KEMA

03-1220

TYPE TEST CERTIFICATE OF COMPLETE TYPE TEST

OBJECT	3-core, XLPE insulated power cable
DESIGNATION	3x240 mm^2 CU/XLPE/STA/PE
Rated voltage U_o/U (U_m)	19/33 (36) kV Rated frequency 50 Hz
MANUFACTURER	NATIONAL CABLES INDUSTRY P.O. Box 27472 - Sharjah - United Arab Emirates
TESTED FOR	NATIONAL CABLES INDUSTRY P.O. Box 27472 - Sharjah - United Arab Emirates
DATE OF TESTS	1 September 2003 up to and including 3 October 2003
TESTED BY	KEMA HIGH-VOLTAGE LABORATORY Utrechtseweg 310 - 6812 AR Arnhem - the Netherlands

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 60502-2

This Type Test Certification has been issued by KEMA following exclusively the STL Guides.

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 1.

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 40 sheets in total.

KEMA Nederland B.V.

S.A.M. Verhoeven

Arnhem, 27 October 2003

RATINGS ASSIGNED BY THE MANUFACTURER AND PROVED BY TESTS

Rated voltage U_o/U (U_m)	19/33 (36)	kV
Rated frequency	50	Hz
Maximum rated conductor temperature for XLPE	90	°C
Rated cross-section	240	mm^2

TEST PROGRAMME

1 Electrical type tests

1.1 Bending test followed by partial discharge test in accordance with IEC 60502-2 clause 18.1.4 and ADWEA specification S-CAB-33-3C-S

1.2 Tan δ measurement in accordance with IEC 60502-2 clause 18.1.5 and ADWEA specification S-CAB-33-3C-S

1.3 Heating cycle test followed by partial discharge test in accordance with IEC 60502-2 clause 18.1.6 and ADWEA specification S-CAB-33-3C-S

1.4 Impulse test followed by a voltage test in accordance with IEC 60502-2 clause 18.1.7 and ADWEA specification S-CAB-33-3C-S

1.5 Voltage test for 4 h in accordance with IEC 60502-2 clause 18.1.8 and ADWEA specification S-CAB-33-3C-S

1.6 Resistivity of semi-conducting screens in accordance with IEC 60502-2 clause 18.1.9 and ADWEA specification S-CAB-33-3C-S

2 Non-electrical type tests

2.1 Measurement of thickness of insulation in accordance with IEC 60502-2 clause 19.1 and ADWEA specification S-CAB-33-3C-S

2.2 Measurement of thickness of non-metallic layers (including extruded separation sheaths, but excluding inner coverings) in accordance with IEC 60502-2 clause 19.2 and ADWEA specification S-CAB-33-3C-S

2.3 Tests for determining the mechanical properties of XLPE insulation before and after ageing in accordance with IEC 60502-2 clause 19.3 and ADWEA specification S-CAB-33-3C-S

2.4 Tests for determining the mechanical properties of non-metallic sheaths before and after ageing in accordance with IEC 60502-2 clause 19.4 and ADWEA specification S-CAB-33-3C-S

2.5 Additional ageing test on pieces of completed cables in accordance with IEC 60502-2 clause 19.5 and ADWEA specification S-CAB-33-3C-S

2.6 Pressure test at high temperature on insulations and non-metallic sheaths in accordance with IEC 60502-2 clause 19.7 and ADWEA specification S-CAB-33-3C-S

2.7 Hot set test for XLPE insulation in accordance with IEC 60502-2 clause 19.11 and ADWEA specification S-CAB-33-3C-S

2.8 Water absorption test on insulation in accordance with IEC 60502-2 clause 19.13 and ADWEA specification S-CAB-33-3C-S

2.9 Carbon black test in accordance with IEC 60502-2 clause 19.15 and ADWEA specification S-CAB-33-3C-S

2.10 Shrinkage test for XLPE insulation in accordance with IEC 60502-2 clause 19.16 and ADWEA specification S-CAB-33-3C-S

2.11 Shrinkage test for PE oversheath in accordance with IEC 60502-2 clause 19.20 and ADWEA specification S-CAB-33-3C-S

2.12 Strippability test for insulation screen in accordance with IEC 60502-2 clause 19.21 and ADWEA specification S-CAB-33-3C-S

2.13 Water penetration test in accordance with IEC 60502-2 clause 19.22 and ADWEA specification S-CAB-33-3C-S

3 Verification of cable construction in accordance with IEC 60502-2 and ADWEA specification S-CAB-33-3C-S

MATERIAL DATA

Manufacturer	National Cables Industry, Sharjah, United Arab Emirates
Type	19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Rated voltage U_0/U (U_m)	19/33 (36) kV
Rated frequency	50 Hz
Year of manufacture	2003
Quantity submitted	approx. 45m
No. of cores	3
Insulation	XLPE
Conductor material	copper
Conductor cross-section	240 mm^2
Screening material	copper
Sheath material	PE, ST_7
Sheath colour	black
Standard	IEC 60502-2 (1997) ADWEA specification S-CAB-33-3C-S

The manufacturer has guaranteed that the object submitted for tests has been manufactured in accordance with the drawing as shown in appendix A of this report.
KEMA has verified that these drawings adequately represent the equipment tested.

SUBCONTRACTING

The following tests, as mentioned in the Test Programme, were subcontracted to KEMA Quality B.V.:
Tests 1.6, 2 and 3.

PERSONS ATTENDING THE TEST

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

THE TESTS WERE CARRIED OUT BY

Mr P.J. Hülkenberg	KEMA Nederland B.V.
Mr H.J. Arnoldus	KEMA Nederland B.V.
Mr C.H. Beverwijk	KEMA Nederland B.V.
Mr G.J.A. Jansen	KEMA Nederland B.V.

PURPOSE OF THE TESTS

Purpose of the tests 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 Bending test followed by partial discharge test

1.1.1 BENDING TEST

The test object was subjected to a bending test in accordance with clause 18.1.4 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The test object was bent around a test cylinder. The diameter of the cylinder was 1900 mm. 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 22 °C.
The results are presented in appendix 1 page 1.

Result

The test was carried out successfully.

1.1.2 MEASUREMENT OF THE PARTIAL DISCHARGES

The test object was subjected to a partial discharge test in accordance with clause 18.1.3 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
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 38 kV, 50 Hz and maintained at this level for

1 minute. Subsequently the voltage was lowered down to 33 kV, 50 Hz. At this level the partial discharge level was determined.
The results are presented in appendix 1 page 1.

Result

The test was passed.

1.2 Tan δ measurement

The test object was subjected to a tan δ measurement in accordance with clause 18.1.5 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
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 5 kV. The loss-factor of the insulation was measured between the conductor and core screen.
During the measurement the temperature of the test object was 97 °C.
The results are presented in appendix 1 page 2.

Result

The test was passed.

1.3 Heating cycle test followed by partial discharge test

1.3.1 HEATING CYCLE TEST

The test object was subjected to a heating cycle voltage test in accordance with clause 18.1.6 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
One heat cycle consists of applying heating current for 5 hours followed by at least 3 hours of natural cooling. The test object was heated up to a conductor temperature of 97 °C within the first 3 hours of the heating period and was kept steady at 97 °C for 2 hours. This temperature was achieved by inducing current in the cable. In total 20 such heating cycles were carried out.
The results are presented in appendix 1 page 3.

Result

The test was carried out successfully.

1.3.2 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 18.3 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The measurements were carried out as mentioned above under item 1.1. The measurement was carried out in a direct circuit. The noise level amounted to 2 pC.
The results are presented in appendix 1 page 3.

Result

The test was passed.

1.4 Impulse test followed by a voltage test

1.4.1 IMPULSE TEST

The test object was subjected to an impulse test in accordance with clause 18.1.7 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The waveform of the impulse voltage was determined at approximately 50 percent of the specified test value. The waveform complied with the specified requirements. The test consisted of 10 positive and 10 negative impulses with crest values of 170 kV. The voltage was applied between the conductor and core screen. The voltage measurement was carried out by means of an RC-voltage divider and a digitiser. During the test the temperature of the test object was 97 °C. In order to achieve this temperature, current was induced in the cable. Two hours after thermal equilibrium was established the impulse test was performed. During the test the atmospheric conditions were not taken into account.
The results are presented in appendix 1 pages 4 up to and including 7.

Result

The test was passed.

1.4.2 VOLTAGE TEST

The test object was subjected to a voltage test in accordance with clause 18.1.7 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
Upon completion of the impulse test, and cooling down to ambient temperature, the test object was subjected to a voltage test of 66,5 kV, 50 Hz for 15 minutes.
The results are presented in appendix 1 page 4.

Result

The test was passed.

1.5 Voltage test for 4 hours

The test object was subjected to a voltage test for 4 h in accordance with clause 18.1.8 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The test was carried out with a power-frequency voltage of 76 kV, 50 Hz, for 4 hours. The voltage was applied between the conductor and core screen. During the test the temperature of the test object was 20 °C. During the test the atmospheric conditions were not taken into account.
The results are presented in appendix 1 page 8.

Result

The test was passed.

1.6 Resistivity of semi-conducting screens

The measurement of the resistivity of the semi-conducting layers was carried out in accordance with clause 18.1.9 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 1 page 9.

Result

The test was passed.

2 NON-ELECTRICAL TYPE TESTS

2.1 Measurement of thickness of insulation

The measurement of thickness of insulation was carried out in accordance with clause 19.1 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 2 page 1.

Result

The test was passed.

2.2 Measurement of thickness of non-metallic sheaths (including extruded separation sheaths, but excluding inner coverings)

The measurement of thickness of non-metallic sheaths was carried out in accordance with clause 19.2 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 2 page 2.

Result

The test was passed.

2.3 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 19.3 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 2 page 3.

Result

The test was passed.

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

The mechanical properties of non-metallic sheaths before and after ageing were determined in accordance with clause 19.4 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 2 page 4.

Result

The test was passed.

2.5 Additional ageing test on pieces of completed cable

An additional ageing test on pieces of completed cable was carried out in accordance with clause 19.5 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 2 page 5.

Result

The test was passed.

2.6 Pressure test at high temperature on insulations and non-metallic sheaths

A pressure test on at high temperature on the XLPE insulation and non-metallic sheath was carried out in accordance with clause 19.7 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 2 page 6.

Result

The test was passed.

2.7 Hot set test for XLPE insulation

A hot set test for XLPE insulation was carried out in accordance with clause 19.11 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S. The results are presented in appendix 2 page 7.

Result

The test was passed.

2.8 Water absorption test on insulation

A water absorption test on insulation was carried out in accordance with clause 19.13 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 2 page 8.

Result

The test was passed.

2.9 Carbon black test

A carbon black test was carried out in accordance with clause 19.15 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 2 page 9.

Result

The test was passed.

2.10 Shrinkage test for XLPE insulation

A shrinkage test for the insulation was carried out in accordance with clause 19.16 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 2 page 10.

Result

The test was passed.

2.11 Shrinkage test for PE oversheath

A shrinkage test for the PE oversheath was carried out in accordance with clause 19.20 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 2 page 11.

Result

The test was passed.

2.12 Strippability test for insulation screen

A strippability test for insulation screen was carried out in accordance with clause 19.21 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S.
The results are presented in appendix 2 page 12.

Result

The test was passed.

2.13 Water penetration test

The test object was subjected to an additional water penetration test in accordance with IEC 60502-2 clause 19.22 and ADWEA specification S-CAB-33-3C-S.
The sample was placed in a tube filled with water, so that the height of the water in the tube is 1 m above the cable centre. The sample was subjected to 10 heating cycles. One heating cycle consists of applying heating current for 5 hours followed by at least 3 hours of natural cooling. The test object was heated up to a conductor temperature of 97 °C and was kept steady at 97 °C for 2 hours. This temperature was achieved by inducing a current of 1050 A into the cable.
The results are presented in appendix 2 page 13.

Result

The test was passed.

3 VERIFICATION OF CABLE CONSTRUCTION IN ACCORDANCE WITH IEC 60502-2

3.1 Check of construction and dimensions

The conductor was checked in accordance with clause 5 of IEC 60502-2 (1997) and ADWEA specification S-CAB-33-3C-S. The remaining cable dimensions and construction were checked according IEC 60502-2 (1997) and the manufacturer's specifications.
The results obtained are presented in appendix 3 pages 1 and 2.

Result

The specified requirements were met.

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 18.1.4 and ADWEA
Test dates	1 September 2003 and 16 September 2003

1.1 RESULTS OF THE BENDING TEST

1.1.1 Bending test

Atmospheric conditions
Ambient temperature 22 °C

Test object
Temperature 22 °C

outer diameter of cable D (mm)	diameter of conductor d (mm)	required bending diameter 15(D+d) ± 5% (mm)	hub diameter of drum (mm)	observations
103	18,4	1821 ± 91	1900	3 cycles (wind/unwind and wind/unwind in opposite direction)

1.1.2 Partial discharge test

Atmospheric conditions

Ambient temperature	21	°C	Ambient air pressure	1020	hPa
Humidity	12	g (H_2O)/m^3			

Test object

Temperature	21	°C	Rated voltage (U_o)	19	kV

Circuit parameters

Power frequency	50	Hz	Calibration	5	pC
Bandwidth	40-400	kHz	Noise level	2	pC
Coupling capacitor	2600	pF	Circuit	balanced	

phase	voltage (kV)	duration (min)	partial discharge level (pC)	max. allowable pd-level (pC)	inception (kV)	inception (pC)	extinction (kV)	extinction (pC)	result
red	38	1		-					
	33		≤ 2	5	-	-	-	-	passed
yellow	38	1		-					
	33		≤ 2	5	-	-	-	-	passed
blue	38	1		-					
	33		≤ 2	5	-	-	-	-	passed

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 18.1.5 and ADWEA
Test date	17 September 2003

1.2 RESULTS OF THE TAN δ MEASUREMENT

Atmospheric conditions

Ambient temperature	22	°C	Ambient air pressure	1018	hPa
Humidity	13	g $(H_2O)/m^3$			

Test object

Length (approx.)	15,9	m	Temperature	97	°C
Rated voltage (U_0)	19	kV			

Circuit parameters

Power frequency	50	Hz
Standard capacitor	100	pF

phase	applied voltage (kV)	core capacity* (μF/km)	tan δ (x 10^{-4})	max. allowable value for tan δ (x 10^{-4})	result
R,Y,B	5	0,636	4,43	80	passed

* total capacitance: for information only

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 18.1.6 and 18.1.3 and ADWEA
Test dates	19 September 2003 up to and including 25 September 2003

1.3 RESULTS OF THE HEATING CYCLE TEST

1.3.1 Heating cycle test

Atmospheric conditions

Ambient temperature (min/max) 20/22 °C

Test object

Temperature ambient/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 97 °C (h)	cooling time (h)	
20	95-100	840	5	2	3	passed

1.3.2 Partial discharge test

Atmospheric conditions

Ambient temperature	19	°C	Ambient air pressure	1027	hPa
Humidity	9	g (H_2O)/m^3			

Test object

Temperature	19	°C	Rated voltage (U_o)	19	kV

Circuit parameters

Power frequency	50	Hz	Calibration	5	pC
Bandwidth	40-400	kHz	Noise level	2	pC
Coupling capacitor	2600	pF	Circuit	balanced	

phase	voltage (kV)	duration (min)	partial discharge level (pC)	max. allowable pd-level (pC)	inception (kV)	inception (pC)	extinction (kV)	extinction (pC)	result
red	38	1		-					
	33		≤ 2	5	-	-	-	-	passed
yellow	38	1		-					
	33		≤ 2	5	-	-	-	-	passed
blue	38	1		-					
	33		≤ 2	5	-	-	-	-	passed

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 18.1.7 and ADWEA
Test dates	25 September 2003 and 26 September 2003

1.4 RESULTS OF THE IMPULSE TEST FOLLOWED BY A VOLTAGE TEST

1.4.1 Impulse test

Atmospheric conditions

Ambient temperature	23	°C	Ambient air pressure	1015	hPa
Humidity	15	g (H_2O)/m^3			

Test object

Temperature 97 °C

voltage and polarity (kV)	description	oscillogram		result
		appendix 1 page	fig. no.	
	waveshape: 3,38/57,63 µs	5	1	
+ 85	1 impulse at 50% of the test voltage		2	
+ 110,5	1 impulse at 65 % of the test voltage		3	
+ 136	1 impulse at 80 % of the test voltage		4	
+ 170	5 impulses at 100 % of the test voltage	6	5	
+170	5 impulses at 100 % of the test voltage		6	passed
- 85	1 impulse at 50% of the test voltage		7	
- 110,5	1 impulse at 65 % of the test voltage		8	
- 136	1 impulse at 80 % of the test voltage	7	9	
- 170	5 impulses at 100 % of the test voltage		10	
- 170	5 impulses at 100 % of the test voltage		11	passed

1.4.2 Voltage test

Atmospheric conditions

Ambient temperature	20	°C	Ambient air pressure	1014	hPa
Humidity	10	g (H_2O)/m^3			

Test object

Temperature 20 °C

applied voltage (kV)	frequency (Hz)	duration (min)	observations	result
66,5	50	15	no breakdown	passed

Fig. 1: Waveshape 70370199, NCl

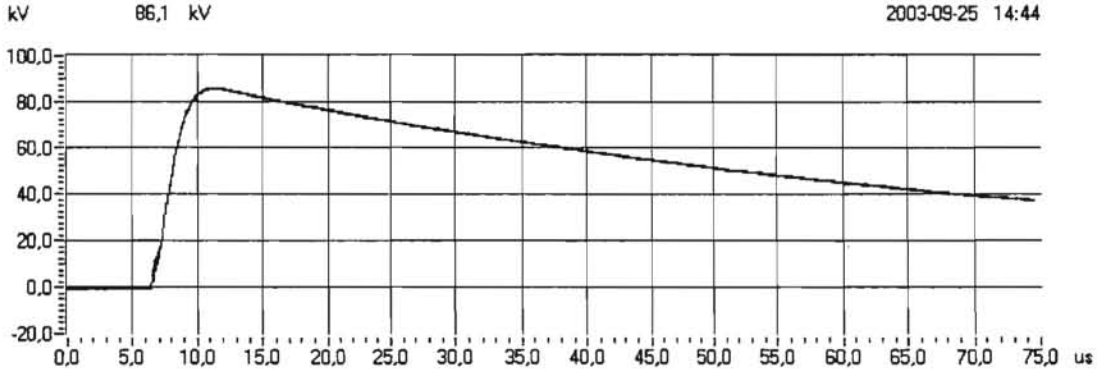


Fig. 2: 70370199, NCl, +50%

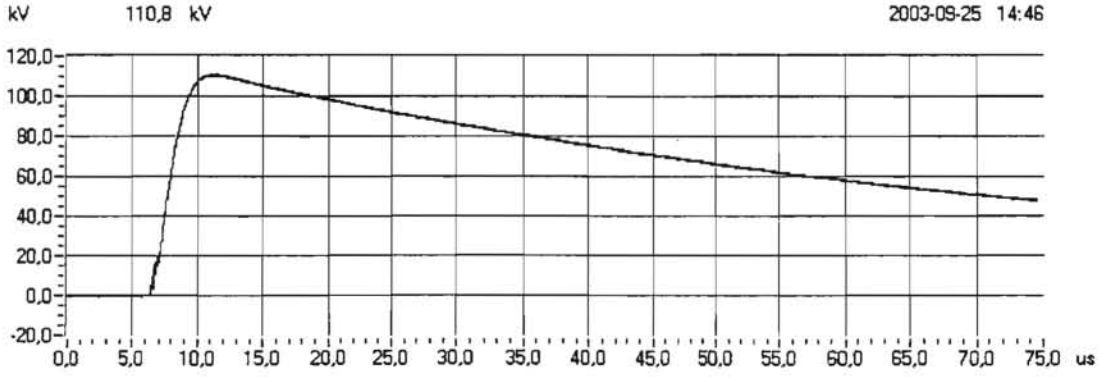


Fig. 3: 70370199, NCl, +65%

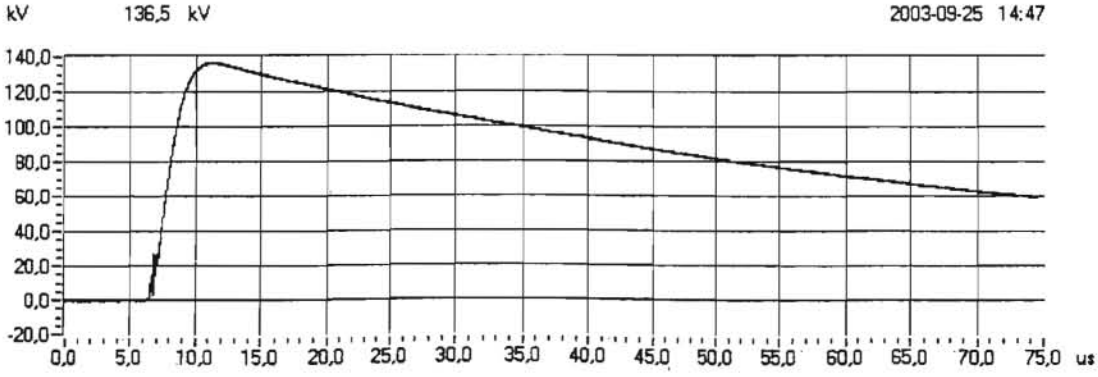


Fig. 4: 70370199, NCl, +80%

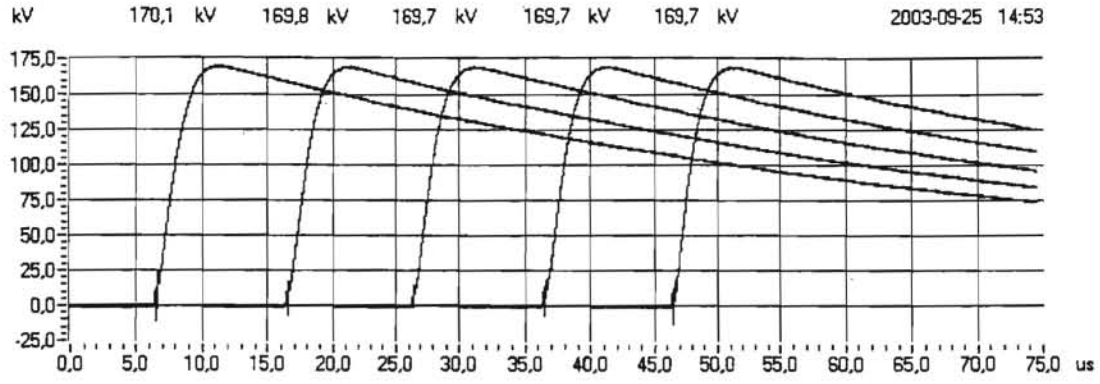


Fig. 5: 70370199, NCI, +100%

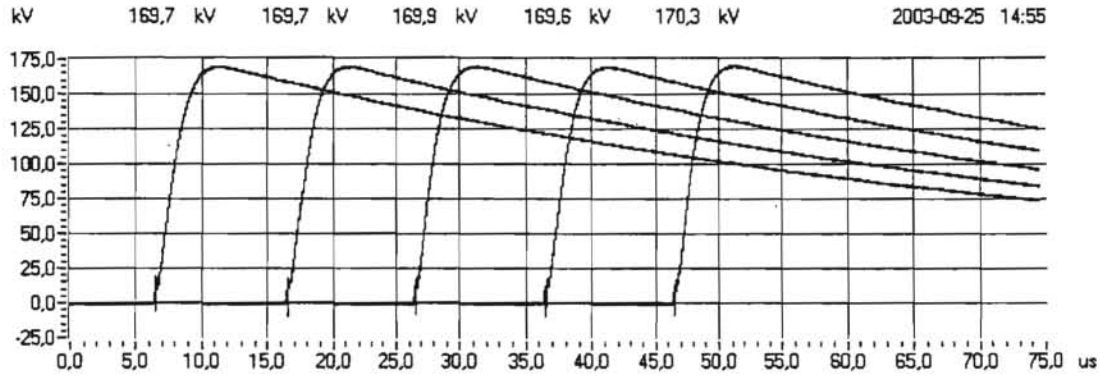


Fig. 6: 70370199, NCI, +100%

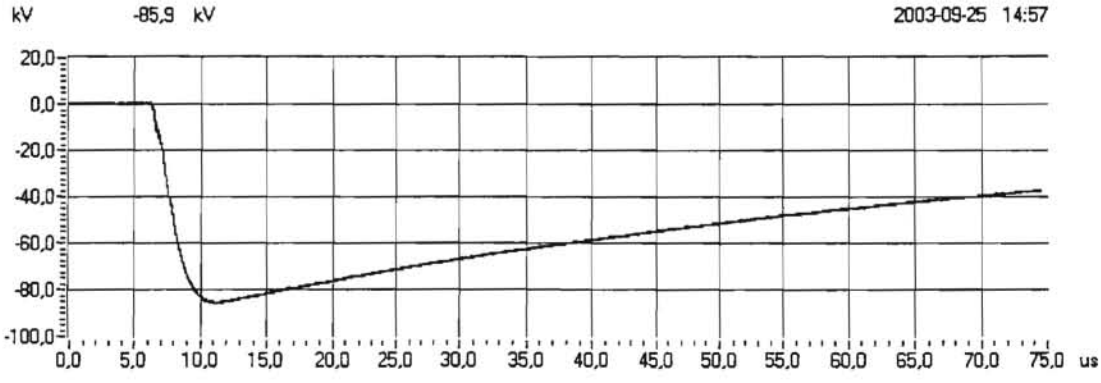


Fig. 7: 70370199, NCI, -50%

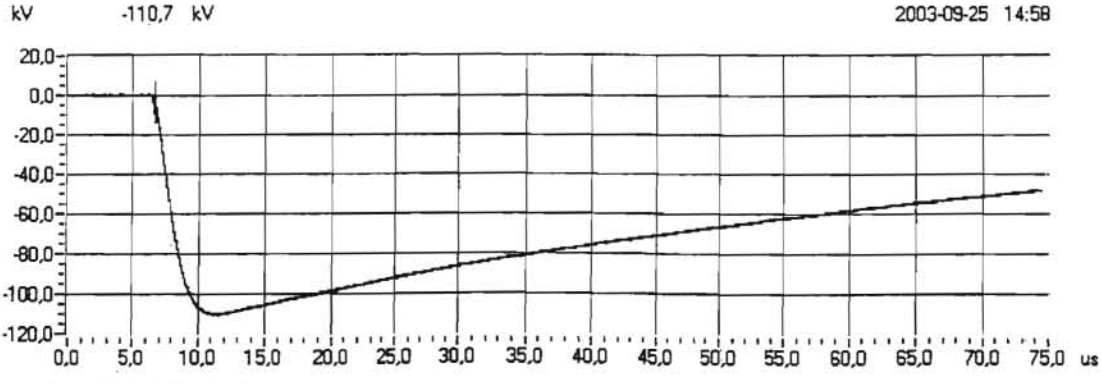


Fig. 8: 70370199, NCI, -65%

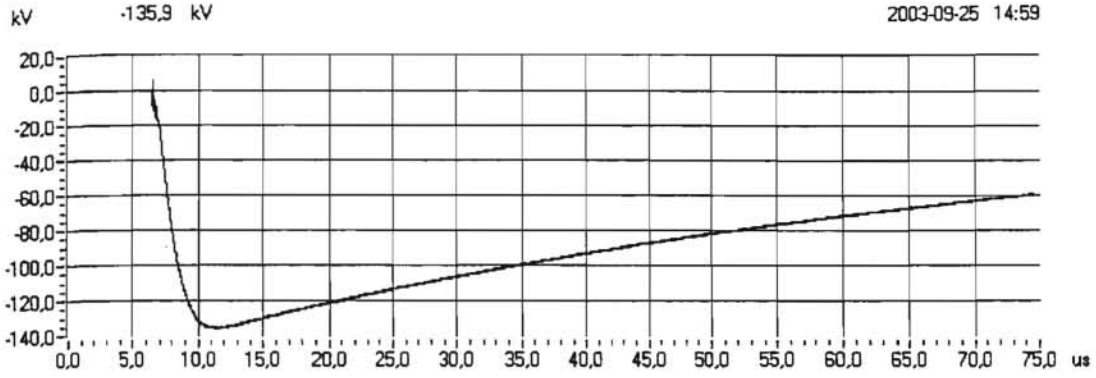


Fig. 9: 70370199, NCL -80%

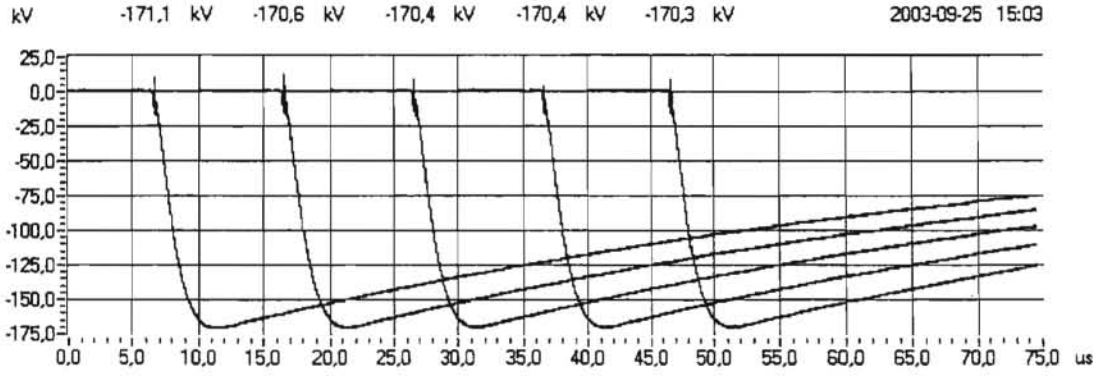


Fig. 10: 70370199, NCL -100%

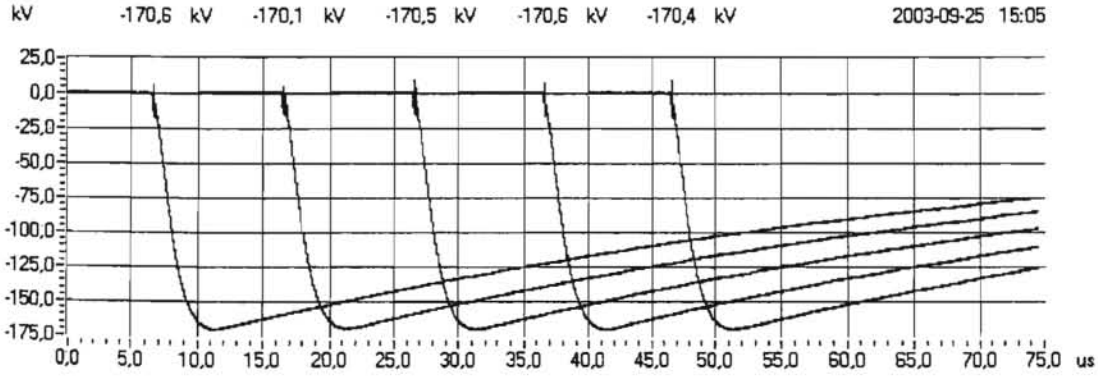


Fig. 11: 70370199, NCL -100%

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 18.1.8 and ADWEA
Test dates	25 September 2003

1.5 RESULTS OF THE VOLTAGE TEST FOR 4 H

Atmospheric conditions

Ambient temperature	20	°C	Ambient air pressure	1014	hPa
Humidity	10	g $(H_2O)/m^3$			

Test object

Temperature	20	°C

applied voltage (kV)	frequency (Hz)	duration (h)	observations	result
76	50	4	no breakdown	passed

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 18.1.9 and ADWEA
Test date	10 September 2003 up to and including 29 September 2003

1.6 RESULTS OF THE MEASUREMENT OF THE RESISTIVITY OF SEMI-CONDUCTING SCREENS

item	unit	requirement	measured/determined			result
conductor screen			Red	Yellow	Blue	
- without ageing	Ωm	≤ 1000	72,4	63,9	92,2	passed
- after ageing	Ωm	≤ 1000	4,7	4,3	4,9	passed
insulation screen						
- without ageing	Ωm	≤ 500	17,3	12,9	16,0	passed
- after ageing	Ωm	≤ 500	0,9	0,4	0,5	passed

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 19.1 and ADWEA
Test date	10 September 2003 up to and including 29 September 2003

2.1 RESULTS OF THE MEASUREMENT OF THICKNESS OF INSULATION

item	unit	requirement	measured/determined			result
			Red	Yellow	Blue	
- specified (average)	mm	≥ 8,0	8,3	8,3	8,4	passed
- minimum	mm	≥ 8,0	8,19	8,22	8,25	passed
- maximum	mm	≤ 8,7	8,35	8,45	8,51	passed
- excentricity	%	≤ 4,0	2,0	2,6	3,2	passed

Client National Cables Industry, Sharjah, United Arab Emirates
Test object power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements IEC 60502-2 (1997) clause 19.2 and ADWEA
Test date 10 September 2003 up to and including 29 September 2003

2.2.1 RESULTS OF THE MEASUREMENT OF THICKNESS OF INNER SHEATH PE ST_7

item	unit	requirement	measured/determined	result
- specified (average)	mm	≥ 2,2	2,4	passed
- minimum	mm	≥ 1,56	2,01	passed

2.2.2 RESULTS OF THE MEASUREMENT OF THICKNESS OF OUTER SHEATH PE ST_7

item	unit	requirement	measured/determined	result
- specified (average)	mm	≥ 4,2	4,8	passed
- minimum	mm	≥ 3,16	3,80	passed

Client National Cables Industry, Sharjah, United Arab Emirates
Test object power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements IEC 60502-2 (1997) clause 19.3 and ADWEA
Test date 10 September 2003 up to and including 29 September 2003

2.3 RESULTS OF THE TESTS FOR DETERMINING THE MECHANICAL PROPERTIES OF INSULATION BEFORE AND AFTER AGEING

item	unit	requirement	measured/determined			result
without ageing			Red	Yellow	Blue	
- tensile strength	N/mm²	≥ 12,5	27,1	28,6	25,9	passed
- elongation	%	≥ 200	569	582	545	passed
after ageing (135°C/7d)						
- tensile strength	N/mm²	-	28,7	29,8	28,1	
variation with samples without ageing	%	± 25 max.	6	4	8	passed
- elongation	%	-	615	564	604	
variation with samples without ageing	%	± 25 max.	8	-3	11	passed

Client National Cables Industry, Sharjah, United Arab Emirates
Test object power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements IEC 60502-2 (1997) clause 19.4 and ADWEA
Test date 10 September 2003 up to and including 29 September 2003

2.4 RESULTS OF THE TESTS FOR DETERMINING THE MECHANICAL PROPERTIES OF NON-METALLIC SHEATHS BEFORE AND AFTER AGEING

Inner sheath PE ST_7

Item	unit	requirement	measured/determined	result
without ageing				
- tensile strength	N/mm²	≥ 12,5	30,5	passed
- elongation	%	≥ 300	854	passed
after ageing (110°C/10d)				
- tensile strength	N/mm²	-	21,9	
variation with samples without ageing	%	-	-28	
- elongation	%	≥ 300	745	passed
variation with samples without ageing	%	-	-13	

Outer sheath PE ST_7

Item	unit	requirement	measured/determined	result
without ageing				
- tensile strength	N/mm²	≥ 12,5	30,0	passed
- elongation	%	≥ 300	807	passed
after ageing (110°C/10d)				
- tensile strength	N/mm²	-	26,1	
variation with samples without ageing	%	-	-13	
- elongation	%	≥ 300	765	passed
variation with samples without ageing	%	-	-5	

Client National Cables Industry, Sharjah, United Arab Emirates
Test object power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements IEC 60502-2 (1997) clause 19.5 and ADWEA
Test date 10 September 2003 up to and including 29 September 2003

2.5 RESULTS OF THE ADDITIONAL AGEING TESTS ON PIECES OF COMPLETED CABLES

item	unit	requirement	measured/determined			result
			Red	Yellow	Blue	
insulation (100°C/7D)						
- tensile strength	N/mm²	-	26,1	27,0	26,5	
variation with samples without ageing	%	± 25 max	-4	-6	2	passed
- elongation	%	-	560	548	561	
variation with samples without ageing	%	± 25 max	-2	-6	3	passed
inner sheath (100°C/7D)						
- tensile strength	N/mm²	-		29,5		
variation with samples without ageing	%	-		-3		
- elongation	%	≥ 300		874		passed
variation with samples without ageing	%	-		2		
outer sheath (100°C/7D)						
- tensile strength	N/mm^2	-		30,0		
variation with samples without ageing	%	-				
- elongation	%	≥ 300		880		passed
variation with samples without ageing	%	-				

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 19.7 and ADWEA
Test date	10 September 2003 up to and including 29 September 2003

2.6.1 RESULTS OF THE PRESSURE TEST AT HIGH TEMPERATURE ON XLPE INSULATIONS AND INNER SHEATH PE ST_7

item	unit	requirement	measured	result
- temperature	°C	110		
- duration	h	6		
- load	N	14,4		
- depth of indentation	%	≤ 50	2	passed

2.6.2 RESULTS OF THE PRESSURE TEST AT HIGH TEMPERATURE ON INSULATIONS AND OUTER SHEATH PE ST_7

item	unit	requirement	measured	result
- temperature	°C	110		
- duration	h	6		
- load	N	21,8		
- depth of indentation	%	≤ 50	2	passed

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 19.11 and ADWEA
Test date	10 September 2003 up to and including 29 September 2003

2.7 RESULTS OF THE HOT SET TEST FOR XLPE INSULATION

item	unit	requirement	measured			result
			Red	Yellow	Blue	
- temperature	°C	200				
- elongation under load	%	≤ 175	75	65	65	passed
- permanent elongation	%	≤ 15	10	10	10	passed

Client National Cables Industry, Sharjah, United Arab Emirates
Test object power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements IEC 60502-2 (1997) clause 19.13 and ADWEA
Test date 10 September 2003 up to and including 29 September 2003

2.8 RESULTS OF THE WATER ABSORPTION TEST ON INSULATION

item	unit	requirement	measured			result
			Red	Yellow	Blue	
- temperature	°C	85				
- duration	d	14				
- variation of mass	mg/cm^2	≤ 1	0,02	0,01	0,01	passed

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 19.15 and ADWEA
Test date	10 September 2003 up to and including 29 September 2003

2.9 RESULTS OF THE MEASUREMENT OF CARBON BLACK CONTENT OF BLACK OVERSHEATH PE ST_7

item	unit	requirement	measured	result
- carbon black content	%	2,5 ± 0,5	2,9	passed

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 19.16 and ADWEA
Test date	10 September 2003 up to and including 29 September 2003

2.10 RESULTS OF THE SHRINKAGE TEST FOR XLPE INSULATION

item	unit	requirement	measured			result
			Red	Yellow	Blue	
- temperature	°C	130				
- duration	h	1				
- shrinkage	%	≤ 4	2	2	2	passed

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clause 19.20 and ADWEA
Test date	10 September 2003 up to and including 29 September 2003

2.11 RESULTS OF THE SHRINKAGE TEST FOR OVERSHEATH PE ST$_7$

item	unit	requirement	measured	result
- temperature	°C	80		
- duration	h	5		
- cycles		5		
- shrinkage	%	≤ 3	1	passed

Client National Cables Industry, Sharjah, United Arab Emirates
Test object power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements IEC 60502-2 (1997) clause 19.21 and ADWEA
Test date 10 September 2003 up to and including 29 September 2003

2.12 RESULTS OF THE STRIPPABILITY TEST

item	unit	requirement	measured			result
			Red	Yellow	Blue	
- before ageing	N	$4 \leq F \leq 45$	12,14,15	20,18,18	20,17,19	passed
- after ageing	N	$4 \leq F \leq 45$	15,17,14	14,19,20	15,18,14	passed
		The insulation surface shall not be damaged and no trace of the insulation screen shall remain on the insulation.	ok	ok	ok	passed

Client National Cables Industry, Sharjah, United Arab Emirates
Test object power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements IEC 60502-2 (1997) clause 19.22 and ADWEA
Test date 24 October 2003 up to and including 27 October 2003

2.13 RESULTS OF THE WATER PENETRATION TEST

Atmospheric conditions
Ambient temperature
(min/max) 10/18 °C

Test object
Temperature 12/97 °C

no. of heat-cycles	required conductor temperature (°C)	applied heating current (A)	heating		cooling
			total heating time (h)	duration of conductor at 97 °C (h)	cooling time (h)
10	95-100	1050	5	2	3

Result
During the period of testing no water emerged from the ends of the test piece.
The test was passed.

Client	National Cables Industry, Sharjah, United Arab Emirates
Test object	power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements	IEC 60502-2 (1997) clauses 5-14 and ADWEA
Test date	10 September 2003 up to and including 29 September 2003

3.1 RESULTS OF THE VERIFICATION OF CABLE CONSTRUCTION

See also manufacturer's drawing in appendix A.

item	required/specified	measured/determined Red Yellow Blue	result
conductor (IEC 60228 Class 2) material: stranded copper wires (circular compacted)	see results of non-electrical type tests above	see results of non-electrical type tests above	
- resistance at 20 °C (Ω/km)	≤ 0,0754	0,0751/0,0752/0,0746	passed
- no. of wires	≥ 61/-	61	passed
- diameter (mm)	≤ 20,6/18,4	18,5/18,5/18,5	passed
screening conductor screening	yes/yes	present, extruded semi-conductive compound	passed
- thickness, minimum (mm)	-/0,8	-	
core screening non-metallic part	yes/yes	present, extruded semi-conductive compound	passed
- thickness, minimum (mm)	-/0,8	-	
metallic part	yes/yes	present, copper tape	passed
- thickness, nominal (mm)	-/0,075	-	-
insulation material: extruded XLPE	see result of non-electrical type tests above	see results of non-electrical type tests above	

Client National Cables Industry, Sharjah, United Arab Emirates
Test object power cable 19/33 kV 3x240 mm^2 Cu/XLPE/STA/PE
Requirements IEC 60502-2 (1997) clauses 5-14 and ADWEA
Test date 10 September 2003 up to and including 29 September 2003

3.1 RESULTS OF THE VERIFICATION OF CABLE CONSTRUCTION (continued)

item	required/specified	measured/determined Red Yellow Blue	result
filler material:	yes/yes	present, synthetic fibre filling with 3 earth conductors of copper wires 19 x ∅ 1,8mm	passed
binder tape	-/-	Synthetic tape	-
inner sheath material: PE ST$_7$	see result of non-electrical type tests above	see result of non-electrical type tests above	-
- thickness, nominal (mm)	-/2,2	-	-
armouring	yes/yes	present, galvanized steel tape	passed
- thickness, nominal (mm)	-/ 0,8	-	-
outer sheath material: PE ST$_7$	see results of non-electrical type tests above	see results of non-electrical type tests above	
marking of the cable	-/-	ELECTRIC CABLE 33000 VOLTS 3x240+2X50MM2 CU/XLPE/DSTA/HDPE/ NATIONAL CABLES United Arab Emirates 2003	
colour of the outer sheath	-/-	black	
outer diameter of the cable average (mm)	-/103	102,8	
outer diameter of the core average (mm)	-/40,0	40,1/40,1/40,1	

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% ± 5.10^{-5}
partial discharge measurement	< 10 pC : 2 pC 10 - 100 pC : 5 pC > 100 pC : 20 %
measurement of impedance a.c.-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 60651 and ANSI S1.4.1971
measurement of voltage ratio	0,1%

Appendix A

Drawing

of

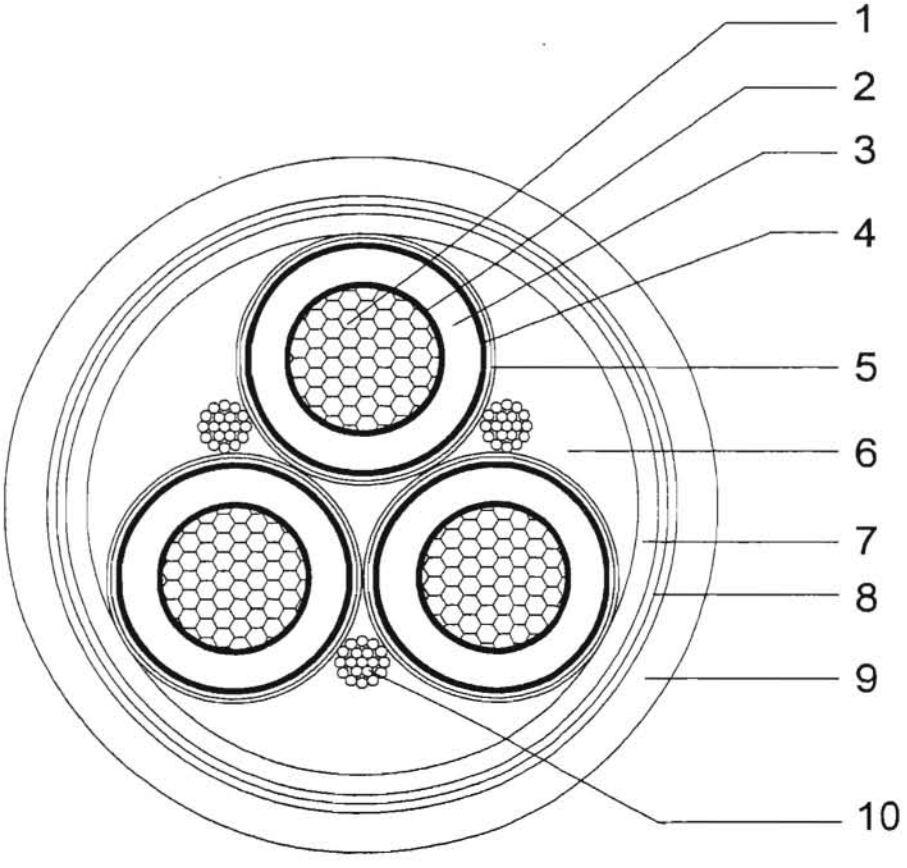
National Cables Industry, Sharjah, United Arab Emirates

No. of pages: 2

33 kV - 3x240+3x50 mm², CU/XLPE/STA/PE Cable

REFERENCE STANDARD : IEC 60502-2 & ADWEA Specification.

1.Conductor	:	Copper round stranded compacted (Watertight).
2.Conductor Screen	:	Extruded semi-conductive compound
3.Insulation	:	Tree-Retardant Cross-linked polyethylene (XLPE)
4.Insulation screen	:	Extruded semi-conductive compound strippable
5.Metallic screen	:	Plain annealed Copper tapes applied with Suitable overlap
6.Filler	:	Polypropylene strings
7.Inner sheath	:	Extruded Polyethylene (Type ST 7),
8.Armour	:	Double galvanized steel tapes
9.Outer sheath	:	Extruded PE (Type ST 7) – Graphite coated
10.Copper conductors	:	50 mm² copper conductor one in each -interstice



DIMENSIONAL DATA FOR 33 kV

3x240 mm² + 3x50 mm² - CU/XLPE/STA/PE

DESCRIPTION	UNIT	DETAILS
Reference Standard		IEC 60502-2
Rated voltage of cable	KV	33
Number of cores	No.	3
Nominal Cross sectional area	mm^2	240
Form of stranding		Stranded, circular compacted
Conductor material		Copper
Diameter of conductor (Approx.)	mm	18.4
Minimum thickness of conductor shield	mm	0.8
Diameter over conductor shield (Approx.)	mm	21.1
Minimum thickness of TR-XLPE Insulation	mm	8.0
Maximum thickness of TR-XLPE Insulation	mm	8.7
Diameter over insulation (Approx.)	mm	37.7
Minimum thickness of extruded insulation shield	mm	0.8
Nominal thickness of copper tape screen	mm	0.075
Diameter over copper tape screen (Approx.)	mm	40.0
No. and size of CU ground conductor in assembly	No/mm^2	3 x 50
No. of strands in each CU ground conductor	No	19
Diameter of CU ground conductor (Approx.)	mm	9.25
Diameter over assembled cores (Approx.)	mm	86.8
Nominal thickness of PE inner sheath (ST-7)	mm	2.2
Nominal thickness of steel tape armour	mm	0.8
Nominal thickness of Black PE outer sheath (ST-7)	mm	4.2
Minimum thickness of PE outer sheath	mm	3.16
Overall diameter of cables (Approx.)	mm	103

Note: PE outer sheath shall be coated with graphite