4, table 7, clause 11

After the above mentioned test the six connectors were disconnected and connected for five times. After this test no damage to the contacts may be visible.

Result

The test was completed successfully. No damage was visible after the test.

1.7 Partial discharge test at high and ambient temperature in accordance with IEC 60502-4, table 7, clause 12

After the above mentioned tests the test set-up was examined for partial discharges in accordance with IEC 60442, clause 7.
Before the test the cable was heated by a current through the conductor until a conductor temperature of at least 95 °C was reached. The sensitivity of the measuring circuit was checked with a calibrator. Discharges with an intensity of 1,5 pC could be detected. The voltage was first set to 2 U_o (24 kV) for 10 s and then lowered until 1,73 U_o (22 kV). At 1,73 U_o the partial discharges were measured. After this measurement the connectors were allowed to cool to the ambient temperature. At this temperature the partial discharges were measured again.
The results of the test are stated in annex A.

Result

The test was completed successfully.

1.8 Impulse test at ambient temperature in accordance with IEC 60502-4, table 7, clause 13

After the above mentioned tests the test set-up was tested with an impulse voltage.
During this test the cables and connectors were at ambient temperature. The test was performed in accordance with IEC 60442, clause 6.
The test set-up was tested with 10 positive and 10 negative impulses of 125 kV.
The oscillograms of the test are stated in annex C.

Result

The test was completed successfully.

1.9 AC withstand voltage test in accordance with IEC 60502-4, table 7, clause 14

The voltage test was carried out with an AC voltage of 50 Hz. The test was performed in accordance with IEC 60442, clause 4.
The connectors were tested with a voltage of at least 32 kV ($2,5xU_o$) during 15 minutes in accordance with the specification.

Result

The test was completed successfully.

1.10 Examination in accordance with IEC 60502-4, table 7, clause 15

Upon completion of all tests the test set-up was dismantled.
The connectors were generally checked and the dimensions were compared with the drawings.

Result

The dimensions complied with the drawing. No cracks or corrosion were detected.

2 TYPE TESTS IN ACCORDANCE WITH IEC 60502-4, TEST SEQUENCE 4.3

In accordance with test sequence 4.3 of IEC 60502-4, six connectors were mounted on two three core XLPE insulated cables in order to create a test loop. Each three of the two pairs of connectors were connected to each other. The connectors connected to each other by means of a bushing.

2.1 Thermal short circuit test on the conductor accordance with IEC 60502-4, table 7, clause 7

The test was performed in accordance with IEC 60442, clause 11.
Three ends of the cable were connected to a short-circuit generator. Six connectors were connected with each other. The other three ends of the cable were connected to a short-bar. The test was performed at ambient temperature. Two short circuits were applied using AC current to raise the conductor temperature to the maximum permissible short-circuit temperature of the cable within 5 seconds. Between the two short circuits, the test loop was allowed to cool 5 °C to 10 °C above ambient temperature prior to the second short circuit.
The results are listed in annex D.

Result

No visible deterioration occurred on the parts at 24,8 kA for 2.00 seconds and at 24,7 kA for 2,01 seconds. The test was completed successfully.

2.2 Dynamic short-circuit test in accordance with IEC 60502-4, table 7, clause 8

After the above mentioned test the test set-up was tested with an dynamic short-circuit test.
The test was performed in accordance with IEC 60442, clause 12.
The test was performed at ambient temperature. The short-circuit current applied met the appropriate values of time and current as described in the standard.
The results are listed in annex E.

Result

No visible deterioration occurred on the parts at 85,3 kA for 0,047. The test was completed successfully.

2.3 Disconnect / connect in accordance with IEC 60502-4, table 7, clause 11

After the above mentioned test the six connectors were disconnected and connected for five times. After this test no damage to the contacts may be visible.

Result

The test was completed successfully. No damage was visible after the test.

2.4 Impulse test at ambient temperature in accordance with IEC 60502-4, table 7, clause 13

After the above mentioned tests the test set-up was tested with an impulse voltage.
During this test the cables and connectors were at ambient temperature. The test was performed in accordance with IEC 60442, clause 6.
The test set-up was tested with 10 positive and 10 negative impulses of 95 kV.
The oscillograms of the test are stated in annex F.

Result

The test was completed successfully.

2.5 AC withstand voltage test in accordance with IEC 60502-4, table 7, clause 14

The voltage test was carried out with an AC voltage of 50 Hz. The connectors were tested with a voltage of at least 32 kV ($2{,}5 \times U_o$) during 15 minutes in accordance with the specification.

Result

The test was completed successfully.

2.6 Examination in accordance with IEC 60502-4, table 7, clause 15

Upon completion of all tests the test set-up was dismantled.
The connectors were generally checked, the dimensions were compared with the drawings.

Result

The dimensions complied with the drawing. No cracks or corrosion were detected.

3 TYPE TESTS ON SEPARATE CONNECTORS

3.1 Screen resistance test in accordance with IEC 60502-4, table 7, clause 17

The test was carried out on a connecter, not installed on a cable or mating bushing. The connector was on each end equipped with copper wires as electrodes. First the screen resistance was measured at ambient temperature. After that the connector was subjected to thermal ageing in an air oven at 120±2 °C for at least 168 hours. Hereafter the connector screen resistance at ambient temperature was measured again.
The results of the test are stated in annex A.

Result

The test was completed successfully.

3.2 Screen leakage current test in accordance with IEC 60502-4, table 7, clause 18

For this test a connecter was installed on a cable and connected to its mating bushing. The test was carried out at ambient temperature. A metal foil of 5 cm x 5 cm was placed mid-way between of the connector. The metal foil was earthed through a milli ampere meter and a resistance of 2000 Ω. In this set-up the leakage current was measured with an AC test voltage of U_m (24 kV) applied between the conductor and earth.
The results of the test are stated in annex A.

Result

The test was completed successfully.

4 IDENTIFICATION OF THE CABLE USED FOR THE TYPE TEST

4.1 Check of the construction of the cable used in accordance with IEC 60502-4, clause 6.1.1

At a cable sample of approximately 0,5 m the dimensions were measured and the materials were identified in accordance with annex I of the specification.
The results are stated in annex G.

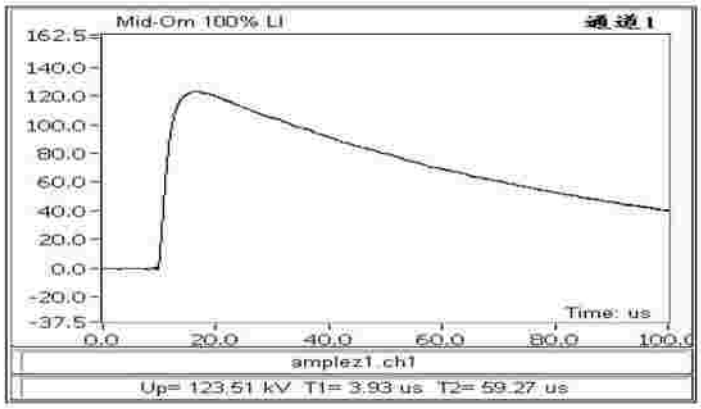
Result

The construction, dimensions and materials of the cable did not give rise to remarks.

ANNEX A RESULTS OF THE ELECTRICAL TESTS

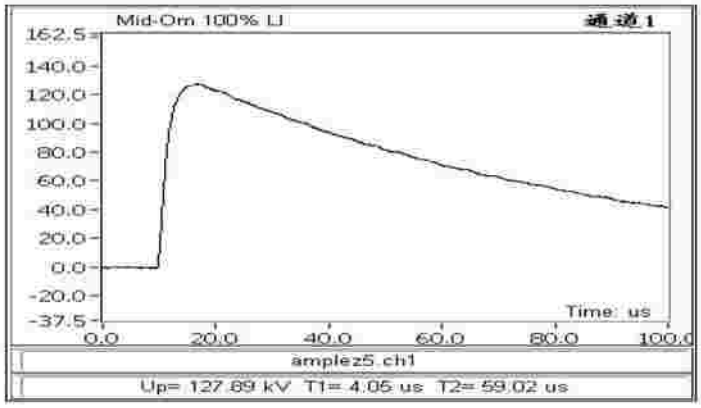
Type of connector: AQT3 24/630KT					
Test	Unit	Result			Req.
		Phase			
Partial discharges at 1,73 U_o		A	B	C	
After the AC withstand test	pC	< 2,5	< 2,0	< 2,0	≤ 10
After disconnect/connect at high temp.	pC	< 4,5	< 1,5	< 1,5	≤ 10
After disconnect/connect at ambient temp.	pC	< 2,5	< 2,5	< 2,5	≤ 10
Thermal cycles in air	#				
Number of cycles	#	30			30
Number of hours		240			240
Thermal cycles under water	#				
Number of cycles	#	30			30
Number of hours		240			240
Screen resistance	Ω				
Before ageing	Ω	590			≤ 5000
After ageing		1360			≤ 5000
Screen leakage current	mA	≤ 0,5			≤ 0,5

Results of the impulse voltage test (§ 1.3)



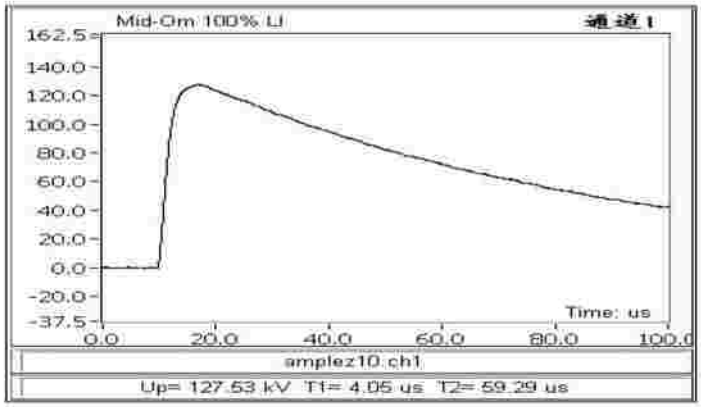
1st positive impulse 125 kV

Diagram 1



5th positive impulse 125 kV

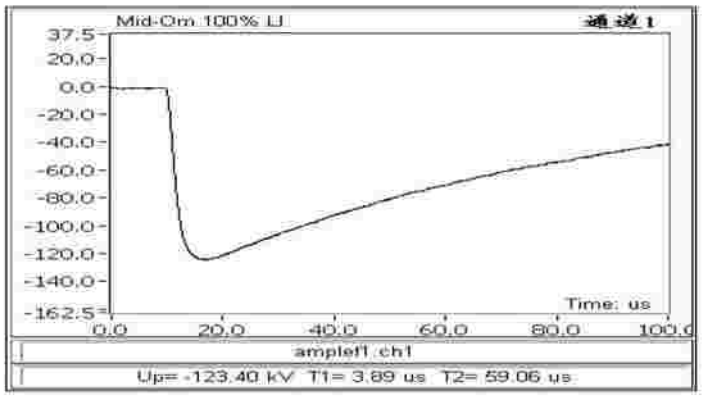
Diagram 2



10th positive impulse 95 kV

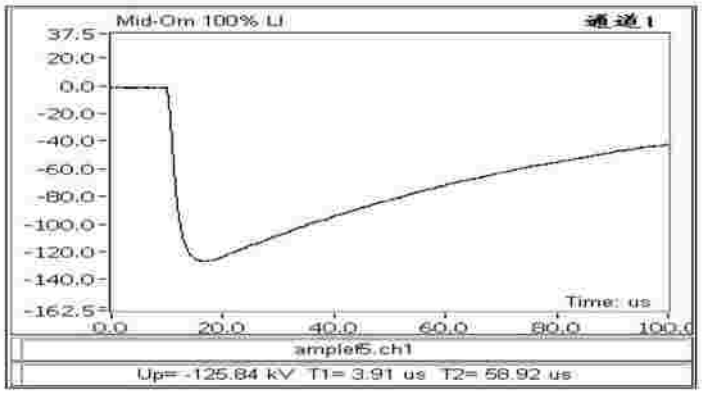
Diagram 3

ANNEX B RESULTS OF THE IMPULSE VOLTAGE TEST (§ 1.3)



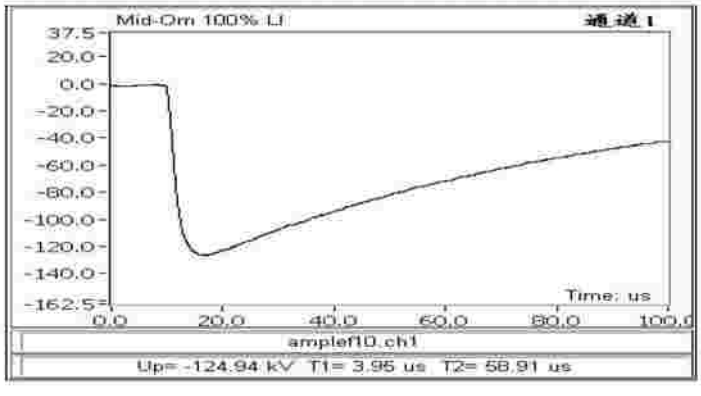
1st negative impulse 125 kV

Diagram 4



5th negative impulse 125 kV

Diagram 5



10th negative impulse 125 kV

Diagram 6

ANNEX C RESULTS OF THE IMPULSE VOLTAGE TEST (§ 1.10)

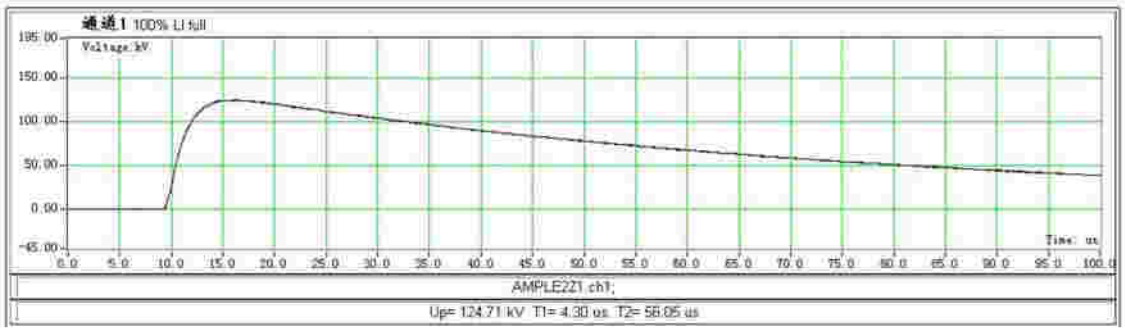


Diagram 1: 1st positive impulse 125 kV

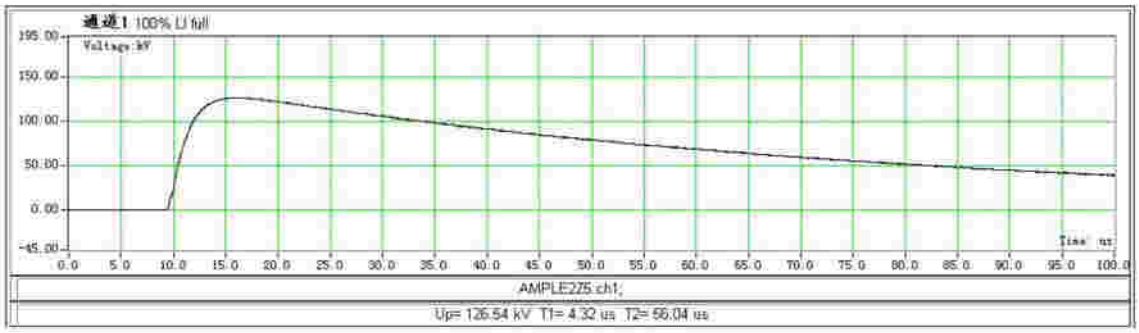


Diagram 2: 5th positive impulse 125 kV

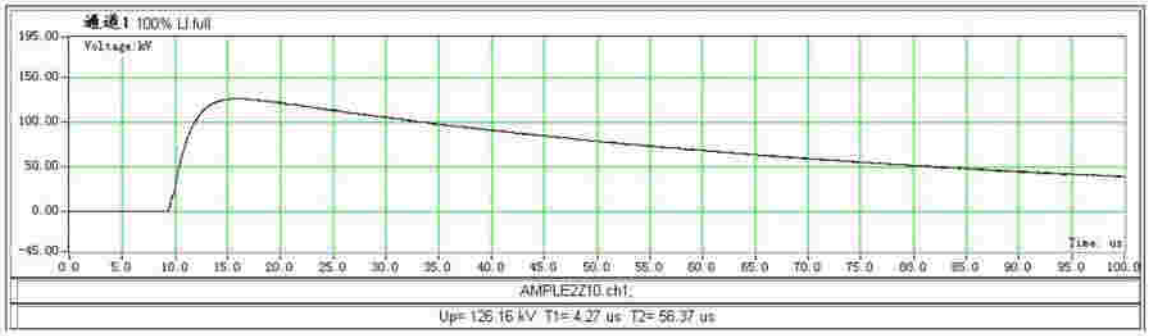


Diagram 3: 10th positive impulse 125 kV

Results of the impulse voltage test (§ 1.10)

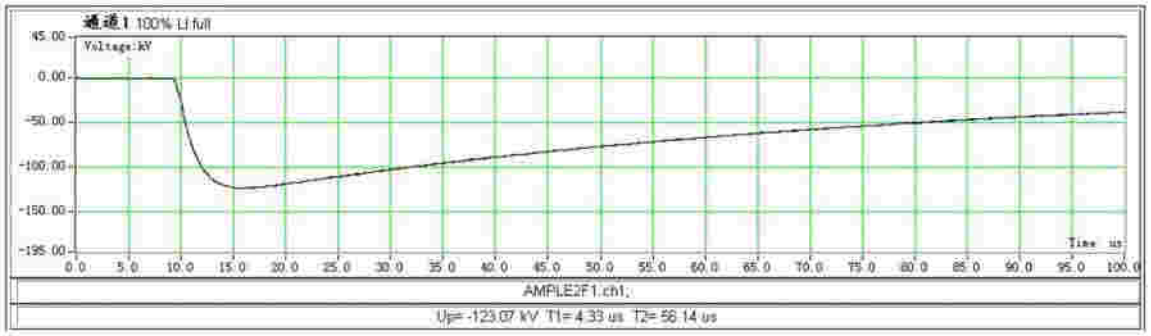


Diagram 1: 1st negative impulse 125 kV

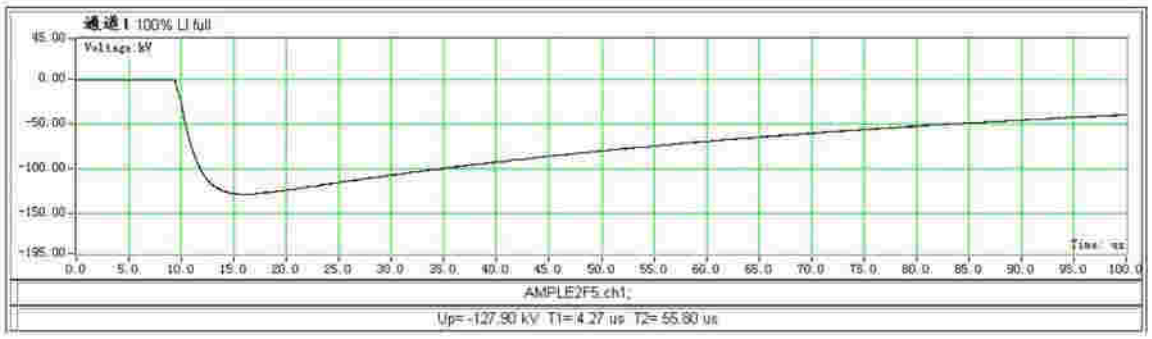


Diagram 2: 5th negative impulse 125 kV

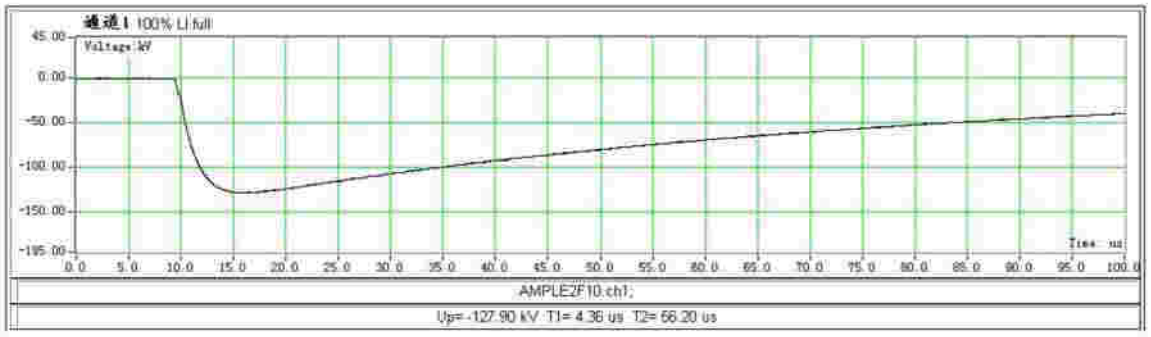
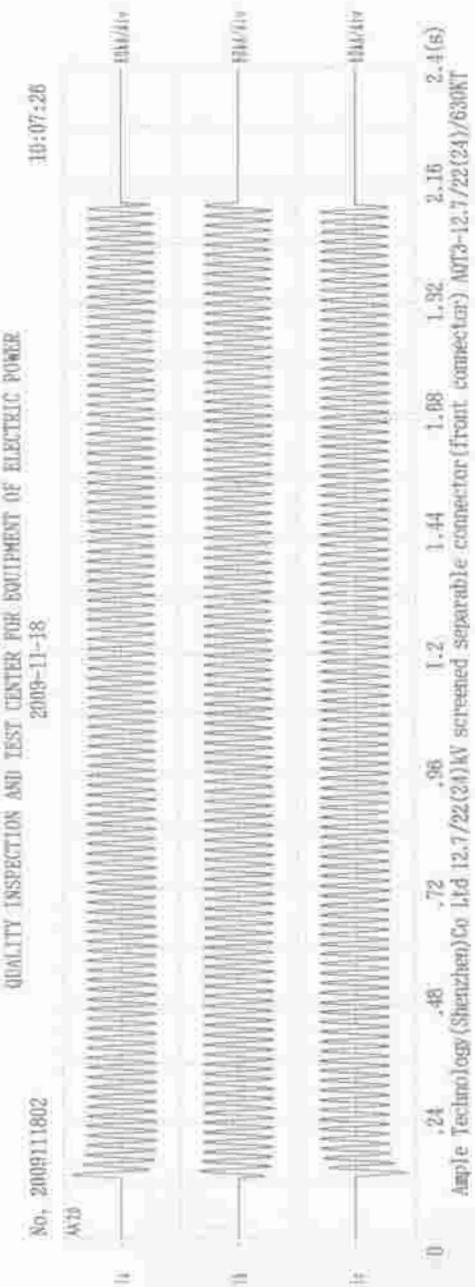


Diagram 3: 10th negative impulse 125 kV

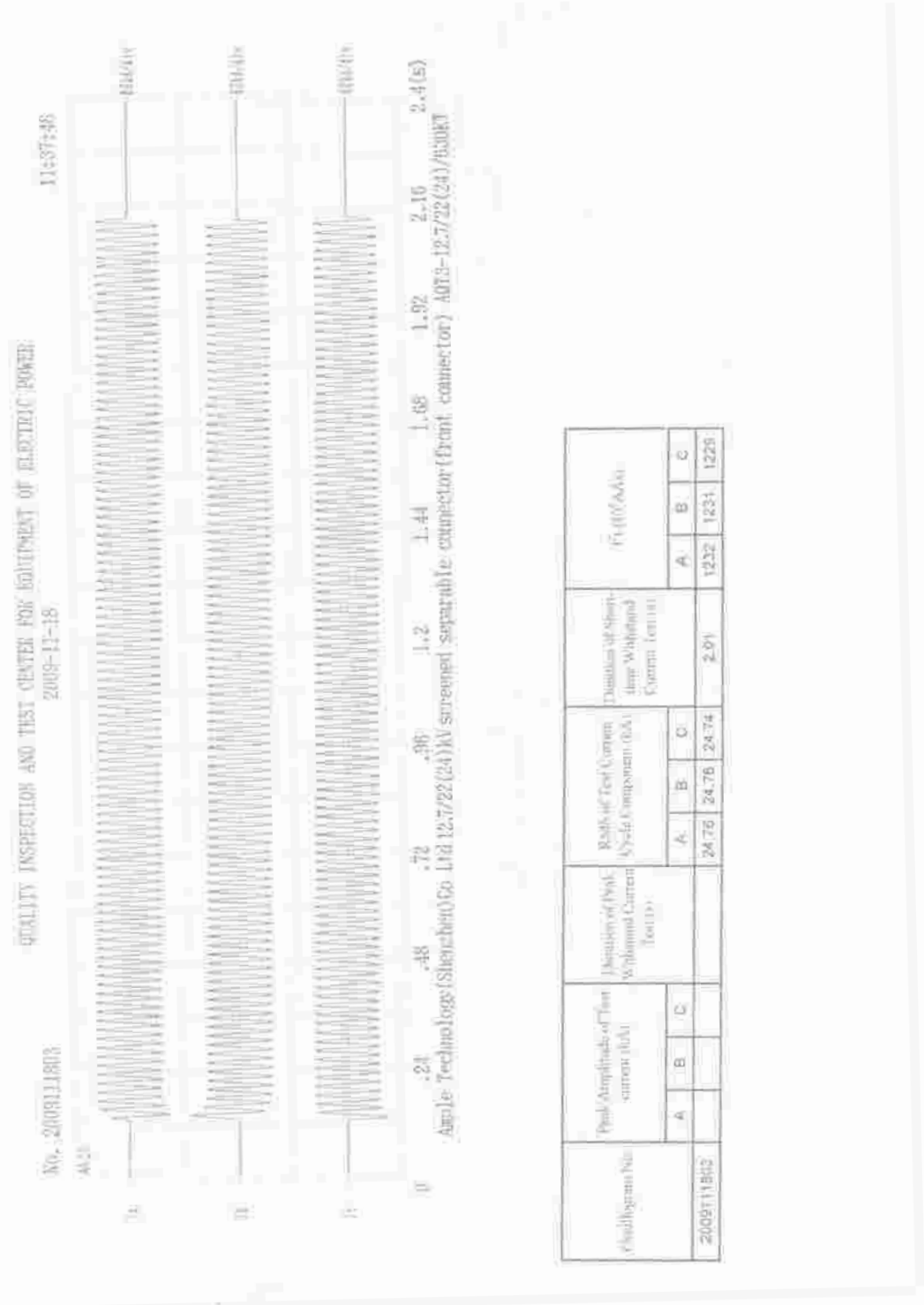
ANNEX D RESULT OF THE 1ST THERMAL SHORT CIRCUIT TEST ON THE CONDUCTOR



Oscillogram No.	Peak Amplitude of Test current (kA)			Duration of Peak Withstand Current Test (s)	RMS of Test Current Cycle Component (kA)			Duration of Short-time Withstand Current Test (s)	I^2t (10^6A^{2}s)		
	A	B	C		A	B	C		A	B	C
2009111802					24.78	24.73	24.79	2	1225	1223	1229

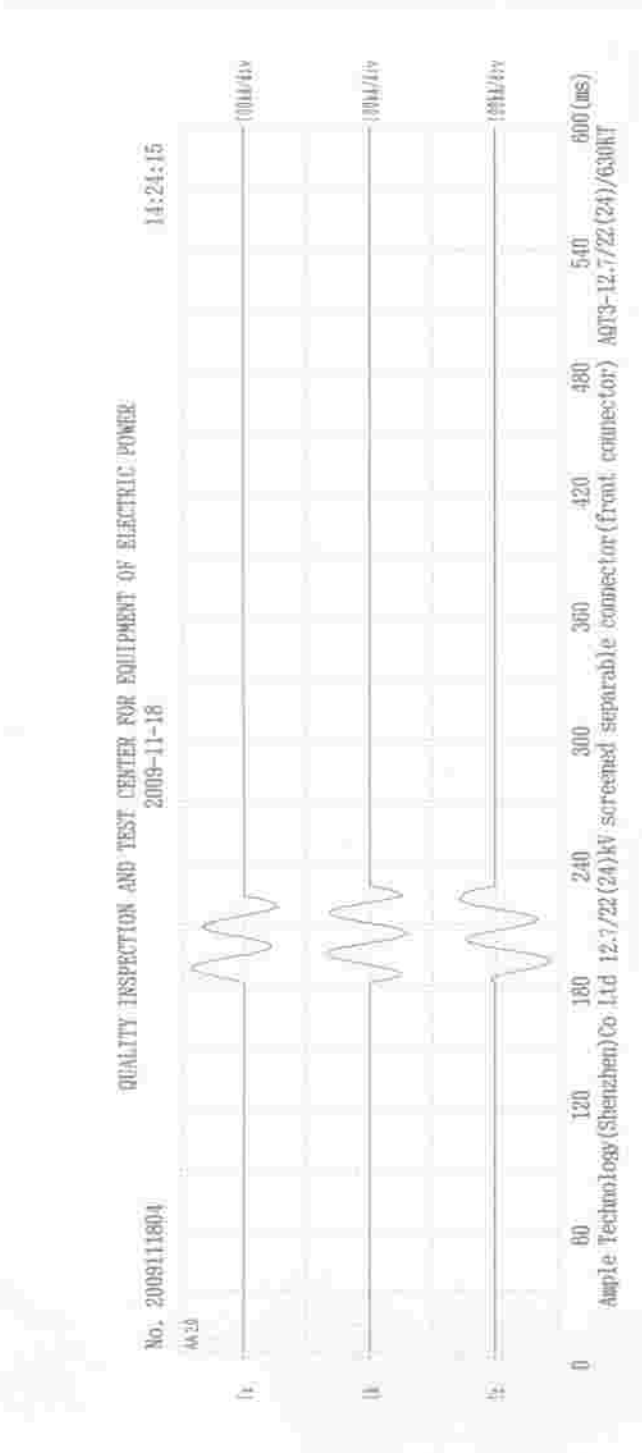
Annex D page 2

Result of the 2nd thermal short circuit test on the conductor



Haulingram No.	Peak Amplitude of Test current (kA)			Duration of Peak Withstand Current (sec)	Rated or Test Current Cycle Component (kA)			Duration of Short-time Withstand Current (sec)	Pressure		
	A	B	C		A	B	C		A	B	C
20091118B					24.76	24.76	24.74	2.91	1232	1231	1229

ANNEX E RESULT OF THE DYNAMIC SHORT CIRCUIT TEST



Oscillogram No.	Peak Amplitude of Test current (kA)			Duration of Peak Withstand Current Test (s)	RMS of Test Current Cycle Component (kA)			Duration of Short-time Withstand Current Test (s)	I^2t (10^6A^{2}s)		
	A	B	C		A	B	C		A	B	C
2009111804	84.28	68.15	67.83	0.048							

ANNEX F RESULTS OF THE IMPULSE VOLTAGE TEST (§ 2.4)

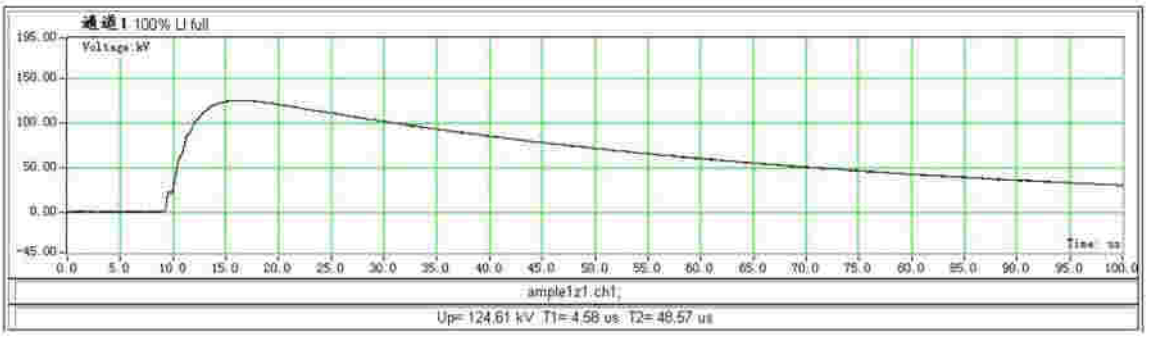


Diagram 1: 1st positive impulse 125 kV

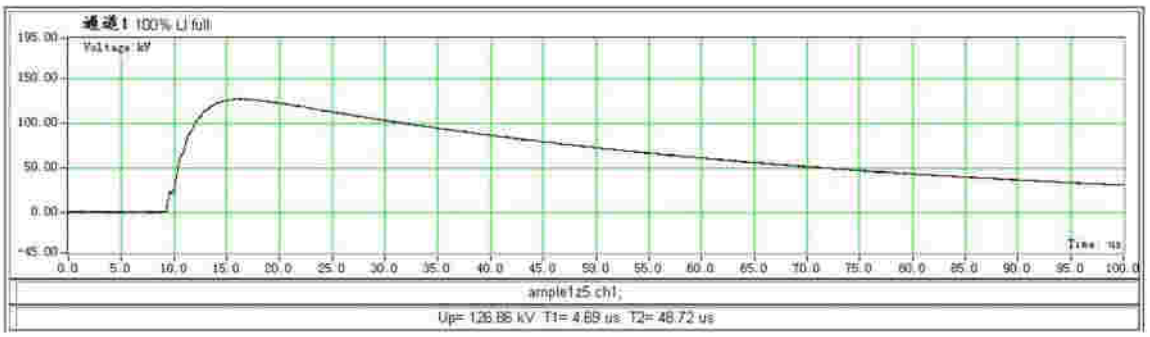


Diagram 2: 5th positive impulse 125 kV

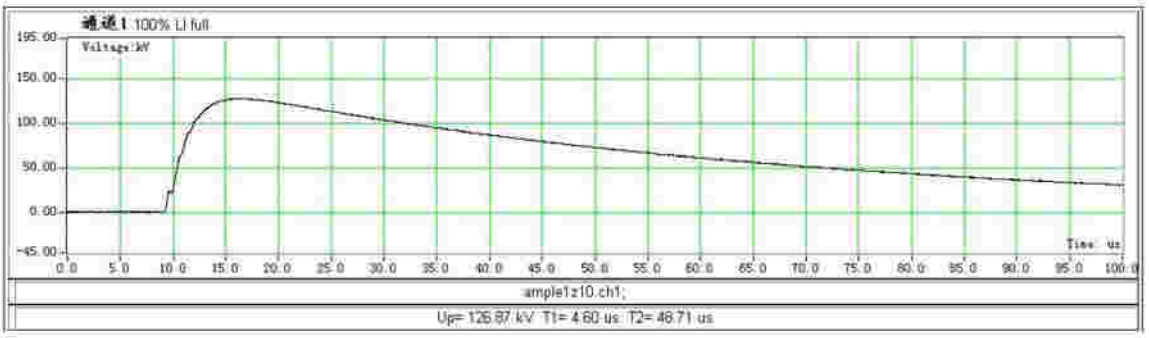


Diagram 3: 10th positive impulse 125 kV

Results of the impulse voltage test (§ 2.4)

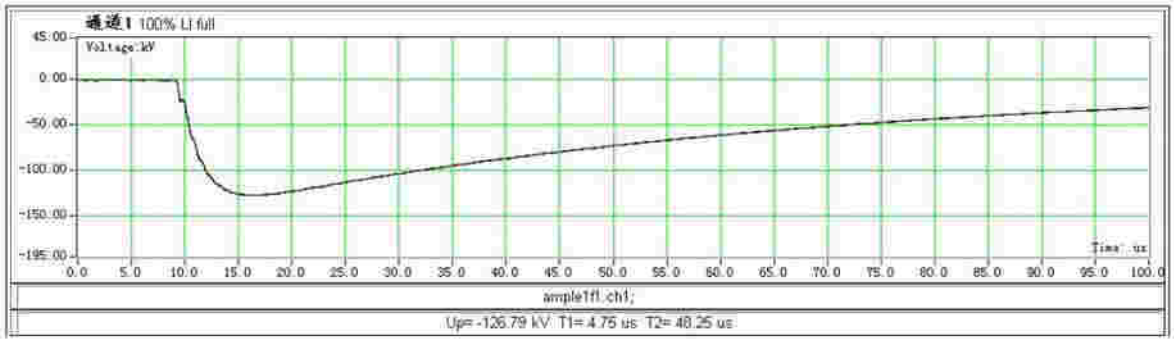


Diagram 1: 1st negative impulse 125 kV

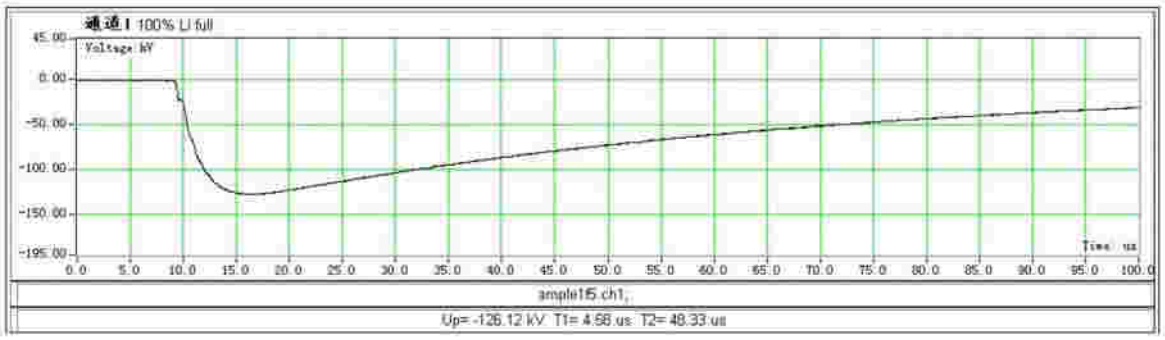


Diagram 2: 5th negative impulse 125 kV

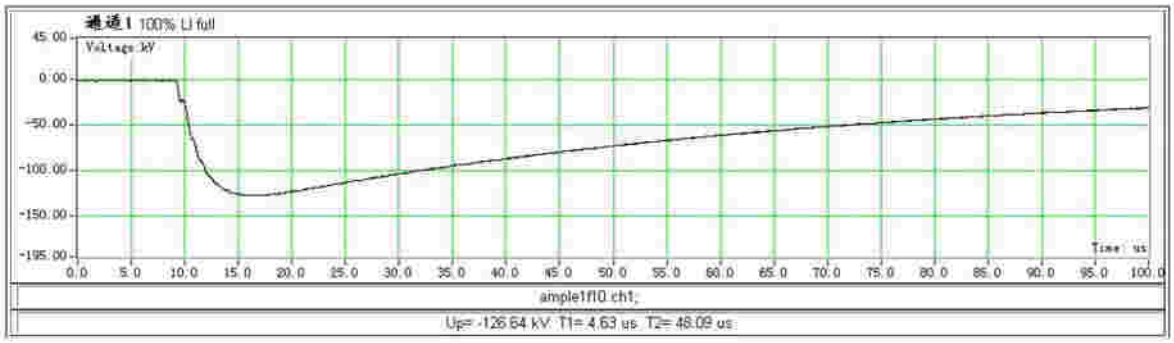


Diagram 3: 10th negative impulse 125 kV

ANNEX G CHECK OF THE CABLE CONSTRUCTION

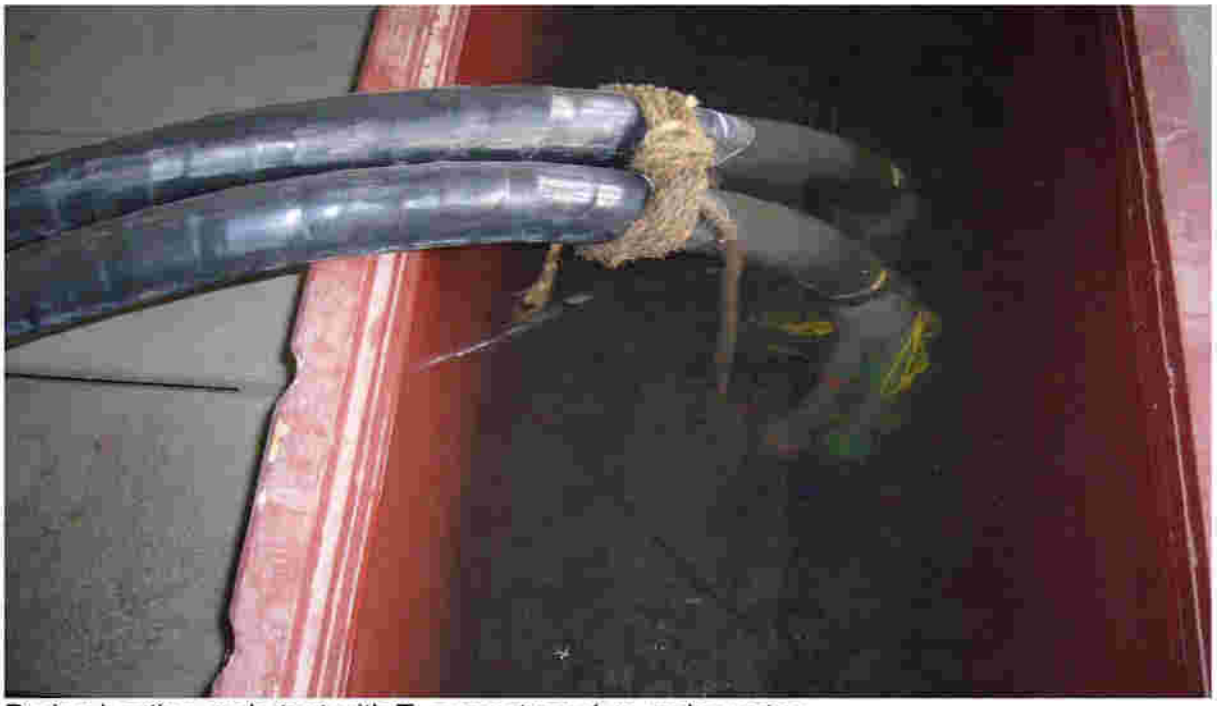
Type of cable: XLPE cable YJV22-12.7/22 kV 3 x 185 sqmm			
			Results
Overall diameter	average	mm	77,7
Oversheath material			PVC
Steel strip armour	average	mm	2 x 0,4 x 45
Copper screen of each core	averag	mm	1 x 0,10 x 35
Diameter over each core	average	mm	31,5
Thickness of the outer strippable semi-	average	mm	0,75
conducting layer	minimum	mm	0,70
Thickness of the insulation	average	mm	6,1
	minimum	mm	5,7
Insulation material			XLPE
Thickness of the inner semi-	average	mm	0,7
conducting layer	minimum	mm	0,6
Conductor thickness	average	mm	16,3
Number of wires in conductor		#	37
Conductor material	-	-	copper

ANNEX H PICTURES OF THE T-CONNECTOR DURING THE TYPE TEST

During electrical type tests

During short circuit tests

Pictures of the T-connector during the type test

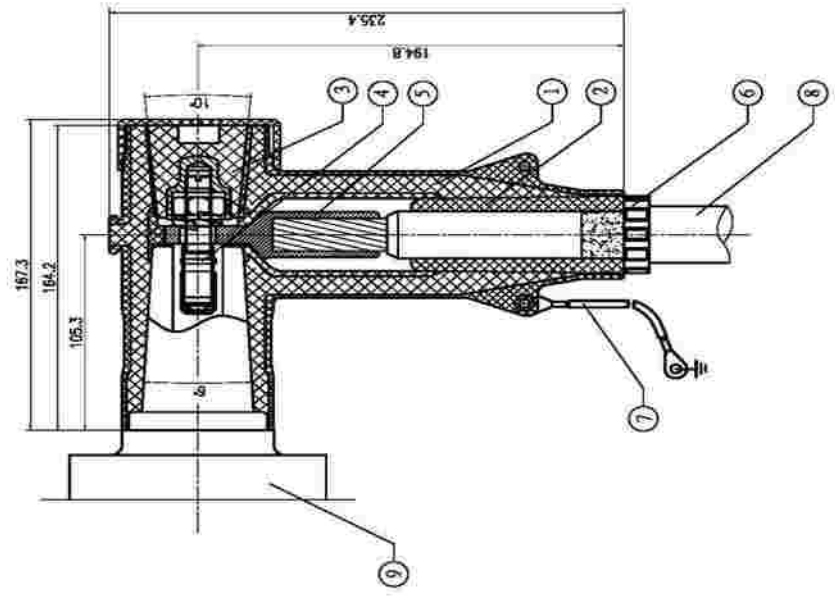


During heating cycle test with T-connectrors 1 m under water

During examination

ANNEX I DRAWING OF THE CONNECTOR: AQT3 24/630KT

No.	Description	Type No.	Material	Remarks
1	12.7/22 (24) kV 630A T connector body	AQT3-24/630KT	EPDM	
2	Cable adapter		EPDM	
3	Insulating plug		Epoxy resin & Cu	
4	Bolt		Cu	
5	Cable lug		Cu	
6	Position chain		Plastic	
7	Earthing wire	L=0.8m	Cu	
8	Cable		Cu	
9	24kV 630A Bushing		Epoxy resin & Cu	



DIMENSION	TOLERANCE
1 ~ 3	± 0.3
4 ~ 6	± 0.4
7 ~ 10	± 0.5
11 ~ 18	± 0.6
19 ~ 30	± 0.8
31 ~ 50	± 1.0
51 ~ 80	± 1.2

AMPLETEK AMPLE TECHNOLOGY (SHENZHEN) CO., LTD.

Description: 12.7/22 (24) kV 630A T Connector (Assembly outline)

Prepared by: Li Mingkui 2009.7.30

Checked by:

Approved by:

PART NO.

Drawing No: AQT3KT-ZH01

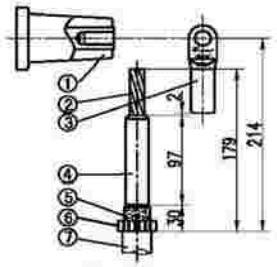
ANNEX J INSTALLATION INSTRUCTIONS

AMPLETEK® 安迪普科技(深圳)有限公司
AMPLE TECHNOLOGY (SHEN ZHEN) C O., LTD.

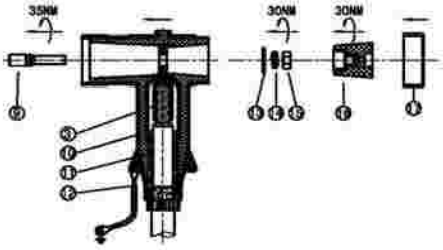
AQT3-24/630KT 用于12.7/22 交联聚乙烯绝缘电缆，适用电缆截面25-500mm²
AHT3-24/630KT Apply to 12.7/22 kV XLPE Insulated Power Cable.Suitable for cable cross section 25-500mm²

配件名称 Components Description

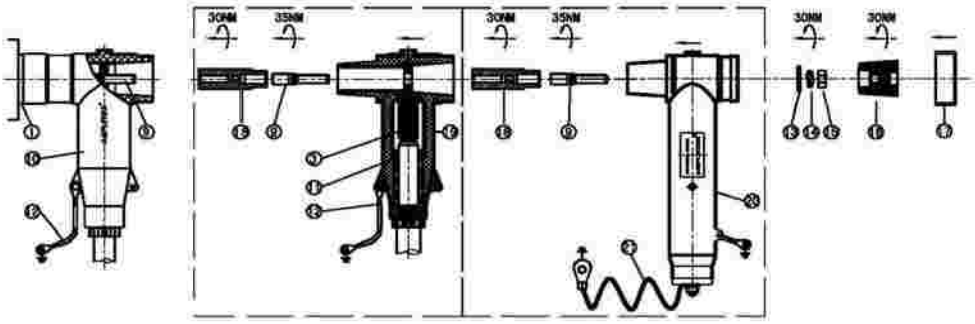
1	套管	Bushing	8	铜屏蔽	Copper screen	15	螺母	Nut
2	电缆线芯	Cable core	9	双头螺栓	Bolt	16	绝缘塞	Insulating plug
3	接线端子	Lug	10	前接头	Front connector	17	封帽	Screen cover
4	芯绝缘	Core insulation	11	应力锥	Cable adaptor	18	连接杆	Linking rod
5	半导电层	Semi-conductive layer	12	接地线	Earthing wire	19	后接头	Rear connector
6	定位链条	Position device	13	平垫圈	Flat washer	20	后接头避雷器	Rear connector w/arrester
7	绝缘管	Insulation tube	14	弹簧垫圈	Spring washer	21	镀锡软导线	Tinned soft wire



电缆切割 Cable stripping



前接头安装 Front connector installation



后接头(后接头避雷器)安装 Rear connector (with arrester) Installation

注意：该产品必须有经专门培训的电气工程人员安装，并要遵守高压设备的安全使用准则。

Attention:This products need to be installed by trained electrical engineer following the safe using guide of high-voltage equipment.

1. 电缆分相长度不小于650mm。
   The length of phase shall not less than 650mm.
2. 不可划伤芯绝缘，对半导电层及芯绝缘进行倒角。
   Do not cut core insulation,Make a bevel at semi-conductive layer and core insulation.
3. 环切冷(热)缩绝缘管，确保切口整齐，尺寸准确。
   Cut the cold (heat) shrink tube circularly, make sure the trim cutting and accurate size.
4. 定位链条固定在半导电层上，并抵住冷(热)缩绝缘管上端。
   The position chain is fixed on the semi-conductive layer against up port of shrink tube.
5. 压接端子时端子孔方向与连接套管方向一致。
   The direction of lug hole and bushing should be in the same line when compress the lug.
6. 必须清洁产品对应接触部位，并均匀涂抹硅脂。
   Must keep the contact parts clean before daub the lubricate evenly.