

TYPE TEST CERTIFICATE OF COMPLETE TYPE TEST**OBJECT** single-core power cable**TYPE** CU/XLPE/CW/HDPE

Rated voltage, U₀/U (U_m)	36 / 60 (72,5) kV	Conductor material	Cu
Conductor cross-section	1 x 630 mm²	Insulation material	XLPE

MANUFACTURER Elsewedy Cables,
El Biar, Algeria**CLIENT** Elsewedy Cables,
El Biar, Algeria**TESTED BY** KEMA HIGH-VOLTAGE LABORATORY
Arnhem, the Netherlands**DATE OF TESTS** 10 April to 18 June 2012

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

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

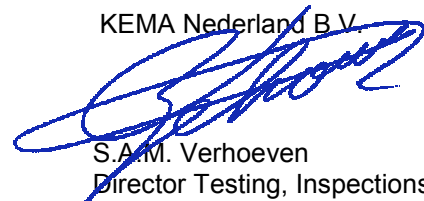
The results are shown in the record of Proving Tests and the oscillograms attached hereto. The values obtained and the general performance are considered to comply with the above Standard and to justify the ratings assigned by the manufacturer as listed on page 4.

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 consists of 32 pages in total.

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KEMA Nederland B.V.

S.A.M. Verhoeven
Director Testing, Inspections &
Certification The Netherlands

Arnhem, 23 August 2012

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1 IDENTIFICATION OF THE TEST OBJECT

1.1 Description of the test object

1.1.1 Single-core power cable

Manufacturer	Elsewedy Cables
Type	Cu/XLPE/CW/HDPE
Year of manufacture	2011
Sampling procedure	by the manufacturer
Quantity submitted	59 m
Rated voltage, U_0/U (U_m)	36 / 60 (66) kV
No. of cores	1
Nominal electrical stress at the conductor screen at U_0 (E_i)	4,48 kV / mm
Nominal electrical stress at the insulation screen at U_0 (E_o)	2,73 kV / mm
Marking on the cable	ELSEWEDY CABLES CEI 60840-SONALGAZ 1X630 MM2 CU/XLPE/CW/HDPE 36 / 60 (72.5) kV 2011

Conductor

- material	soft annealed copper
- nominal cross-sectional area	630 mm ²
- nominal diameter	30,05 mm
- type	circular stranded compacted
- maximum conductor temperature in normal operation	90 °C

Conductor screen

- material	extruded semi conductive
- nominal thickness	1,2 mm
- material designation	LE 595
- manufacturer	Borealis

Insulation

- material	XLPE
- nominal thickness (t_n)	10,4 mm
- nominal inner diameter of insulation (d_{ii})	32,6 mm
- nominal outer diameter of insulation (D_{io})	53,4 mm
- material designation	LS 4201 S
- manufacturer	Borealis

Insulation screen

- material extruded semi-conductive
- nominal thickness 1,0 mm
- material designation LE 595
- manufacturer Borealis

Metallic screen

- material copper wires banded with open helix copper tape
- number and nominal diameter of wires 55 wires of Ø 1,43 mm
- nominal thickness and width of tape 1 x 20 mm open helix
- cross-sectional area 88,3 mm²
- DC resistance 0,201 Ω/km
- nominal capacitance between conductor and metallic screen 0,281 µF/km

Metal foil longitudinally applied

- yes
- material aluminium laminated tape
- nominal thickness 0,3 mm

Oversheath

- material HDPE, ST₇
- nominal thickness 3,3 mm
- nominal overall diameter of the cable 67,7 mm
- material designation HE 6062
- manufacturer Borealis
- colour black
- graphite coating applied yes

Longitudinally watertightness

- along insulation screen yes, over and under the screen
 - number of swelling tapes one under the screen and one over it
 - nominal thickness and width (overlap) 60 x 0,3 mm (overlap: 30%)
 - material designation ZSD60 & BSZD50
 - manufacturer Tianrong tapes
- along the conductor not claimed

Fire retardant (IEC 60332-1)

no

Manufacturing details

- location of manufacturing Algeria
- type of extrusion line CCV
- type of extrusion triple common extrusion
- manufacturer of the extrusion line Mellifere
- curing means dry cure
- factory identification of extrusion line CV1
- cooling means water cooling
- manufacturing lenght 500 m
- length marking on cable sample sent to begin: 0 m
KEMA end: 59 m

1.2 List of documents

The manufacturer has guaranteed that the cable submitted for tests has been manufactured in accordance with the following drawings and documents.

KEMA has verified that these drawings adequately represent the object tested.

The following drawing is included in this Certificate:

drawing no./document no.	revision	date	title
DB6-TX01-N60-00-02	1	4/7/2012	630mm ² 60kV CU/XLPE/CW/HDPE

2 GENERAL INFORMATION

2.1 The tests were partly witnessed by

Name	Company
Mr Adly Kafafy Mrs Hamadouche Naima	Elsewedy Cables, El Biar, Algeria
Mr Benchabane Salah	GRTE
Mr Amarkhodja Lies	CEEG / GRTE

2.2 The tests were carried out by

Name	Company
Mr S. Smeenk Mr J. Stankovic Mr P. Kuipers	KEMA Nederland B.V., Arnhem, the Netherlands

2.3 Subcontracting

The following tests were subcontracted to KEMA CES/NET:

- measurement of resistivity of semi-conducting screens in accordance with clause 12.3.9
- non-electrical type tests in accordance with clause 12.4, with exception of the water penetration test

2.4 Purpose of the test

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

2.5 Measurement uncertainty

A table with measurement uncertainties is enclosed in appendix A. unless otherwise indicated in the report, the measurement uncertainties of the results presented are as indicated in this table.

2.6 Applicable standards

When reference is made to a standard and the date of issue is not stated, this applies to the latest issue, including amendments, which have been officially published prior to the date of the tests.

3 ELECTRICAL TYPE TESTS

3.1 General

3.1.1 Tests at elevated conductor temperature

For the tests with the cable system at elevated temperature, a reference loop for temperature control of the conductor was installed. The reference cable was cut from the total cable length submitted by the client intended for the type test. This reference loop was installed close to the main loop in order to create the same environmental conditions as for the test loop.

The heating currents in both the reference loop and the test loop were kept equal at all times, thus the conductor temperature of the reference loop is representative for the conductor temperature of the test loop. Annex A, method 1 of IEC 60840 was used as a guide.

The tests at elevated temperature are carried out two hours after thermal equilibrium has been established.

3.2 Test voltage values

Standard and date

Standard IEC 60840, clause 12.4.1
Test date 17 April 2012

nominal thickness (mm)	maximum allowed thickness (mm)	measured average thickness (mm)
10,4	$10,4 + 5\% = 10,9$	10,4

Result

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

3.3 Bending test followed by a partial discharge test

3.3.1 Bending test

Standard and date

Standard IEC 60840, clause 12.4.3
 Test date 10 April 2012

Environmental conditions

Ambient temperature 10 °C
 Temperature of test object 10 °C

Characteristic test data

Bending diameter:
 "Cable with lead, corrugated metallic sheath or metal foil" 25 (d + D) + 5%

measured outer diameter of cable D (mm)	measured diameter of cable conductor d (mm)	maximum required bending diameter D _r (mm)	diameter of test cylinder D _t (mm)
73	30,1	D _r ≤ 2706	2200

Procedure

The test sample shall be bent around a test cylinder at ambient temperature for at least one complete turn. It shall then be unwound and repeated, except that the bending of the sample shall be in the reverse direction without axial rotation. This cycle of operation shall be carried out three times.

Result

The bending test was carried out successfully. The test gave no rise for remarks.

3.3.2 Partial discharge test

Standard and date

Standard IEC 60840, clause 12.4.4
 Test date 18 April 2012

Environmental conditions

Ambient temperature 21 °C
 Temperature of test object 21 °C

Characteristic test data

Circuit direct
 Calibration 5 pC
 Noise ≤ 2 pC
 Sensitivity 4 pC
 Required sensitivity ≤ 5 pC
 Bandwidth 48 ± 20 kHz
 Test frequency 50 Hz
 Coupling capacitor 2600 pF

core	voltage applied, 50 Hz		duration (s)	partial discharge level (pC)
	xU ₀	(kV)		
1	1,75	63	10	not detectable
	1,5	54	-	

Requirement

There shall be no detectable discharge exceeding the declared sensitivity from the test object at 1,5xU₀.

Result

The test object passed the test.

3.4 Tan δ measurement

Standard and date

Standard IEC 60840, clause 12.4.5
 Test date 19 April 2012

Environmental conditions

Ambient temperature 21 °C
 Temperature of test object 97 °C

Characteristic test data

Length of test object 15,2 m
 Standard capacitor 100 pF

core	voltage applied, 50 Hz		core capacitance ¹⁾ (μ F/km)	tan δ
	xU_0	(kV)		
1	1	36	0,25	$1,4 \times 10^{-4}$
¹⁾ for information only				

Requirement

The measured value shall not be higher than 10×10^{-4} at U_0 .

Result

The test object passed the test.

3.5 Heating cycle voltage test

Standard and date

Standard IEC 60840, clause 12.4.6
 Test period 20 April 2012 until 10 May 2012

Environmental conditions

Ambient temperature 21 °C

Characteristic test data

Heating method conductor current
 Stabilized temperature 97 °C

no. of heating-cycles	required steady conductor temperature	heating current at stable condition	heating per cycle		cooling per cycle	voltage per cycle	
			total duration	duration of conductor at steady temperature		total duration	applied voltage
	(°C)	(A)	(hours)	(hours)	(hours)	(hours)	(kV)
20	95-100	1505	8	2	16	24	72

Requirements

No breakdown shall occur.

Result

The test object passed the test.

3.6 Partial discharge test

Standard and date

Standard IEC 60840, clause 12.4.4
 Test date 11 May 2012

Environmental conditions

Ambient temperature 21 °C
 Temperature of test object 21 °C

Characteristic test data

Circuit direct
 Calibration 5 pC
 Noise 2 pC
 Sensitivity 4 pC
 Required sensitivity ≤ 5 pC
 Bandwidth 127 ± 20 kHz
 Test frequency 50 Hz
 Coupling capacitor 2600 pF

core	voltage applied, 50 Hz		duration (s)	partial discharge level (pC)
	xU_0	(kV)		
1	1,75	63	10	not detectable
	1,5	54	-	

Requirement

There shall be no detectable discharge exceeding the declared sensitivity from the test object at $1,5xU_0$.

Result

The test object passed the test.

3.7 Lightning impulse test followed by a power-frequency voltage test

3.7.1 Impulse test

Standard and date

Standard IEC 60840, clause 12.4.7
 Test date 14 May 2012

Environmental conditions

Ambient temperature 21 °C
 Temperature of test object 97 °C

Characteristic test data

Specified test voltage 325 kV

The waveshape of the impulse voltage was determined at approximately 50 percent of the specified test value (see figure 1 and 5).

testing arrangement		polarity	voltage applied (% of test voltage)	no. of impulses	see figure
voltage applied to	earthed				
conductor	metallic screen	positive	50	1	1 (waveshape)
			65	1	2
			80	1	2
			100	10	3 and 4
conductor	metallic screen	negative	50	1	5 (waveshape)
			65	1	6
			80	1	6
			100	10	7 and 8

Requirement

No breakdown of the insulation shall occur.

Result

The test object passed the test.

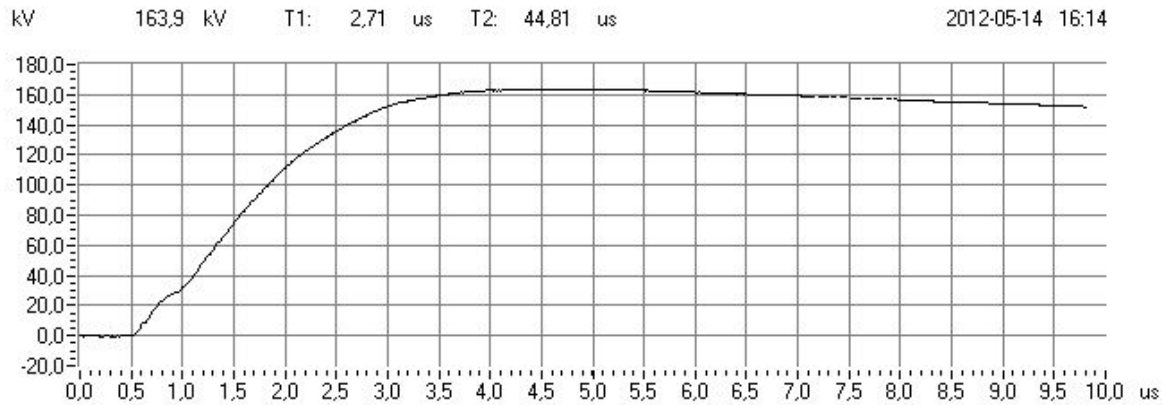


Fig. 1: Waveshape 72120727, +50%

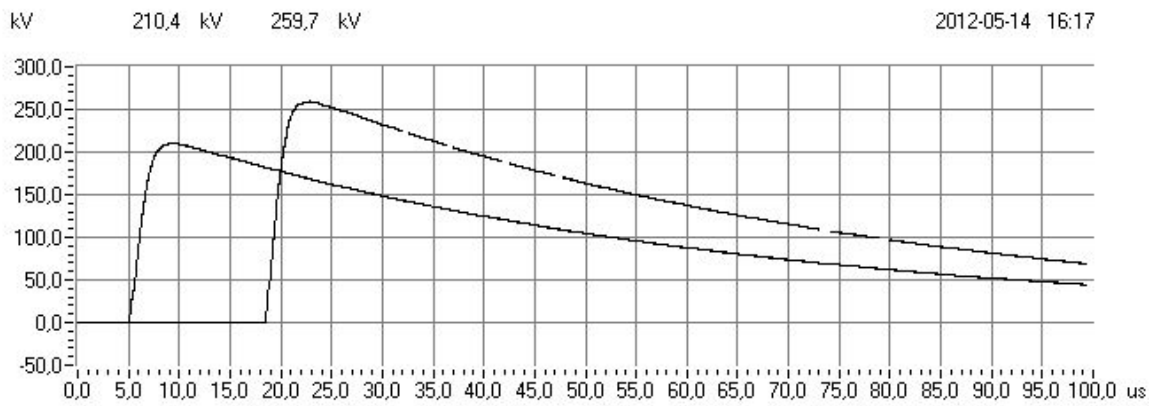


Fig. 2: 72120727, +65% and +80%

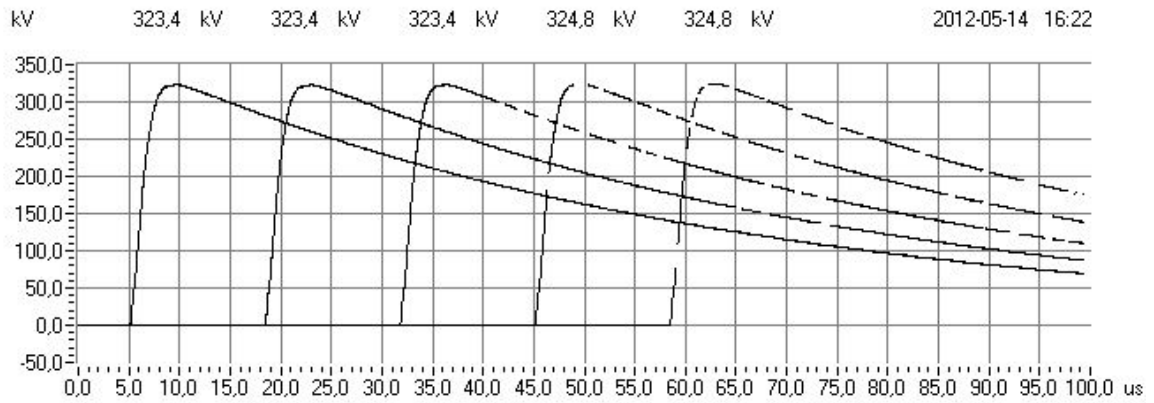


Fig. 3: 72120727, +100%

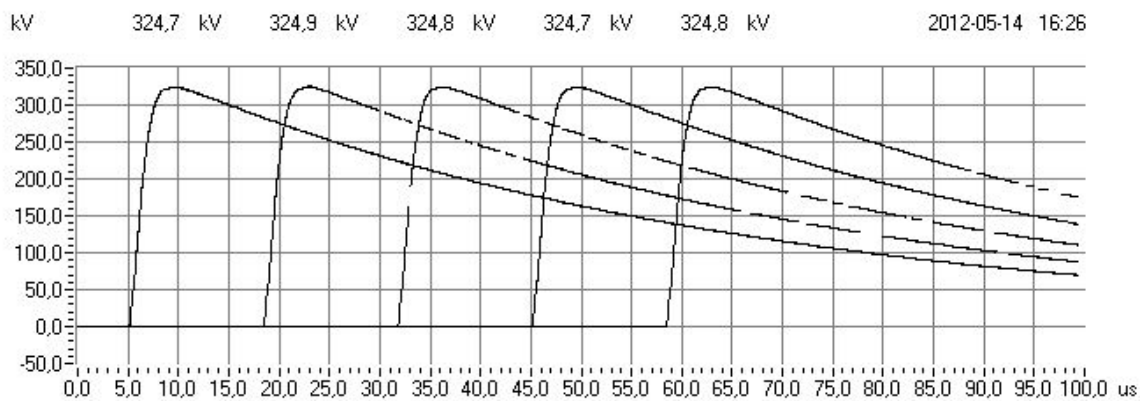


Fig. 4: 72120727, +100%

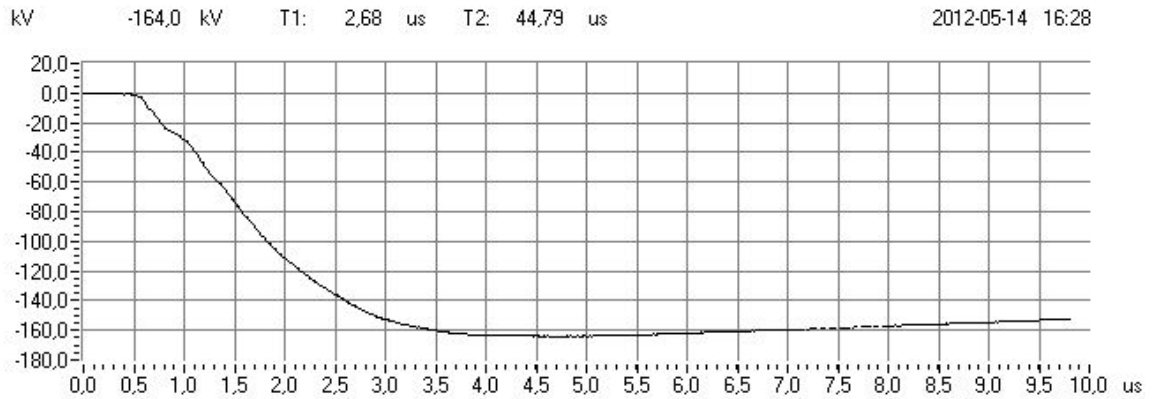


Fig. 5: Waveshape 72120727, -50%

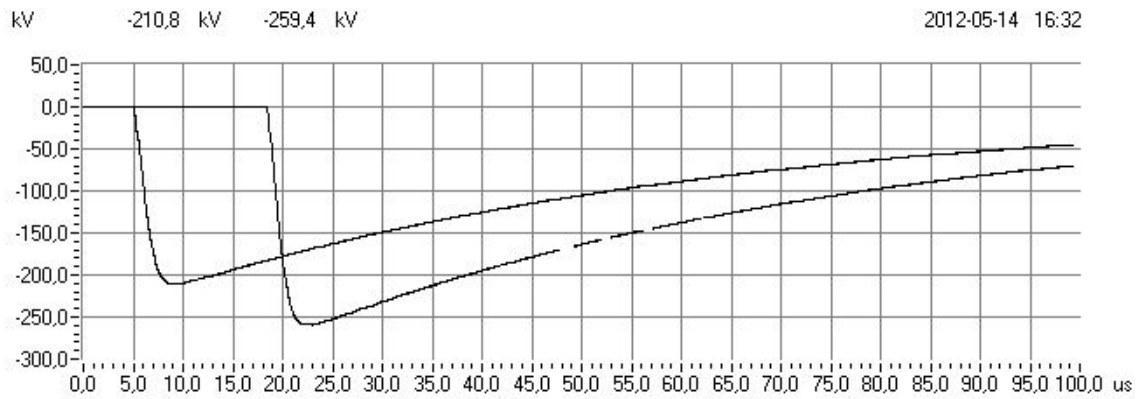


Fig. 6: 72120727, -65% and -80%

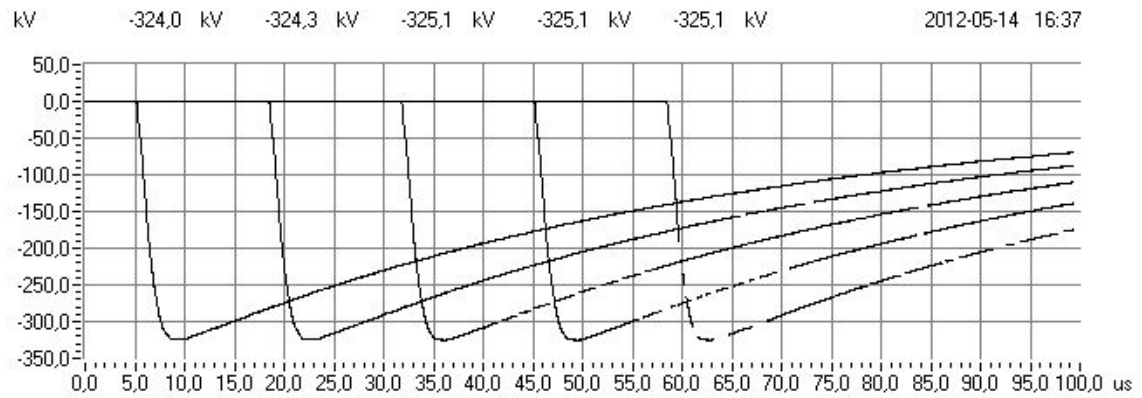


Fig. 7: 72120727, -100%

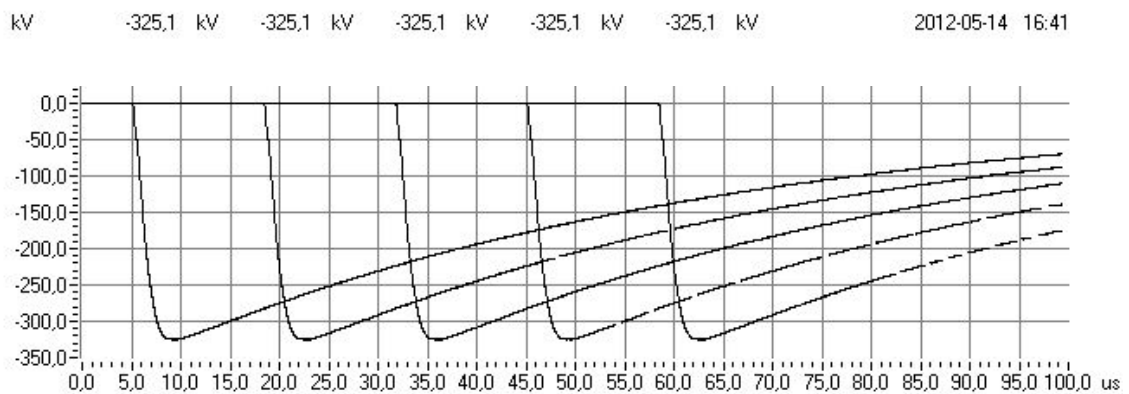


Fig. 8: 72120727, -100%

3.7.2 Power frequency voltage test

Standard and date

Standard IEC 60840, clause 12.4.7
Test date 16 May 2012

Environmental conditions

Ambient temperature 21 °C
Temperature of test object 21 °C

testing arrangement		voltage applied, 50 Hz		duration
voltage applied to	earth connected to	xU ₀	(kV)	(min)
conductor	metallic screen	2,5	90	15

Requirement

No breakdown of the insulation shall occur.

Result

The test object passed the test.

3.8 Examination

Standard and date

Standard IEC 60840, clause 12.4.8
 Test date 12 June 2012

3.8.1 Examination of cable

No sign of deterioration, e.g. electrical degradation, was found.

Result

The test object passed the test.

3.8.2 Tests of components of cables with a longitudinally applied metal foil

item	unit	requirement	measured/determined				
visual examination							
- inspection	-	no cracks or separations	no cracks or separations				
adhesion strength							
- strength	N/mm	≥ 0,5	1,4	1,8	1,4	1,7	1,9
peel strength							
- strength	N/mm	≥ 0,5	2,2	1,8	2,6	2,4	2,0

Result

The test object passed the test.

3.9 Resistivity of semi-conducting screens

Standard and date

Standard IEC 60840, clause 12.4.9
 Test period 5 and 14 June 2012

Characteristic test data

Temperature during ageing 100 °C
 Duration 7 days
 Resistivity measured at 90 ± 2 °C

item	unit	requirement	measured/determined
conductor screen			
- without ageing	Ωm	≤ 1000	2,83
- after ageing	Ωm	≤ 1000	2,51
insulation screen			
- without ageing	Ωm	≤ 500	0,30
- after ageing	Ωm	≤ 500	0,29

Result

The test object passed the test.

4 NON-ELECTRICAL TYPE TESTS

4.1 Check of cable construction

Standard and date

Standard IEC 60840, clause 12.5.1

Test period 5 June 2012

item	unit	requirement	specified	measured/ determined
conductor				
- diameter of conductor	mm	-		30,4
- number of wires		≥ 53		60
- diameter of wires	mm	-		3,2
- resistance at 20°C	Ω/km	$\leq 0,283$		0,283
thickness of insulation				
- nominal	mm	-	10,4	
- average	mm	-		10,4
- minimum, t_{\min}	mm	$\geq 9,4$		9,8
- maximum, t_{\max}	mm	-		10,8
- $(t_{\max} - t_{\min}) / t_{\max}$	-	$\leq 0,15$		0,09
thickness of oversheath				
- nominal	mm	-	3,3	
- average	mm	-		5,3
- minimum, t_{\min}	mm	$\geq 2,7$		4,1

Result

The cable construction complied with the requirements.

4.1 Check of cable construction (continued)

	observed/determined
construction	<p>outer sheath, thick 5,3 mm</p> <p>aluminium laminated sheath, thick 0,30 mm</p> <p>swell tape (white) width 60 mm, thick 0,25 mm, overlap 27%</p> <p>copper wire screen, 55 wires</p> <p>copper tape, open helix width 20 mm, thick 0,10 mm</p> <p>swell tape (black) width 48 mm, thick 0,22 mm, overlap 21%</p> <p>isolation screen outer diameter 56,9 mm, thick 1,27 mm</p> <p>isolation outer diameter 54,3 mm, thick 10,38 mm</p> <p>conductor screen outer diameter 33,3mm, thick 1,30 mm</p> <p>conductor outer diameter 30,4 mm, composition 1-6-12-18-23</p>
outer diameter of the cable average (mm)	71,2 mm
outer diameter of the core average (mm)	57,2 mm

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

Standard and date

Standard IEC 60840, clause 12.5.2
 Test period 18 June 2012

Characteristic test data

Temperature during aging 135 ± 3 °C
 Ageing duration 7 days

item	unit	requirement	measured/determined
without ageing			
- tensile strength	N/mm ²	≥ 12,5	24,7
- elongation	%	≥ 200	538
after ageing			
- tensile strength	N/mm ²	-	25,7
- variation with samples without ageing	%	± 25 max.	-4
- elongation	%	-	589
- variation with samples without ageing	%	± 25 max.	-9

Result

The test object passed the test.

4.3 Tests for determining the mechanical properties of oversheaths before and after ageing

Standard and date

Standard IEC 60840, clause 12.5.3
 Test period 18 June 2012

Characteristic test data

Temperature during aging 110 ± 2 °C
 Ageing duration 10 days

item	unit	requirement	measured/determined
without ageing			
- tensile strength	N/mm ²	≥ 12,5	63,5
- elongation	%	≥ 300	1029
after ageing			
- tensile strength	N/mm ²	-	45,6
- variation with samples without ageing	%	-	-28
- elongation	%	≥ 300	951
- variation with samples without ageing	%	-	8

Result

The test object passed the test.

4.4 Ageing tests on pieces of complete cable to check compatibility of materials

Standard and date

Standard IEC 60840, clause 12.5.4
 Test period 18 June 2012

Characteristic test data

Temperature during aging 100 ± 2 °C
 Ageing duration 7 days

Insulation

item	unit	requirement	measured/determined
- tensile strength	N/mm ²	-	30,6
- variation with samples without ageing	%	± 25 max.	-24
- elongation	%	-	579
- variation with samples without ageing	%	± 25 max.	-8

Oversheath

item	unit	requirement	measured/determined
- tensile strength	N/mm ²	-	34,1
- variation with samples without ageing	%	-	46
- elongation	%	≥ 300	630
- variation with samples without ageing	%	-	39

Result

The test object passed the test.

4.5 Pressure test at high temperature on overshooth

Standard and date

Standard IEC 60840, clause 12.5.6
 Test period 8 June 2012

Characteristic test data

Temperature 110 ± 2 °C
 Load 18,41 N
 Duration 6 h

item	unit	requirement	measured/determined
- depth of indentation	%	≤ 50	5

Result

The test was passed.

4.6 Hot set test for insulation

Standard and date

Standard IEC 60840, clause 12.4.10
 Test period 8 June 2012

Characteristic test data

Air temperature 200 ± 3 °C
 Time under load 15 min
 Mechanical stress 20 N/cm²

item	unit	requirement	measured/determined
- elongation under load	%	≤ 175	60
- permanent elongation	%	≤ 15	-3

Result

The test object passed the test.

4.7 Measurement of carbon black content of black PE oversheaths

Standard and date

Standard IEC 60840, clause 12.5.12

Test period 8 June 2012

item	unit	requirement	measured/determined
- carbon black content	%	2,5 ± 0,5	2,3

Result

The test object passed the test.

4.8 Shrinkage test for XLPE insulation

Standard and date

Standard IEC 60840, clause 12.5.16

Test period 4 June 2012

Characteristic test data

Temperature 130 ± 3 °C

Duration 6 h

item	unit	requirement	measured/determined
- shrinkage	%	≤ 4,5	0,9

Result

The test object passed the test.

4.9 Shrinkage test for PE oversheaths

Standard and date

Standard IEC 60840, clause 12.5.17
Test period 8 June 2012

Characteristic test data

Temperature 80 ± 2 °C
Duration 5 h
Heating cycles 5

item	unit	requirement	measured/determined
- shrinkage	%	$\leq 3,0$	1,1

Result

The test object passed the test.

4.10 Water penetration test

Standard and date

Standard IEC 60840, clause 12.4.18 and Annex E
 Test period 27 April to 7 May 2012

Environmental conditions

Ambient temperature 20 °C

Characteristic test data

Length of cable sample 6 m
 Water height above cable centre 1 m
 Heating method conductor current
 Stabilized conductor temperature 97 °C

no. of heating cycles	required steady conductor temperature	heating current at stable condition	heating per cycle		cooling per cycle
			total duration	duration of conductor at steady temperature	total duration
	(°C)	(A)	(hours)	(hours)	(hours)
10	95-100	1534	8	2	16

Note

The manufacturer has claimed that barriers have been included, which prevents longitudinal water penetration in the region of the metallic layers.

Requirement

No water shall emerge from the ends of the cable sample.

Result

The test object passed the test.

4.11 Tests on components of cable with a longitudinally applied metal foil

Standard and date

Standard IEC 60840, clause 12.5.15
 Test period 12 June 2012

item	unit	requirement	measured/determined				
visual examination - inspection	-	no cracks or separations	no cracks or separations				
adhesion strength - strength	N/mm	≥ 0,5	1,4	1,8	1,4	1,7	1,9
peel strength - strength	N/mm	≥ 0,5	2,2	1,8	2,6	2,4	2,0

Result

The test object passed the test.

APPENDIX A MEASUREMENT UNCERTAINTIES

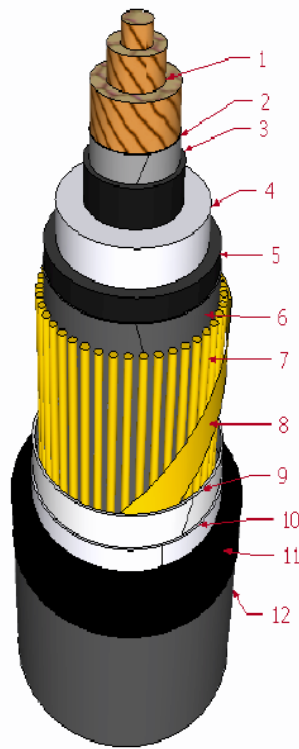
The measurement uncertainties in the results presented are as specified below unless otherwise indicated.

measurement	measurement uncertainty
dielectric tests and impulse current tests:	
peak value	≤ 3%
time parameters	≤ 10%
capacitance measurement	0,3%
tan δ measurement	± 0,5% ± 5 × 10 ⁻⁵
partial discharge measurement:	
< 10 pC	2 pC
10 to 100 pC	5 pC
> 100 pC	20%
measurement of impedance	≤ 1%
AC-resistance measurement	
measurement of losses	≤ 1%
measurement of insulation resistance	≤ 10%
measurement of DC resistance:	
1 to 5 μΩ	1%
5 to 10 μΩ	0,5%
10 to 200 μΩ	0,2%
radio interference test	2 dB
calibration of current transformers	2,2 × 10 ⁻⁴ I _r /I _u and 290 μrad
calibration of voltage transformers	1,6 × 10 ⁻⁴ U _r /U _u and 510 μrad
measurement of conductivity	5%
measurement of temperature:	
-50 to -40 °C	3 K
-40 to 125 °C	2 K
125 to 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 B MANUFACTURER'S DRAWING/DATA SHEET

2 pages (including this page)

drawing no.	title	date	rev.
DB6-TX01-N60-00-02	630mm ² kV CU/XLPE/CW/HDPE	4/7/2012	0



Title: 630mm² 60kV CU/XLPE/CW/HDPE
 Drawing No.: DB6-TX01-N60-00-02
 Rev. 1
 Date: 4/7/2012

Section : 1 x 630 mm ²		Type : CU/XLPE/CW/HDPE	
Tension: 60 kV		Norme: IEC 60840, 60228	
Code : DB6-TX01-N60-00-02		ELSEWEDY CABLES - Algeria	
Sr.	Description	Thickness mm	Approx. Diameter mm
1.	<i>Copper Conductor with Swelling Material</i>		30.05
2.	Semi Conductive Swelling Tape	0.1	
3.	Extruded Semi Conductive screen	1.2	
4.	XLPE Insulation	10.4	
5.	Extruded Semi Conductive screen	1	
6.	Semi Conductive Swelling Tape	0.3	
7.	<i>Copper wires screen</i>	55 x 1.43	
8.	<i>Open Helix Copper Tape</i>	0.1	
9.	Non Conductive Swelling Tape	0.05/0.2/0.05	
10.	Aluminum Laminated Tape	0.3	
11.	HDPE Jacket	3.3	
12.	Graphite Coating		Approx. 68
Not to scale		Drawn by : Mr. Hussieny ahmed	Approved by: Eng. Ayman A. Elkholy