KEMA

HIGH-VOLTAGE LABORATORY

Certificate

KEMA

TYPE TEST CERTIFICATE OF COMPLETE TYPE TEST

OBJECT	single fase XLPE insulated power cable
DESIGNATION	132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Rated voltage	76/132/145 kV
Rated frequency	50 Hz
MANUFACTURER	Egytech Cables Co. 21 Cleopatra st., From El Thawra st., Heliopolis-Cairo-Egypt.
TESTED BY	KEMA HIGH-VOLTAGE LABORATORY Utrechtseweg 310 – 6812 AR Arnhem - the Netherlands
DATE OF TESTS	17 November 1998 to 5 August 1999

The object, constructed in accordance with the description, drawings and photographs incorporated in this Certificate, has been subjected to the series of proving tests in accordance with

IEC 60840

The results are shown in the record of Proving Tests and the oscillograms attached hereto. The values obtained and the general performance are considered to comply with the above Standard and to justify the ratings assigned by the manufacturer as listed on page 2.

The Certificate applies only to the object tested. The responsibility for conformity of any object having the same designations with that tested rests with the manufacturer.

This Certificate comprises 31 sheets in total.

KEMA Nederland B.V.

G.P.T. Roelofs

Arnhem, 5 August 1999.

RATINGS ASSIGNED BY THE MANUFACTURER AND PROVED BY TESTS

Rated voltage $U_o/U/U_m$	76/132/145	kV
Rated frequency	50	Hz
Maximum rated conductor temperature for XLPE	90	°C
Rated cross-section	1x500	mm^2

TEST PROGRAMME

1 Electrical type tests

1.1 Check on insulation thickness of cable for electrical type tests in accordance with IEC 60840 clause 11.3.1

1.2 Bending test in accordance with IEC 60840 clause 11.3.4

1.3 Partial discharge test in accordance with IEC 60840 clause 11.3.5

1.4 Tan δ measurement in accordance with IEC 60840 clause 11.3.6

1.5 Heating cycle voltage test followed by partial discharge test in accordance with IEC 60840 clause 11.3.7

1.6 Impulse voltage test followed by a.c. voltage test in accordance with IEC 60840 clause 11.3.8

1.7 Resistivity of semi-conducting layers in accordance with IEC 60840 clause 11.3.9

2 Non-electrical type tests

2.1 Check of cable construction in accordance with IEC 60840 clause 11.4.1

2.2 Tests for determining the mechanical properties of insulation before and after ageing in accordance with IEC 60840 clause 11.4.2

2.3 Tests for determining the mechanical properties of non-metallic sheaths before and after ageing in accordance with IEC 60840 clause 11.4.3

2.4 Ageing tests on pieces of complete cable to check compatibility of materials in accordance with IEC 60840 clause 11.4.4

2.5 Pressure test at high temperature on sheaths in accordance with IEC 60840 clause 11.4.6

2.6 Hot-set test for XLPE insulation in accordance with IEC 60840 clause 11.4.10

2.7 Carbon black content of PE sheaths in accordance with IEC 60840 clause 11.4.12

2.8 Shrinkage test for XLPE insulation in accordance with IEC 60840 clause 11.4.13

2.9 Water penetration test in accordance with IEC 60840 clause 11.4.15

3 Verification of cable construction in accordance with IEC 60840

MATERIAL DATA

Manufacturer	Egytech Cable Co.
Type	132kV XLPE/lead sheath/HDPE/Cu 1x500 mm^2
Year of manufacture	1998
Quantity submitted	approx. 50 m
No. of phases	1
Insulation	Extra clean XLPE
Conductor material	Copper
Conductor cross-section	500 mm^2
Screening material	Lead
Sheath material	HDPE (ST7)
Sheath colour	Black
Rated voltage	132 kV
Rated frequency	50 Hz
Standard	IEC 60840 (1999)

The manufacturer has guaranteerd that the object submitted for tests has been manufactured in accordance with the following data sheet, see also appendix A.
KEMA has verified that these data sheet adequately represent the equipment tested.

SUBCONTRACTING

The following tests, as mentioned in the Test Programme, were subcontracted to KEMA Registered Quality:

1.7 resistivity of semi-conducting screens in accordance with IEC 60840, clause 11.3.9
2 non-electrical type test in accordance with IEC 60840, clause 11.4
3 verification of cable construction in accordance with IEC 60840.

PERSONS ATTENDING THE TEST

Neither the manufacturer nor the purchaser were represented during the tests.

THE TEST WAS CARRIED OUT BY

Mr H.E. Keizer	KEMA Nederland B.V.
Mr A.G.J. Jansen	KEMA Nederland B.V.

PURPOSE OF THE TEST

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

DESCRIPTION AND RESULTS OF THE TESTS

MEASUREMENT UNCERTAINTY

The last page of this report contains a table with measurement uncertainties. Unless otherwise indicated in the report, the measurement uncertainties of the results presented are as indicated in this table.

1 ELECTRICAL TYPE TESTS

1.1 Check on insulation thickness before electrical type tests

Prior to the electrical type tests the insulation thickness was measured in accordance with clause 11.3.1 of IEC 60840 (1999). The results are represented in appendix 1 page 1.

Result

The average thickness of the insulation did not exceed the specified value by more than 5%.
The test voltages shall be the normal values specified for the rated voltage of the cable.

1.2 Bending test

The test object was subjected to a bending test in accordance with clause 11.3.4 of IEC 60840 (1999).
The test object was bent around a test cylinder. The diameter of the cylinder was 2,74 m. The test consisted of three cycles of wind, unwind, reverse winding direction, wind and unwind.
During the test the temperature of the test object was approximately 5 °C.
The results are represented in appendix 1 page 2.

Result

The test was carried out successfully.

1.3 Partial discharge test

The test object was subjected to a partial discharge test in accordance with clause 11.3.5 of IEC 60840 (1999).
On completion of the bending test, the test sample was subjected to a partial discharge measurement. The partial discharges were measured between the conductor and core screen.

The measurement was carried out in a balanced circuit. For this purpose a partial discharge-free coupling capacitor was used. Special precautions were taken in order to avoid external discharges of the test object. The partial discharges were detected by means of a wide-band amplifier, a high pass filter and an oscilloscope. The measuring circuit was calibrated by means of an impulse generator giving a repeating pulse of a known pC-value. The noise level amounted to 2 pC. The voltage was raised up to 133 kV, 50 Hz and maintained at this level for 10 seconds. Subsequently the voltage was lowered down to 114 kV, 50 Hz. At this level the partial discharge level was determined.
The results are represented in appendix 1 page 3.

Result

The test was passed.

1.4 Tan δ measurement

The test object was subjected to a tan δ measurement in accordance with clause 11.3.6 of IEC 60840 (1999).
The measurement of the dielectric loss factor was carried out by using a Schering bridge and a loss-free standard capacitor. The measurement was carried out at U_0. The loss-factor of the insulation was measured between the conductor and core screen.
During the measurement the temperature of the test object was 96 °C.
The results are represented in appendix 1 page 4.

Result

The test was passed.

1.5 Heating cycle voltage test

1.5.1 HEATING CYCLE VOLTAGE TEST

The test object was subjected to a heating cycle voltage test in accordance with clauses 11.3.7 of IEC 60840 (1999).
The cable was mounted in the test set-up in a U-bend having a diameter of 3,34 m. One heat cycle consists of applying heating current for at least 8 hours followed by at least 16 hours of natural air cooling. The test object was heated up to a conductor temperature of 95 °C within the first 6 hours of the heating period and was kept steady at 95 °C for 2 hours. This temperature was achieved by inducing current in the cable. In total 20 such heating cycles were carried out. During the whole of the test period, a voltage of $2U_0$ was applied to the test object.
The results are represented in appendix 1 page 5.

Result

The test was passed.

1.5.2 PARTIAL DISCHARGE TEST

After cooling down to ambient temperature, after the last heat cycle, the test object was subjected to a partial discharge test in accordance with clause 11.3.5 of IEC 60840 (1999). The measurements were carried out as mentioned above under item 1.3. The measurement was carried out in a balanced circuit. The noise level amounted to 3 pC.
The results are represented in appendix 1 page 5.

Result

The test was passed.

1.6 Impulse voltage test (followed by a.c. voltage test)

1.6.1 IMPULSE VOLTAGE TEST

The test object was subjected to a lightning impulse voltage withstand test in accordance with clauses 11.3.8 of IEC 60840 (1999).
The waveform of the impulse voltage was determined at approximately 50 percent of the specified test value. The recorded front duration and time to half value amounted to 2,83 µs and 48 µs respectively. The waveform complied with the specified requirements. The test consisted of 10 positive and 10 negative impulses with crest values of 650 kV. The voltage was applied between the conductor and core screen. The voltage measurement was carried out by means of a RC-voltage divider and a digitizer. During the test the temperature of the test object was 95 °C. In order to achieve this temperature, current was induced in the cable. Two hours after thermal equilibrium was established the impulse voltage withstand test was performed. During the test the atmospheric conditions were not taken into account.
The results are represented in appendix 1 pages 6 up to and including 9.

Result

The test was passed.

1.6.2 A.C. VOLTAGE TEST

The test object was subjected to an a.c. voltage test in accordance with clause 11.3.8 of IEC 60840 (1999).
Upon completion of the impulse voltage withstand test, and cooling down to ambient temperature, the test object was subjected to an a.c. voltage test of 218 kV, 50 Hz for 15 minutes.
The results are represented in appendix 1 page 6.

Result

The test was passed.

1.7 Resistivity of semi-conducting layers

The measurement of the resistivity of the semi-conducting layers was carried out in accordance with clause 11.3.9 of IEC 60840 (1999).
The results are represented in appendix 1 page 10.

Result

The test was passed.

2 NON-ELECTRICAL TYPE TESTS

2.1 Check of cable construction

The examination of the conductor and measurements of insulation and sheath thickness were carried out in accordance with clause 11.4.1 of IEC 60840 (1999).
The results are represented in appendix 2 page 1.

Result

The test was passed.

2.2 Tests for determining the mechanical properties of insulation before and after ageing

The mechanical properties of insulation before and after ageing were determined in accordance with clause 11.4.2 of IEC 60840 (1999).
The results are represented in appendix 2 page 2.

Result

The test was passed.

2.3 Tests for determining the mechanical properties of non-metallic sheaths before and after ageing

The mechanical properties of the outer sheath before and after ageing were determined in accordance with clause 11.4.3 of IEC 60840 (1999).
The results are represented in appendix 2 page 3.

Result

The test was passed.

2.4 Ageing tests on pieces of completed cable to check compatibility of materials

Ageing tests on pieces of completed cable were carried out in accordance with clause 11.4.4 of IEC 60840 (1999).
The results are represented in appendix 2 page 4.

Result

The test was passed.

2.5 Pressure test at high temperature on sheaths

A pressure test at high temperature on sheaths was carried out in accordance with clause 11.4.6 of IEC 60840 (1999).
The results are represented in appendix 2 page 5.

Result

The test was passed.

2.6 Hot set test for XLPE insulation

A hot set test for the XLPE insulation was carried out in accordance with clause 11.4.10 of IEC 60840 (1999).
The results are represented in appendix 2 page 6.

Result

The test was passed.

2.7 Carbon black content of PE sheath

The carbon black content of the outer sheath was measured in accordance with clause 11.4.12 of IEC 60840 (1999).
The results are represented in appendix 2 page 7.

Result

The test was passed.

2.8 Shrinkage test for XLPE insulation

A shrinkage test for the XLPE insulation was carried out in accordance with clause 11.4.13 of IEC 60840 (1999).
The results are represented in appendix 2 page 8.

Result

The test was passed.

2.9 Water penetration test

The water penetration test was carried out in accordance with clause 11.4.15 of IEC 60840 (1999).
The cable was tested for longitudinal water tightness along the gap between the outer surface of the insulation screen and the water impermeable barrier.
The results are represented in appendix 2 page 9.

Result

The test was passed.

3 CONSTRUCTION

3.1 Check of cable construction and dimensions

The construction of the cable was checked against the manufacturer's specification.
The results obtained are represented in appendix 3 page 1.

Result

No deviations were observed.

Client: Egytech Cables Co.
Test object: 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements: IEC 60840 (1999), clause 11.3.1
Test date: 23 November 1998

1.1 RESULTS OF THE CHECK ON INSULATION THICKNESS OF CABLE FOR ELECTRICAL TYPE TEST

average thickness (mm)	specified thickness (mm)	maximum allowed thickness (mm)	result
21,2	21,0	(21+5%=) 22,1	the average thickness of the insulation did not exceed the specified value by more than 5%. The test voltages shall be the normal values specified for the rated voltage of the cable

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999), clause 11.3.4
Test dates 17 November 1998

1.2 RESULTS OF THE BENDING TEST

Atmospheric conditions
Ambient temperature 5 °C

Test object
Temperature 5 °C

outer diameter of cable D (mm)	diameter of conductor d (mm)	requirement bending diameter 25(D+d) + 5% (mm)	hub diameter of drum (mm)	observations
100,8	26,6	3344 max.	2740	3 cycles (wind/unwind and wind/unwind in opposite direction)

Client	Egytech Cables Co.
Test object	132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements	IEC 60840 (1999), clause 11.3.5
Test dates	1 December 1998

1.3 RESULTS OF THE PARTIAL DISCHARGE TEST

Atmospheric conditions

Ambient temperature	20	°C	Ambient air pressure	1032	hPa
Humidity	6,5	g/m^3			

Test object

Temperature	20	°C	Rated voltage (U_0)	76	kV

Circuit parameters

Power frequency	50	Hz	Calibration	5	pC
Bandwidth	400	kHz	Noise level	2	pC
Coupling capacitor	2600	pF	Circuit	balanced	

voltage	duration	partial discharge level	max. allowable pd-level	inception		extinction		result
(kV)	(sec)	(pC)	(pC)	(kV)	(pC)	(kV)	(pC)	
133 114	10	≤ 2	5	-	-	-	-	passed

Client	Egytech Cables Co.
Test object	132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements	IEC 60840 (1999), clause 11.3.6
Test date	2 December 1998

1.4 RESULTS OF THE TAN δ MEASUREMENT

Atmospheric conditions

Ambient temperature	19	°C	Ambient air pressure	1017	hPa
Humidity	6,5	g/m^3			

Test object

Length (approx.)	14	m	Temperature	96	°C
Rated voltage (U_o)	76	kV			

Circuit parameters

Power frequency	50	Hz
Standard capacitor	99,94	pF

applied voltage (kV)	C* (nF)	tan δ (x 10^{-4})	max. allowable value for tan δ (x 10^{-4})	result
76	1,83	2,3	10	passed

* for information only

Client	Egytech Cables Co.
Test object	132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements	IEC 60840 (1999), clause 11.3.7
Test dates	3 December until 24 December 1998

1.5 RESULTS OF THE HEATING CYCLE VOLTAGE TEST

1.5.1 Heating cycle voltage test

Atmospheric conditions

Ambient temperature (min/max) 18,5/22,0 °C

Test object

Temperature ambient/97 °C

no. of heat-cycles	required conductor temperature (°C)	applied heating current (A)	heating		cooling	continuous voltage applied (kV)	result
			total heating time (h)	duration of conductor at -- °C (h)	cooling time (h)		
20	95 ≤ t ≤ 100	1350	8	2	16	152	passed

1.5.2 Partial discharge test

Atmospheric conditions

Ambient temperature	21	°C	Ambient air pressure	1009	hPa
Humidity	7	g/m^3			

Test object

Temperature	21	°C	Rated voltage (U_o)	76	kV

Circuit parameters

Power frequency	50	Hz	Calibration	5	pC
Bandwidth	400	kHz	Noise level	3	pC
Coupling capacitor	2600	pF			

voltage (kV)	duration (sec)	partial discharge level (pC)	max. allowable pd-level (pC)	inception (kV)	inception (pC)	extinction (kV)	extinction (pC)	result
133 114	10	≤ 3	- 5	-	-	-	-	passed

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999), clause 11.3.8
Test dates 8 and 11 Januari 1999

1.6 RESULTS OF THE IMPULSE VOLTAGE TEST (followed by a.c. voltage test)

1.6.1 Impulse voltage test

Atmospheric conditions

Ambient temperature 23 °C Ambient air pressure 995 hPa
Humidity 8,5 g/m^3

Test object

Temperature 96 °C

voltage and polarity (kV)	description	oscillogram		result
		appendix 1 page	fig. no.	
+ 325	waveshape: 2,83/48 µs	7	1	
+ 325	1 impulse at 50 % of the test voltage		2	
+ 420	1 impulse at 65 % of the test voltage		3	
+ 518	1 impulse at 80 % of the test voltage		4	
+ 650	5 impulses at 100 % of the test voltage	8	5	
+ 650	5 impulses at 100 % of the test voltage		6	passed
- 321	waveshape: 2,92/47 µs		7	
- 326	1 impulse at 50 % of the test voltage		8	
- 426	1 impulse at 65 % of the test voltage	9	9	
- 522	1 impulse at 80 % of the test voltage		10	
- 650	5 impulses at 100 % of the test voltage		11	
- 650	5 impulses at 100 % of the test voltage		12	passed

1.6.2 A.c. voltage test

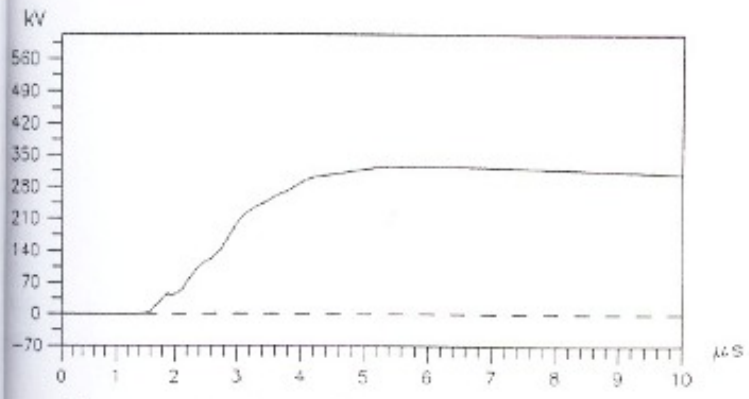
Atmospheric conditions

Ambient temperature 20 °C Ambient air pressure 1009 hPa
Humidity 6 g/m^3

Test object

Temperature 20 °C

applied voltage (kV)	frequency (Hz)	duration (min)	observations	result
190	50	15	no breakdown	passed

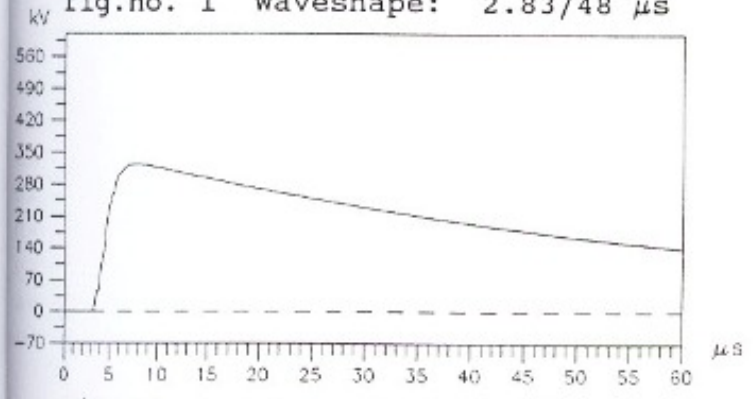


PEAKVALUE:

325 kV

Date: 99-08-01
Time: 12:54

fig.no. 1 Waveshape: 2.83/48 µs

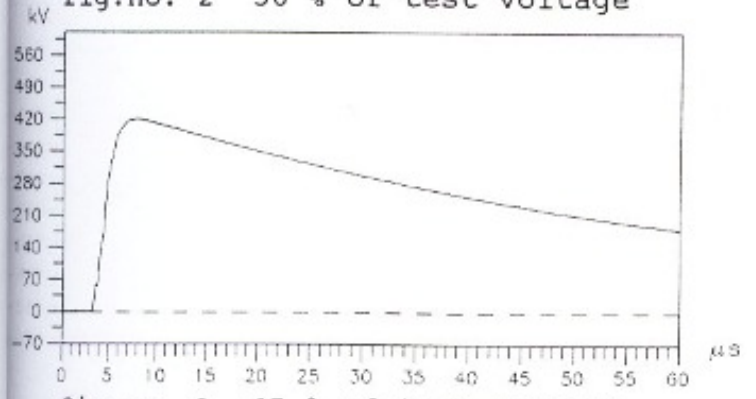


PEAKVALUE:

325 kV

Date: 99-08-01
Time: 12:56

fig.no. 2 50 % of test voltage

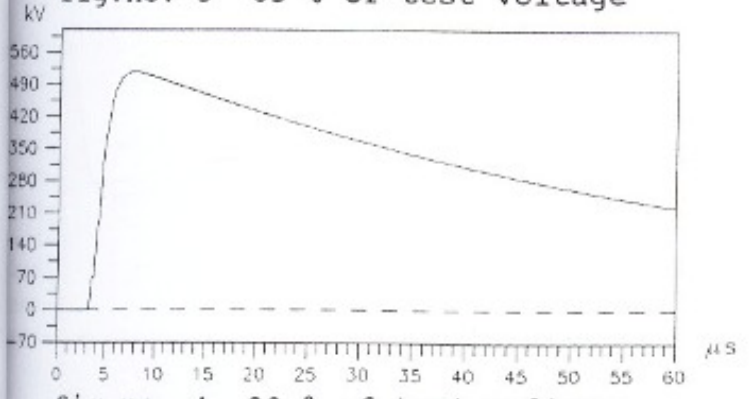


PEAKVALUE:

420 kV

Date: 99-08-01
Time: 13:02

fig.no. 3 65 % of test voltage

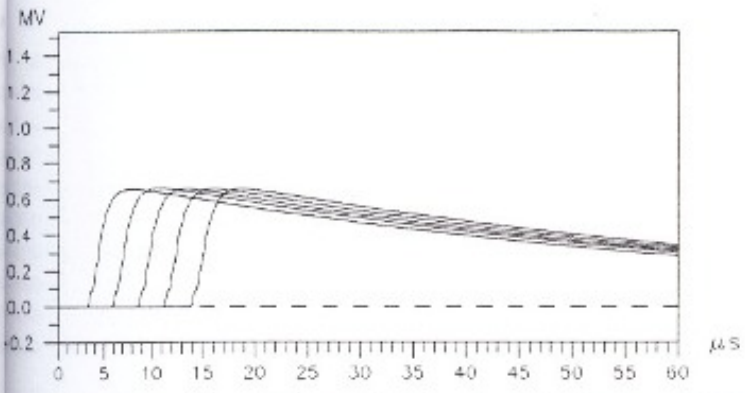


PEAKVALUE:

518 kV

Date: 99-08-01
Time: 13:14

fig.no. 4 80 % of test voltage

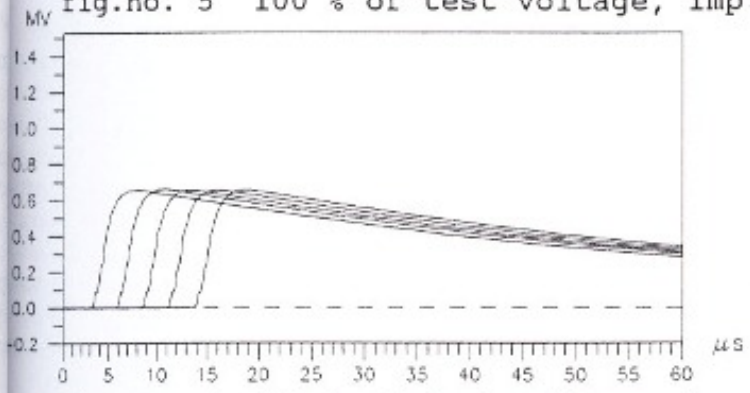


PEAKVALUES:

655 kV
662 kV
655 kV
655 kV
655 kV

Date: 99-08-01
Time: 13:32

fig.no. 5 100 % of test voltage, imp. nos. 01 - 05

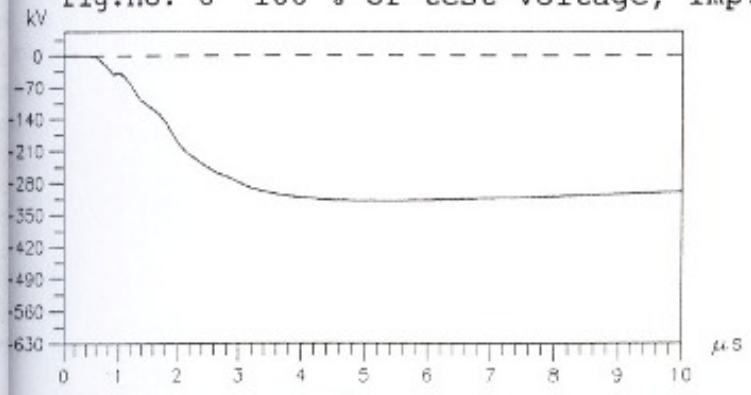


PEAKVALUES:

655 kV
662 kV
655 kV
655 kV
655 kV

Date: 99-08-01
Time: 13:39

fig.no. 6 100 % of test voltage, imp. nos. 06 - 10

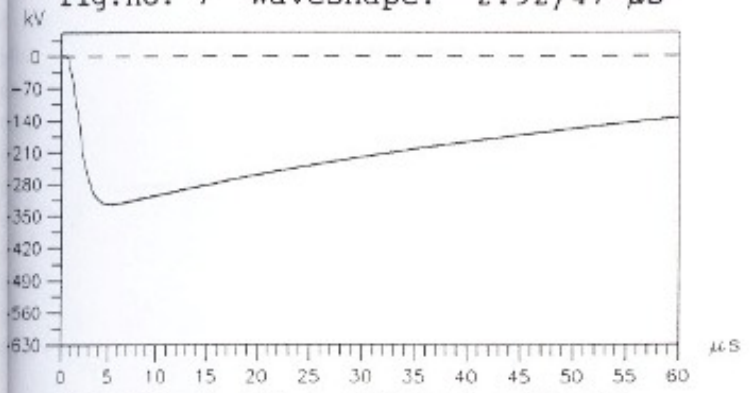


PEAKVALUE:

-321 kV

Date: 99-08-01
Time: 13:36

fig.no. 7 Waveshape: 2.92/47 µs

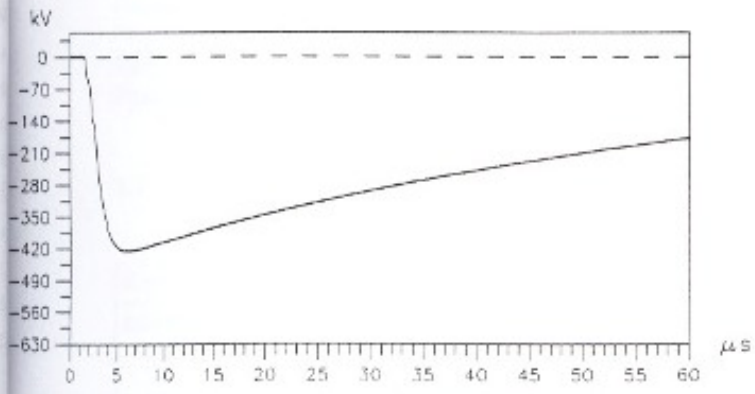


PEAKVALUE:

-326 kV

Date: 99-08-01
Time: 13:37

fig.no. 8 50 % of test voltage

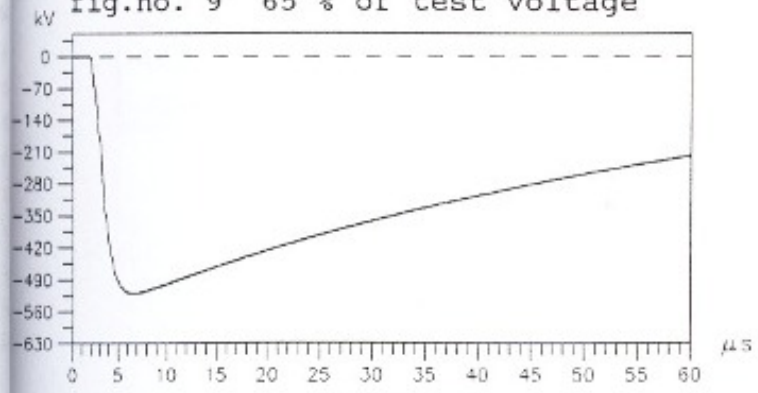


PEAKVALUE:

-426 kV

Date: 99-08-01
Time: 13:38

fig.no. 9 65 % of test voltage

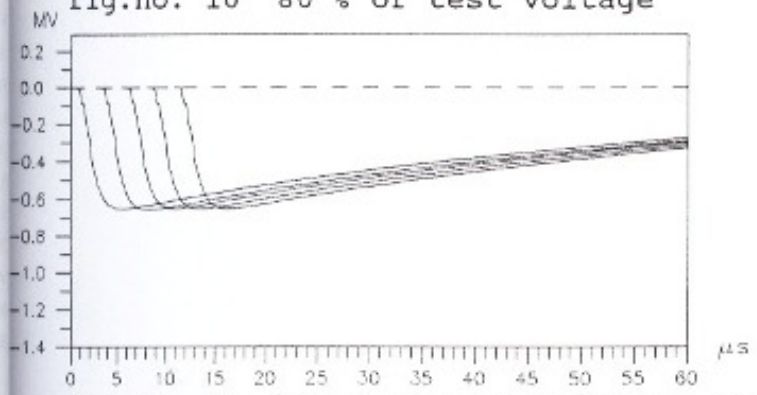


PEAKVALUE:

-522 kV

Date: 99-08-01
Time: 13:39

fig.no. 10 80 % of test voltage

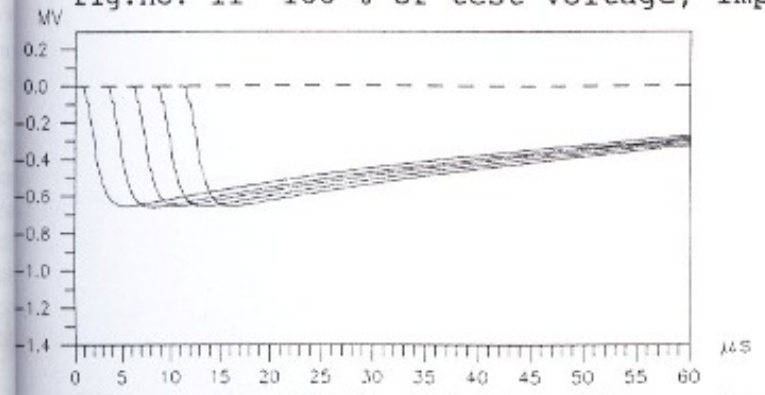


PEAKVALUES:

-653 kV
-660 kV
-653 kV
-655 kV
-657 kV

Date: 99-08-01
Time: 13:44

fig.no. 11 100 % of test voltage, imp. nos. 01 - 05



PEAKVALUES:

-653 kV
-660 kV
-653 kV
-655 kV
-657 kV

Date: 99-08-01
Time: 13:50

fig.no. 12 100 % of test voltage, imp. nos. 06 - 10

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999), clause 11.3.9
Test date 23 November 1998 until 5 January 1999

1.7 RESULTS OF THE MEASUREMENT OF THE RESISTIVITY OF SEMI-CONDUCTING LAYERS

item	unit	requirement	measured/determined	result
conductor screen				
- non-aged	Ωm	≤ 1000	27	passed
- aged	Ωm	≤ 1000	56	passed
core screen				
- non-aged	Ωm	≤ 500	0,7	passed
- aged	Ωm	≤ 500	1,0	passed

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999), clause 11.4.1
Test date 23 November 1998 until 5 january 1999

2.1 RESULTS OF THE CHECK OF CABLE CONSTRUCTION

item	unit	requirement	measured/determined	result
conductor (IEC 228, Class 2)				
- resistance at 20 °C	Ω/km	≤ 0,0366	0,0356	passed
- no. of wires		≥ 53	55	passed

item	unit	requirement	measured/determined	result
thickness insulation				
- specified	mm	21		
- minimum	mm	≥ 18,9	20,39	passed
- $(t_{max} - t_{min}) / t_{max}$	-	≤ 0.15	0,085	passed
thickness non-metallic sheath				
- specified	mm	6,0		
- average	mm	≥ 6,0	6,5	passed
- minimum	mm	≥ 5,0	5,1	passed

item	unit	requirement	measured/determined	result
thickness lead alloy sheath				
- specified	mm	4,4	4,3	
- minimum	mm	4,1	4,1	passed

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999), clause 11.4.2
Test date 23 November 1998 until 5 January 1999

2.2 RESULTS OF THE TESTS FOR DETERMINING OF THE MECHANICAL PROPERTIES OF INSULATION

item	unit	requirement	measured/determined	result
without ageing				
- tensile strength	N/mm²	≥ 12,5	24,9	passed
- elongation	%	≥ 200	721	passed
after ageing				
- tensile strength	N/mm²	N.A.	18,8	
variation with samples without ageing	%	≤ ±25	-24	passed
- elongation	%	N.A.	500	
variation with samples without ageing	%	≤ ± 25	-9	passed

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999), clause 11.4.3
Test date 5 August 1999

2.3 RESULTS OF THE TESTS OF DETERMINING OF THE MECHANICAL PROPERTIES OF NON-METALLIC SHEATHS

item	unit	requirement	measured/determined	result
without ageing				
- tensile strength	N/mm²	≥ 12,5	23,4	passed
- elongation	%	≥ 300	801	passed
after ageing				
- tensile strength	N/mm²	N.A.		
variation with samples without ageing	%	N.A.		
- elongation	%	≥ 300	749	passed
variation with samples without ageing	%	N.A.		

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999), clause 11.4.4
Test date 23 November 1998 until 5 January 1999 and 5 August 1999

2.4 RESULTS OF THE AGEING TESTS ON PIECES OF COMPLETED CABLE TO CHECK COMPATIBILITY OF MATERIALS

item	unit	requirement	measured/determined	result
Insulation				
- tensile strength	N/mm²	N.A.	18,9	
variation with samples without ageing	%	≤ ± 25	-24	passed
- elongation	%	N.A.	493	
variation with samples without ageing	%	≤ ± 25	-9	passed
Sheath				
- tensile strength	N/mm²	N.A.		
variation with samples without ageing	%	N.A.		
- elongation	%	≥ 300	795	passed
variation with samples without ageing	%	N.A.		

Client: Egytech Cables Co.
Test object: 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements: IEC 60840 (1999), clause 11.4.6
Test date: 5 August 1999

2.5 RESULTS OF THE PRESSURE TEST AT HIGH TEMPERATURE ON SHEATHS

item	unit	requirement	measured	result
- depth of indentation	%	≤ 50	1,5	passed

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999), clause 11.4.10
Test date 23 November 1998 until 5 January 1999

2.6 RESULTS OF THE HOT SET TEST FOR XLPE INSULATION

item	unit	requirement	measured	result
- elongation under load	%	≤ 175	70	passed
- permanent elongation	%	≤ 15	10	passed

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999), clause 11.4.13
Test date 23 November 1998 until 5 January 1999

2.8 RESULTS OF THE SHRINKAGE TEST OF XLPE INSULATION

item	unit	requirement	measured	result
- shrinkage	%	≤ 4	4	passed

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999), clause 11.4.15
Test dates 8 - 18 December 1998

2.9 RESULTS OF THE WATER PENETRATION TEST

Atmospheric conditions
Ambient temperature
(min/max) 18/21 °C
Temperature of test object 97 °C

no. of heat-cycles	required conductor temperature (°C)	applied heating current (A)	heating		cooling	result
			total heating time (h)	duration of conductor at 95-100 °C (h)	cooling time (h)	
10	95-100	1410	8	2	16	no water passed the ends of the cable sample

Remarks
The water penetration was approximately 240 mm one side and 200 mm to the other side.

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999)

3 VERIFICATION OF CABLE CONSTRUCTION

See also manufacturer's drawing in appendix A and manufacturer's datasheet in appendix B.

	determinations	remarks
marking of the cable	-	
colour of the core	black	
colour of the outer sheath	black	
construction	- compacted copper conductor - 55 wires of ± 3,45 mm diameter - 1 semi-conducting layer - semi-conducting conductor screen (black) - XLPE insulation - semi-conducting insulation screen (black) - 1 semi-conducting layer (50 x 0,3 mm) - lead sheath - bitumenised tape - HDPE(ST7) oversheath (black)	
outer diameter of the cable (mm)	102,0 average	
outer diameter of the lead sheath (mm)	86,2 average	
outer diameter of the core (mm)	77,4average	

The measurement uncertainties in the results presented are as specified below unless otherwise indicated.

measurement	measurement uncertainty
dielectric tests and impulse current tests	peak value: ≤ 3% time parameters: ≤ 10%
capacitance measurement tan δ measurement	0,3% ± 0,5% ± $5x10^{-5}$
partial discharge measurement	< 10 pC : 2 pC 10 - 100 pC : 5 pC > 100 pC : 20 %
measurement of impedance ac-resistance measurement	≤ 1%
measurement of losses	≤ 1%
measurement of insulation resistance	≤ 10%
measurement of dc resistance	1 μΩ - 5 μΩ : 1% 5 μΩ - 10 μΩ : 0,5% 10 μΩ - 200 μΩ : 0,2%
radio interference test	2 dB
calibration of current transformers	2,2 x 10^{-4} Ii/Iu and 290 μrad
calibration of voltage transformers	1,6 x 10^{-4} Ui/Uu en 510 μrad
measurement of conductivity	5%
measurement of temperature	-50 °C - -40 °C : 3 K -40 °C - 125 °C : 2 K 125 °C - 150 °C : 3 K
tensile test	1%
sound level measurement	type 1 meter as per IEC 651 and ANSI S1.4.1971
measurement of voltage ratio	0,1%

Data sheet of cable construction

of

Egytech Cables Co. 132 kV

Egytech Cables Co. (EL Sewedy) 132 kV Cable
Technical Department

Cable Construction

1. Conductor

Material	Plain ,Annealed Copper	
Size	500	mm2
No. of Wires	55 x 3.57	mm
Conductor Diameter	26.6	mm
Conductor Type	Round Compact	

2. Swelling Powder

Material	Swelling powder inside the conductor	

3. Smoothing Tape

Material	Semi Conducting	
Thickness	0.13	mm
Application	Helical / 20 %	

4. Conductor Screen

Material	Extruded Extra Clean super smooth Semi Conducting	
Thickness	2.2	mm (nominal)
	2.0	mm (minimum)
Diameter	31.4	mm (Approx.)

5. Insulation

Material	Extra Clean XLPE	
Thickness	21.0	mm (nominal)
	19.0	mm (minimum)
Diameter	73.4	mm (Approx.)

6. Insualtion Screen

Material	Extruded Semi conducting	
Thickness	1.5	mm (nominal)
	1.3	mm (minimum)
Diameter	76.4	mm (Approx.)

7. SC Swelling Tape

Material	Water Blocking Semi Conducting tapes	
Thickness	1.0	mm (approximately)
Diameter	78.4	mm (Approx.)

Egytech Cables Co. (EL Sewedy) 132 kV Cable
Technical Department

Cable Construction

8. Lead Alloy

Material	Alloy	
Thickness	4.4	mm (nominal)
	4.1	mm (minimum)
Type	E	
Diameter	87.2	mm (Approx.)

9. Impregnated Tape

Material	Bitumenised Tape	
Thickness	0.8	mm (approximately)
Diameter	88.8	mm (Approx.)

10. Sheath

Material	HDPE	
Thickness	6.0	mm (nominal)
	5.0	mm (minimum)
Outer diameter	100.8	mm (Approx.)

11. Graphite Coating

Material	Graphite

Client Egytech Cables Co.
Test object 132kV/Cu/XLPE/lead sheath/HDPE/1x500 mm^2
Requirements IEC 60840 (1999), clause 11.4.10
Test date 23 November 1998 until 5 January 1999

2.6 RESULTS OF THE HOT SET TEST FOR XLPE INSULATION

item	unit	requirement	measured	result
- elongation under load	%	≤ 175	70	passed
- permanent elongation	%	≤ 15	10	passed