

Report.

70441018-TDT 05-48917A

05-06-15

**Several type tests on screened load break
plug-in separate elbow connector**

Type: CEE YJSYC 8.7/15/17.5 kV/200 A

Manufacturer: Fujian CEE Installations Co., Ltd.



INSPECTION REPORT

Report number 70441018-TDT 05-48917A
Client Fujian CEE Installations Co., Ltd.
No. 20, Jinzhou North Road,
Golden Mountain Industrial Zone
P.C. 350002
Fuzhou, China

Reference agreement of October 27, 2004

Concerning several type tests
Date November 9, 2004 until January 6, 2005
Place Wuhan, China
Object screened load break plug-in separable elbow connector
Type CEE YJSYC 8.7/15/17.5 KV / 200 A
Manufacturer Fujian CEE Installations Co., Ltd.

REQUIREMENTS

The requirements as mentioned in the standard IEC 60502-4 (1997-03).

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 in page 4, the requirements were met.

Author R.A.J. Blokhuis

This B-report consists of:
28 pages
1 annex (1 page)

KEMA Nederland B.V.



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

Arnhem, 14 June, 2005

MATERIAL DATA**SCREENED LOAD BREAK PLUG-IN SEPARABLE ELBOW CONNECTOR**

Manufacturer	Fujian CEE Installations Co., Ltd.
Type	CEE YJSYC 8.7/15/17.5 kV / 200 A
Meanings of the type code:	CEE: logo
	YJ: for XLPE cable
	S: termination for equipment
	Y: premolded type
	C: plug-in type
	8.7/15/17.5: $U_0/U/U_m$
	200: current rating

RATINGS ASSIGNED BY THE MANUFACTURER

Rated voltages $U_0/U/U_m$	8.7/15/17.5 kV
Rated frequency	50 Hz
Rated current	200 A
Rated cable conductor cross section	25 to 300 mm ²
AC 5 minute withstand	39 kV
Impulse withstand	95 kV
Partial discharge level	≤ 5 pC @ 15 kV

Insulation

Insulating material	EPDM
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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 the drawing and data of the connector reference is made to annex A.



PERSONS ATTENDING THE TESTS

Mr Tony Wang
Mr Yang Rongkai

Fujian CEE Installations Co., Ltd.
Wuhan High Voltage Research Institute State Grid
Corporation of China

THE INSPECTION WAS CARRIED OUT BY

Mr R.A.J. Blokhuis
Mr C. Eilander

KEMA Nederland B.V.
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 39 kV - 5 min.	1
1.2	Partial discharge test at ambient temperature	2
1.3	Impulse test at high temperature	3
1.4	Thermal cycles in air	4
1.5	Partial discharge test at high and ambient temperature	5
1.6	Thermal cycles in air	9
1.7	Thermal cycles under water	10
1.8	Disconnect / connect	11
1.9	Partial discharge test at high and ambient temperature	12
1.10	Impulse test at ambient temperature	13
1.11	AC withstand test 23 kV 15 min.	14
1.12	Visual inspection	-
1.13	Check of the construction of the cable used	IEC 60811-1-1, clause 8
2	TYPE TESTS ACCORDING TEST SEQUENCE 4.2/4.3	
2.1	Thermal short circuit test on the conductor	7
2.2	Disconnect / connect	11
2.3	Impulse test at ambient temperature	13
2.4	AC withstand test 23 kV 15 min.	14
3	TYPE TESTS ACCORDING TEST SEQUENCE 4.4	
3.1	Operating eye test	15
3.2	Partial discharge test at ambient temperature	16
4	TYPE TESTS ON SEPARATE CONNECTORS	
4.1	Screen resistance test	17
4.2	Screen leakage current test	18
4.3	Operating force test	20
4.4	Capacitive test point test	21

DESCRIPTION OF THE TESTS

0 INSPECTION OF THE TEST SET-UP

The tests were carried out in the laboratory of the Wuhan High Voltage Research Institute State Grid Corporation of China in Wuhan. 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 where 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, four connectors were mounted on cable in order to create a test loop. Each two of the two pairs of connectors were connected to each other. The sets of connectors were erected with all associated metalwork and fittings.

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 39 kV ($4.5 \times U_0$) 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 1.5 pC could be detected. The voltage was first set to $2 U_0$ (17.4 kV) for 10 s and then lowered until $1.73 U_0$ (15 kV). At $1.73 U_0$ the partial discharges were measured. The results are stated in annex 1.

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 95 kV.

The oscillograms of the test are stated in annex 2.

Result

The test was completed successfully.

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

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 3 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_0 (23 kV), 50 Hz.

Result

The test was completed successfully.

1.5 Partial discharge test at high and ambient temperature in accordance with IEC 60502-4, table 7, clause 5

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 2.5 pC could be detected. The voltage was first set to 2 U_0 (17.4 kV) for 10 s and then lowered until 1.73 U_0 (15 kV). At 1.73 U_0 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 1.

Result

The test was completed successfully.

1.6 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 (23 kV), 50 Hz. The results are listed in annex 1.

Result

The test was completed successfully.

1.7 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 (23 kV), 50 Hz. The results are listed in annex 1.

Result

The test was completed successfully.

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

After the above mentioned test the two pairs of two 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.

1.9 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 3 pC could be detected. The voltage was first set to 2 U₀ (17.4 kV) for 10 s and then lowered until 1.73 U₀ (15 kV). At 1.7 U₀ 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 1.

Result

The test was completed successfully.

1.10 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 3.

Result

The test was completed successfully.

1.11 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 23 kV ($2.5 \times U_0$) during 15 minutes in accordance with the specification.

Result

The test was completed successfully.

1.12 Visual inspection

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.

1.13 Check of the construction of the cable used in accordance with IEC 60811-1-1, clause 8

At a sample of approximately 0.5 m the dimensions of the insulating and protecting layers were measured.

The results are stated in annex 6.

Result

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

2 TYPE TESTS ACCORDING TEST SEQUENCE 4.2 / 4.3

In accordance with test sequence 4.2 and 4.3 of IEC 60502-4, three connectors were mounted on cable in order to create a test loop. Each connector was mounted on a junction. The connectors were erected with all associated metalwork and fittings.

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 connectors were connected on a short-circuiting bar. The other three ends of the cable were connected to a short-circuit generator. 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 4.

Result

No visible deterioration occurred on the parts at 10.5 kA for 0.819 seconds and at 10.5 kA for 0.812 seconds. The test was completed successfully.

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

After the above mentioned test the three 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.

2.3 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 5.

Result

The test was completed successfully.

2.4 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 23 kV ($4.5 \times U_0$) during 15 minutes in accordance with the specification.

Result

The test was completed successfully.

3 TYPE TESTS ACCORDING TEST SEQUENCE 4.4

3.1 Operating eye test in accordance with IEC 60502-4, table 7, clause 15

A connector was assembled on a cable loop in accordance with the manufacturer's instructions and connected to its mating bushing. The test was performed in accordance with IEC 60442, clause 18.

The connector was mechanically clamped along the interface. A tensile force was gradually applied to the operating eye in the direction of the bushing axis. The force applied was 2200 N and was maintained for at least 1 minute.

Hereafter a rotational torque was gradually applied in a clockwise direction and after this in the anticlockwise direction. The force applied was 14 Nm.

Result

The test was completed successfully.

3.2 Partial discharge test at ambient temperature in accordance with IEC 60502-4, table 7, clause 16

After the above mentioned tests the test set-up was examined for partial discharges in accordance with IEC 60442, clause 7.

The sensitivity of the measuring circuit was checked with a calibrator. Discharges with an intensity of 3 pC could be detected. The voltage was first set to 2 U_0 (17.4 kV) for 10 s and then lowered until 1.73 U_0 (15 kV). At 1.7 U_0 the partial discharges were measured.

The results of the test are stated in annex 1.

Result

The test was completed successfully.

4 TYPE TESTS ON SEPARATE CONNECTORS

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

The test was carried out on a connector, not installed on a cable or mating bushing. The connector was on each end equipped with silver painted 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 1.

Result

The test was completed successfully.

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

For this test a connector 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 the metal flange and the earthed bond of the cable screen. The metal foil was earthed through a mill 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 (17.5 kV) applied between the conductor and earth.

The results of the test are stated in annex 1.

Result

The test was completed successfully.

4.3 Operating force test in accordance with IEC 60502-4, table 7, clause 20

This test was carried out on a connector which was connected to its mating bushing. The connector assembly was conditioned at -20 ± 2 °C for at least 12 hours. The test was carried out within 5 minutes after removal from the conditioning chamber.

The connector was clamped by means of a suitable tool, which allowed operation along the axis of the connector and mating bushing interface. A force was then gradually applied to the separable connector in the axial direction. The force to open and close the connector/bushing interface was measured.

The results of the test are stated in annex 1.

Result

The test was completed successfully.

4.4 Capacitive test point in accordance with IEC 60502-4, table 7, clause 21

This test was carried out on a connector which was installed on a cable and the outer screen earthed in accordance with the manufacturer's instructions. The connector needs not to be connected to its mating bushing. The length of cable used was about 30 cm. The following capacitances were measured at ambient temperature:

- C_{tc} : capacitance between the test point and the cable conductor
- C_{te} : capacitance between the test point and the earth.

To eliminate the influence of stray capacitances and since the capacitances to be measured are very small, a differential bridge was used.

The results of the test are stated in annex 1.

Result

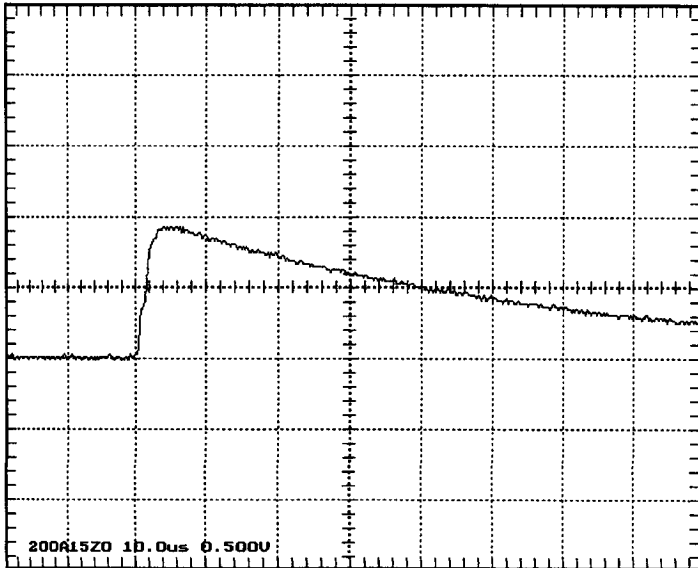
The test was completed successfully.



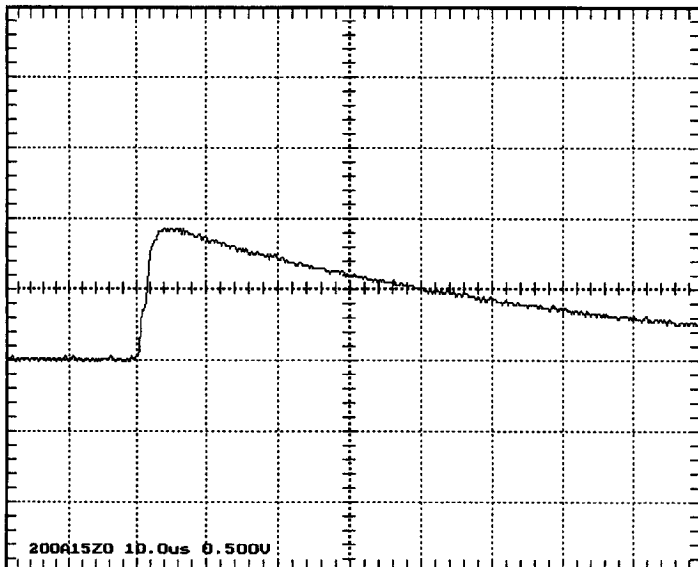
Results of the electrical tests

Type of connector: CEE YJSYC 8.7/15/17.5 kV / 200 A			
		Results	Requirements
<u>Partial discharges at 1,73 U₀</u>			
After the AC withstand test	pC	< 1.5	≤ 5
After thermal cycle test at high temp.	pC	< 2.5	≤ 5
After thermal cycle test at ambient temp.	pC	< 2.5	≤ 5
After disconnect/connect at high temp.	pC	< 4	≤ 5
After disconnect/connect at ambient temp.	pC	< 4	≤ 5
After the operating eye test	pC	< 4	≤ 5
<u>Thermal cycles in air</u>			
Number of cycles	#	30	30
Number of hours	#	240	240
<u>Thermal cycles under water</u>			
Number of cycles	#	30	30
Number of hours	#	240	240
<u>Screen resistance</u>			
Before ageing	Ω	16	≤ 5000
After ageing	Ω	9	≤ 5000
Screen leakage current	mA	≤ 0.5	≤ 0.5
<u>Operating force</u>			
Opening force	N	450	≤ 900
Closing force	N	< 700	≤ 900
<u>Capacitive test point</u>			
C _{tc}	pF	1.337	≥ 1.0
C _{te} /C _{tc}	-	8.8	≤ 12.0

Results of the impulse voltage test (§ 1.3)

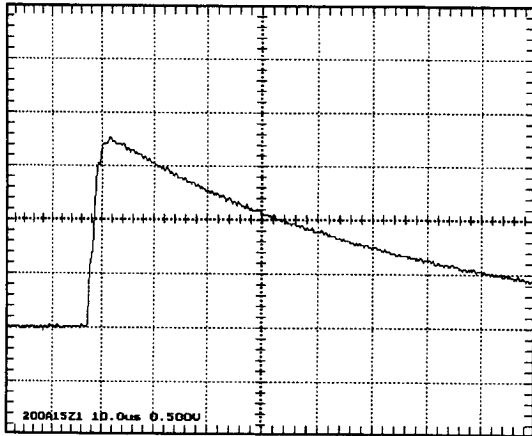


80% of 95 kV
Front time 3,37 μ s
Requirement 1-5 μ s

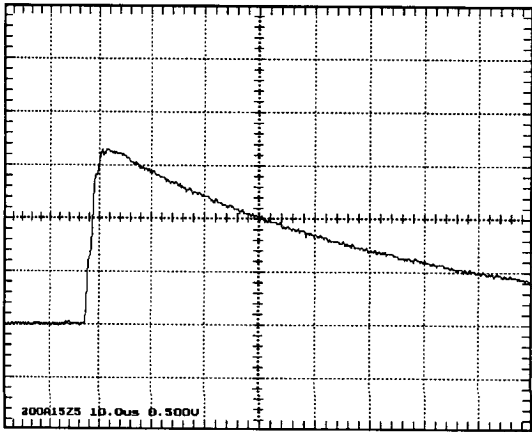


80% of 95 kV
Time to half value 43 μ s
Requirement 40-60 μ s

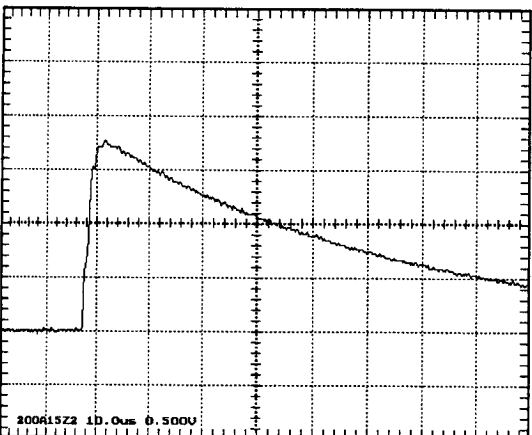
Results of the impulse voltage test (§ 1.3)



1st positive impulse 95 kV

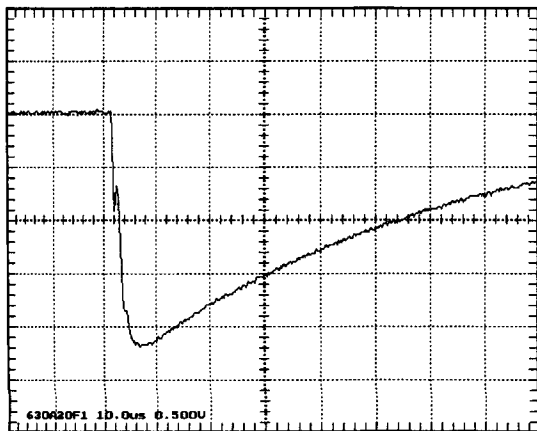


5th positive impulse 95 kV

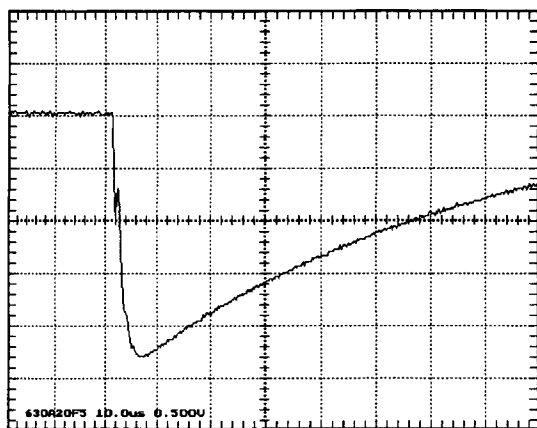


10th positive impulse 95 kV

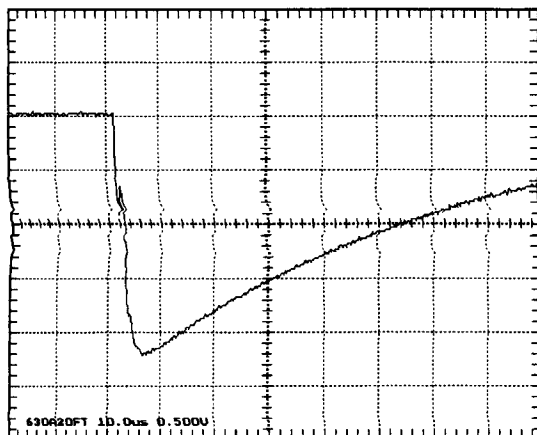
Results of the impulse voltage test (§ 1.3)



1st negative impulse 95 kV

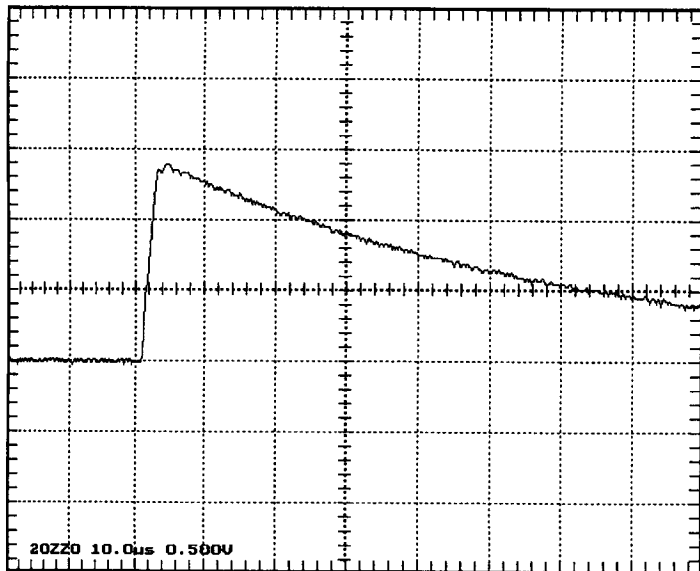


5th negative impulse 95 kV

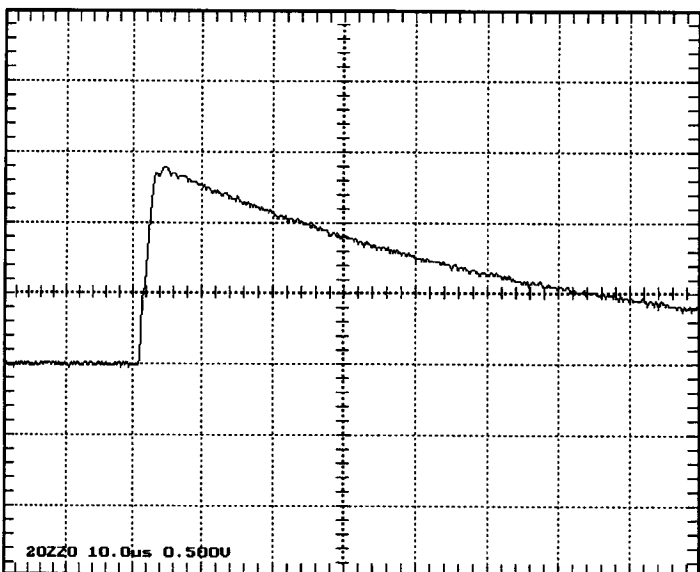


10th negative impulse 95 kV

Results of the impulse voltage test (§ 1.10)

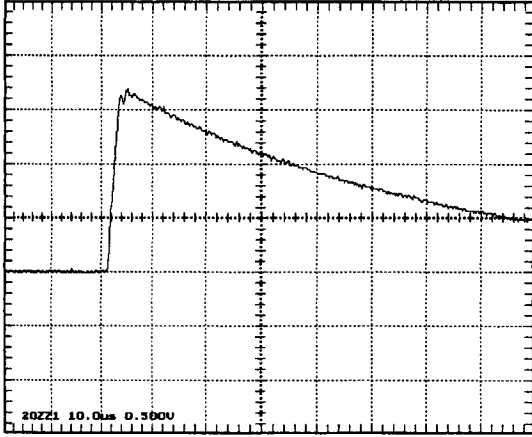


80% of 95 kV
Front time 3,41 μ s
Requirement 1-5 μ s

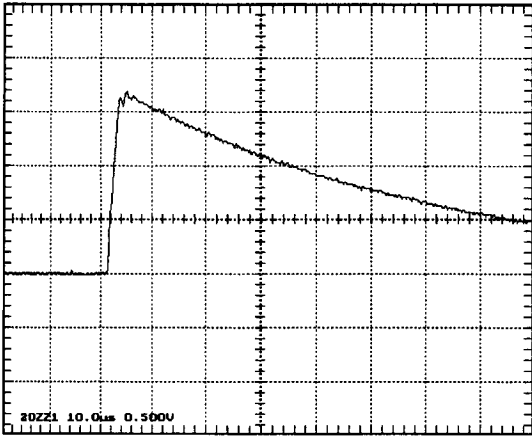


80% of 95 kV
Time to half value 43 μ s
Requirement 40-60 μ s

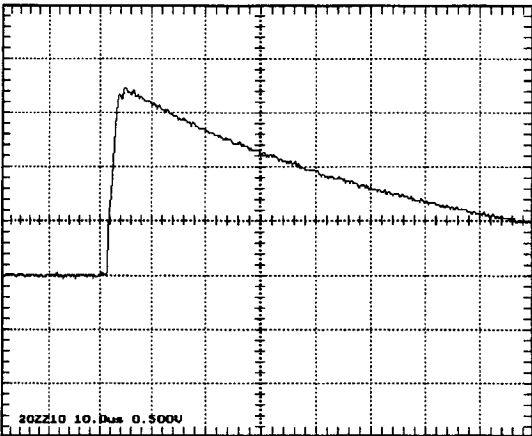
Results of the impulse voltage test (§ 1.10)



1st positive impulse 95 kV

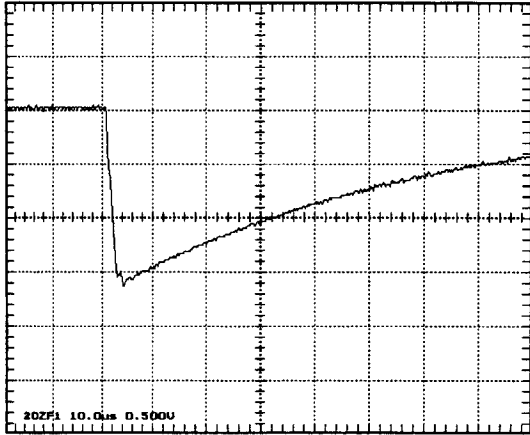


5th positive impulse 95 kV

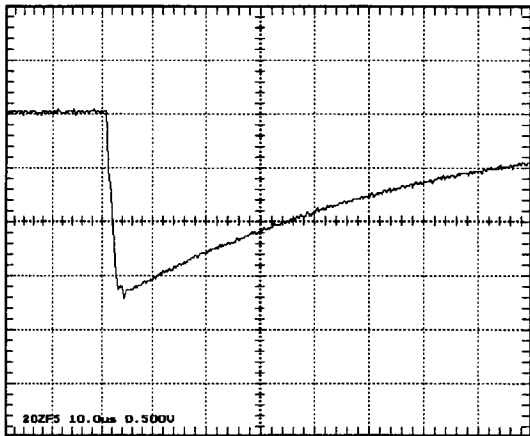


10th positive impulse 95 kV

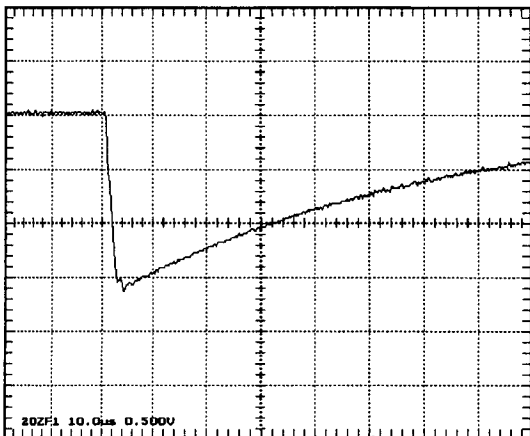
Results of the impulse voltage test (§ 1.10)



1st negative impulse 95 kV

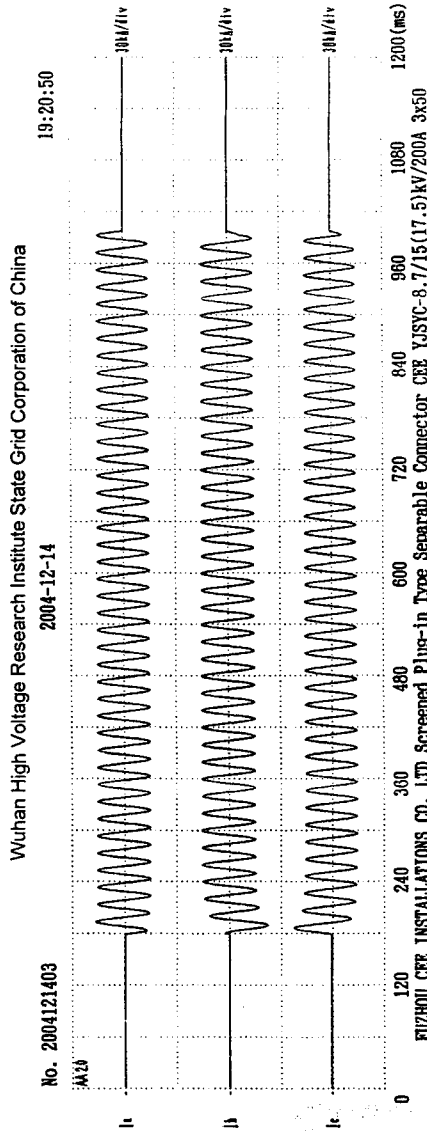


5th negative impulse 95 kV



10th negative impulse 95 kV

Result of the 1st thermal short circuit test on the conductor

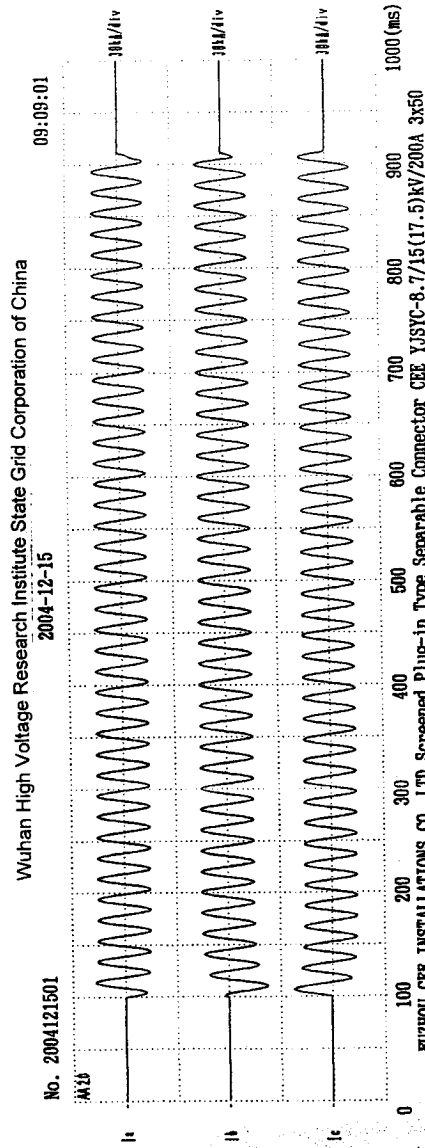


Oscillogram No.	Test Current Crest (kA)			Dynamic Short Circuit Duration	Test Current Cycle Components rms (kA)			Thermal Short Circuit Duration	Thermal Short Circuit Value		
	A	B	C		A	B	C		A	B	C
2004121403	16.51	22.38	22.13		10.46	10.48	10.41	0.819	89.59	89.92	88.67

Witness :

Test: 彭超
Verified: 彭超 2004-12-14

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



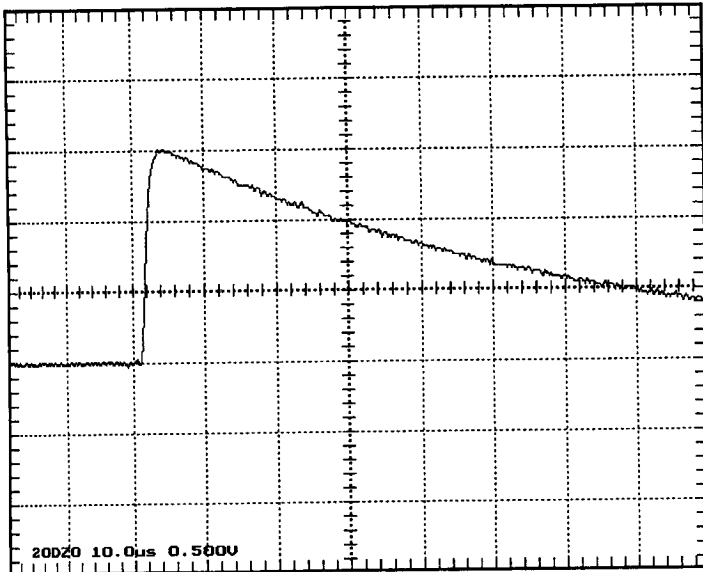
Oscillogram No.	Test Current Crest (kA)			Dynamic Short Circuit Duration	Test Current Cycle Components rms (kA)			Thermal Short Circuit Value			
	A	B	C		A	B	C	A	B	C	
2004121501	16.92	22.45	21.50		10.52	10.54	10.45	0.812	89.91	90.20	88.66

Witness:

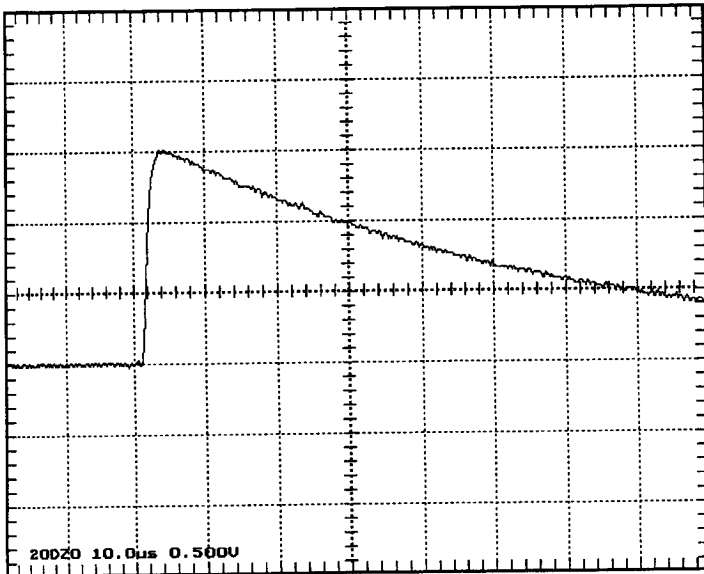


Test: 刘超
Verified: 刘超 2004-12-15

Results of the impulse voltage test (§ 2.5)

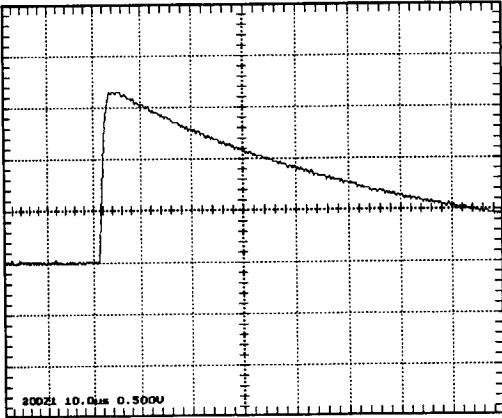


80% of 95 kV
Front time 3,32 µs
Requirement 1-5 µs

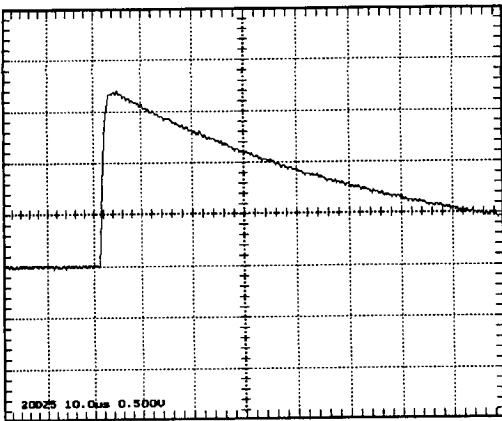


80% of 95 kV
Time to half value 43 µs
Requirement 40-60 µs

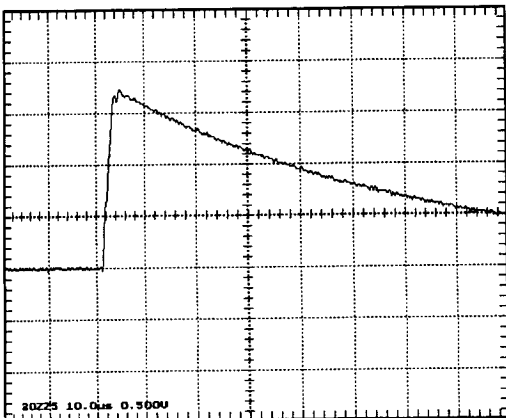
Results of the impulse voltage test (§ 2.5)



1st positive impulse 95 kV

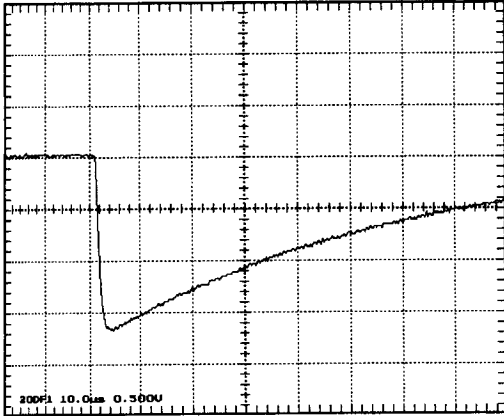


5th positive impulse 95 kV

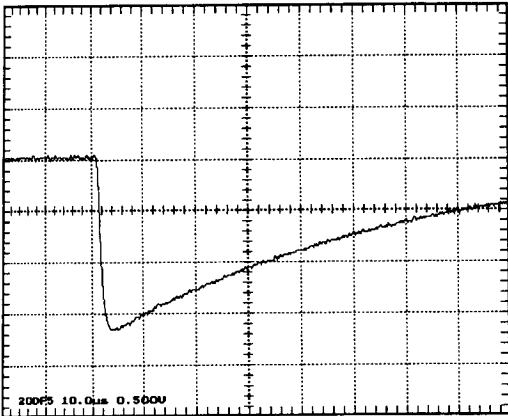


10th positive impulse 95 kV

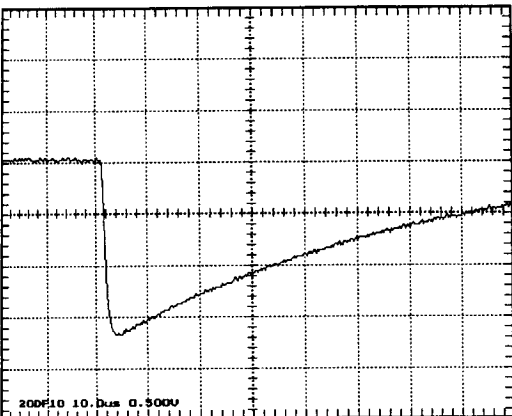
Results of the impulse voltage test (§ 2.3)



1st negative impulse 95 kV



5th negative impulse 95 kV



10th negative impulse 95 kV



Check of the construction of the cable

Type of cable: XLPE cable 8.7/15 kV 3 x 50 sqmm			Results
Overall diameter	average	mm	59.7
Thickness of copper tape	average	mm	0.11
Number of wires in conductor	-	#	19
Diameter over the core	average	mm	20.9
Thickness of the outer semi-conducting layer	average	mm	0.70
	minimum	mm	0.60
Thickness of the insulation	average	mm	5.10
	minimum	mm	4.90
Thickness of the inner semi-conducting layer	average	mm	0.60
	minimum	mm	0.50
Conductor thickness	average	mm	8.8
Conductor material	-	-	round copper

Drawing of the connector: CEE YJSYC 8.7/15/17.5 kV 200 A

