REPORT OF PERFORMANCE 1188-15

OBJECT	Single-core power cable 127/220 (245) kV – 1x800 mm^2 – Cu – XLPE
CLIENT	Elsewedy Cables, Algiers, Algeria
MANUFACTURERS	Elsewedy Cables, Algiers, Algeria
TESTED BY	KEMA Nederland B.V., Arnhem, The Netherlands
DATE OF TESTS	12 March to 3 June 2015
TEST SPECIFICATION	The programme was specified by the client (see page 2). The test procedures and parameters were based on IEC 62067 (2011).
SUMMARY AND CONCLUSION	The object passed the tests.

This report applies only to the object tested. The responsibility for conformity of any object having the same type references as that tested rests with the manufacturer.

This report consists of 39 pages in total.

KEMA Nederland B.V.

J.P. Fonteijne
Executive Vice President
KEMA Laboratories

Arnhem, 13 July 2016

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1 IDENTIFICATION OF THE OBJECT TESTED

1.1 Ratings/characteristics of the object tested

1.1.1 Characteristics of the cable

Rated voltage, U_0/U (U_m)	127/220 (245) kV
Rated maximum conductor temperature	90 °C
Rated conductor cross-section	800 mm^2

The test voltages and calculated nominal field stresses were based on U_0 test = 127 kV.

1.1.2 Characteristics of the cable

Standard	IEC 62067, Clause 6
Manufacturer (as stated by the client)	Elsewedy, Algiers, Algeria
Type	U_0=127 kV, 1x800mm^2, CU/XLPE/CW/HDPE CABLE
Manufacturing year	2012
Quantity submitted	81 m
Rated voltage, U_0/U (U_m)	127/220 (245) kV
Overall diameter (D)	100,1 mm
Calculated nominal electrical stress at conductor screen at U_0 = 127 kV (E_i)	8,72 kV/mm
Calculated nominal electrical stress at insulation screen at U_0 = 127 kV (E_o)	4,02 kV/mm
Nominal capacitance between conductor and metal screen	0,179 µF/km
Marking on the oversheath	CEI 62067 – GRTE/CEEG – EL SEWEDY CABLES ALG - 800 CU – PR – 22 – Cuivre – 127/220 (72.5) kV – 2012 – Lot 1 - 1
Construction	see drawing

Conductor

– material	soft annealed copper
– material designation	IEC 60228
– DC conductor resistance	≤ 0,0221 Ω/km
– cross-section	800 mm^2
– nominal diameter (d)	34,5 mm
– type	circular compacted
– number and nominal diameter of wires	61 wires and Ø 4,31 mm
– maximum conductor temperature in normal operation	90 °C
– presence and nature of measures to reduce skin effect	no
– presence and nature of measures to achieve longitudinal watertightness	yes
– swelling material	swelling tape
– number of layers of swelling tapes	3
– nominal thickness and width of tape	3 x 0,1 mm touched 50-75-100 mm
– material designation	kept in KEMA Laboratories'file
– manufacturer of the material	United Metal- Elsewedy

Conductor screen

– material	semi-conducting
– nominal thickness	1,4 mm
– material designation	kept in KEMA Laboratories'file
– manufacturer of the material	kept in KEMA Laboratories'file

Insulation

– material	XLPE
– nominal thickness	22,0 mm
– nominal inner diameter of the insulation	37,6 mm
– nominal outer diameter of the insulation	81,6 mm
– material designation	kept in KEMA Laboratories'file
– manufacturer of the material	kept in KEMA Laboratories'file

Insulation (core) screen

– material	extruded semi-conductive
– nominal thickness	1,4 mm
– material designation	kept in KEMA Laboratories'file
– manufacturer of the material	kept in KEMA Laboratories'file

Longitudinally watertightness

– presence and nature of measures to achieve longitudinal watertightness along insulation screen	yes, swelling tape
– number of swelling tapes	1
– nominal thickness and width	70 x 1,0 mm (overlap: 30%)
– material designation	semi-conductive swelling tape
– manufacturer of the material	kept in KEMA Laboratories'file

Metal screen

– material	copper tape, 1 layer, and copper wires
– number of wires	77
– nominal diameter of wires	1,43 mm
– number of tapes	1
– nominal thickness and width of tape	20 x 0,1 mm open helix
– cross-sectional area	123,67 mm2
– DC resistance	0,144 Ω/km
– manufacturer of the material	United metal Elsewedy
– semi-conductive water blocking	white

Metal foil or tape, longitudinally applied, bonded to the oversheath	yes
– material	aluminum laminated tape
– nominal thickness	0,2 mm

Oversheath

– material	PE type ST_7
– nominal thickness	4,0 mm
– nominal overall diameter of the cable (D)	100,1 mm
– material designation	kept in KEMA Laboratories'file
– manufacturer of the material	kept in KEMA Laboratories'file
– colour	black
– graphite coating applied	yes

Fire retardant (acc. IEC 60332-1)	no

Manufacturing details insulation system

– location of manufacturing	Algiers, Algeria
– type of extrusion line	CCV
– type of extrusion	triple common extrusion
– factory identification of extrusion line	CCV
– manufacturer of the extrusion line	Maillefer - Finland
– identification of production batch	1
– curing means	dry
– cooling means	dry
– manufacturing length (where cable sample for testing has been taken from)	400 m
– length markings on cable sample sent to KEMA Laboratories	begin: 10.199 m, end: 10.280 m

1.2 List of drawings

The manufacturer has guaranteed that the object submitted for tests has been manufactured in accordance with the following drawing. KEMA Laboratories has verified that this drawing adequately represent the object tested. The manufacturer is responsible for the correctness of this drawing and the technical data presented.

The following drawing has been included in this report:

Drawing No./document No.	Revision
DB8-TX01-K70-17-00	0

2 GENERAL INFORMATION

2.1 The tests were witnessed by

Name	Company
Mr Rriadh Fellouh (20 to 22 May 2015)	Elsewedy Cables, Algiers, Algeria
Mr Banoun Lamine Mr Boucif Smail (20 to 22 May 2015)	CEEG Sonelgaz, Algiers, Algeria

2.2 The tests were carried out by

Name	Company
Mr A. Sengers Mr S. Smeenk Mr L. Scheltinga	KEMA Nederland B.V., Arnhem, The Netherlands

2.3 Subcontracting

The following tests were subcontracted to DNV-GL/NET (former KEMA/NET):

- measurement of resistivity of semi-conducting screens in accordance with Subclause 12.4.9
- non- electrical type tests in accordance with Subclause 12.5, with the exception of the water penetration test of Subclause 12.5.14.

2.4 Purpose of the tests

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

2.5 Measurement uncertainty

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

3 ELECTRICAL TYPE TESTS ON COMPLETE CABLE

3.1 Test arrangement

3.1.1 Determination of the cable conductor temperature

Standard

Standard IEC 62067, Annex A, Subclause A.3.1

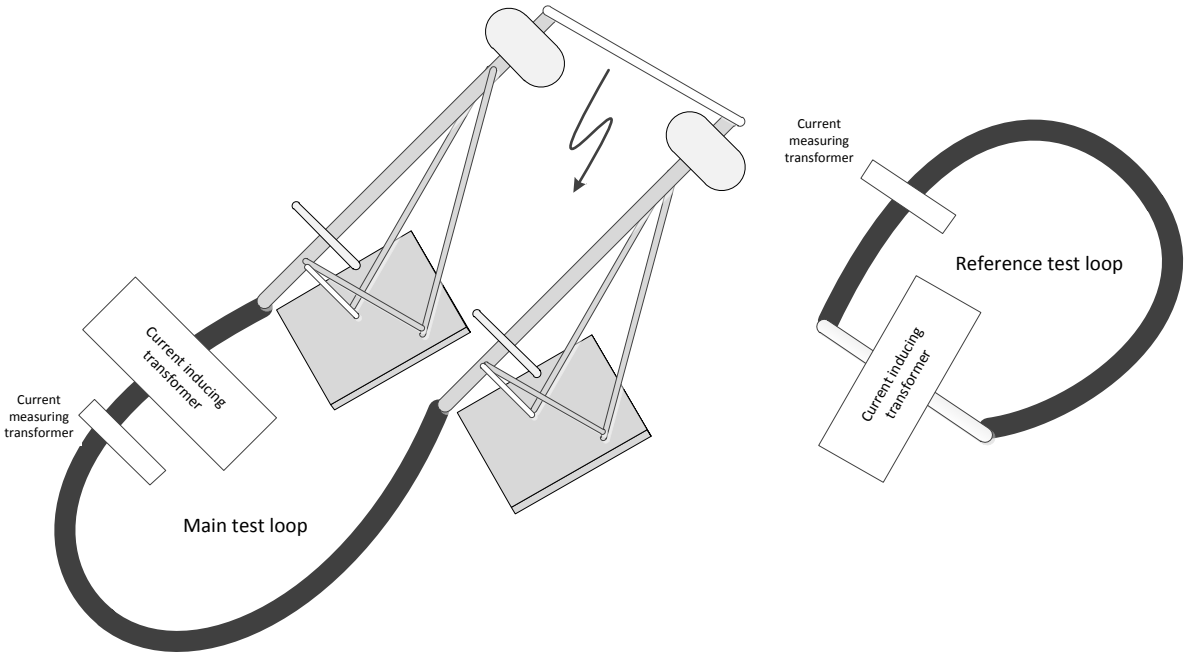
For the tests with the cable system at elevated temperature, a reference loop for temperature control of the conductor was installed and conductor current was used for heating. The reference cable was cut from the total cable length intended for the type test. This reference loop was installed close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

The heating currents in 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 was used as a guide and Subclause A.3.1, method 1 was applied.

The tests at elevated temperature are carried out after the conductor temperature has been within the stated limit for at least 2 hours.

3.1.2 **Test set-up**

In order to perform the test, the following test loop was prepared by staff of KEMA Laboratories:



– 1 piece of power cable type 1x800mm^2, CU/XLPE/CW/HDPE CABLE, 16 meters long.

3.1.3 Photograph of test set-up

3.2 Test voltage values

Standard and date

Standard IEC 62067, Subclause 12.4.1
Test date 12 March 2015

Characteristic test data

Length of cable sample 0,5 m

Nominal insulation thickness (mm)	Measured average insulation thickness (mm)	Deviation of measured average insulation thickness from nominal insulation thickness (%)
22,0	21,7	-1,4

Requirement

If the average thickness of the insulation does not exceed the nominal value by more than 5%, the test voltages shall be the values specified in Table 4 for the rated voltage of the cable.
If the average thickness of the insulation exceeds the nominal value by more than 5% but by no more than 15%, the test voltage shall be adjusted to give an electrical stress at the conductor screen equal to that applying when the average thickness of the insulation is equal to the nominal value, and the test voltages are the normal values specified for the rated voltage of the cable.
The cable length used for the electrical type tests shall not have an average thickness exceeding the nominal value by more than 15%.

Result

The measured average insulation thickness did not exceed the nominal value by more than 5%. The voltage tests can be performed with the values specified before.

3.3 Bending test

Standard and date

Standard IEC 62067, Subclause 12.4.3
Test date 12 March 2015

Environmental conditions

Ambient temperature 4 °C

Characteristic test data

Temperature of test object 15 °C
Maximum bending diameter 25(d + D) + 5%

Length of cable bended 50 m
Length marking of cable bended 10.199 – 10.249m

Nominal outer diameter of cable D (mm)	Nominal diameter of cable conductor d (mm)	Maximum required bending diameter D_r (mm)	Diameter of test cylinder D_t (mm)
34,5	100,1	3365	3250

Result

The test was carried out successfully.

3.4 Partial discharge test at ambient temperature

Standard and date

Standard	IEC 62067, Subclause 12.4.4
Test date	20 March 2015

Environmental conditions

Ambient temperature	20 °C

Characteristic test data

Temperature of test object	20 °C
Circuit	direct
Calibration	5 pC
Noise level at 1,5 U_0	2 pC
Declared sensitivity	4 pC
Required sensitivity	≤ 5 pC
Centre frequency	134 kHz
Bandwidth (Δf)	100 kHz
Test frequency	50 Hz
Coupling capacitor	833 pF

Assembly	Voltage applied, 50 Hz		Duration	Partial discharge level
	... x U_0	(kV)	(s)	(pC)
Cable system	1,75	222,3	10	-
	1,5	190	-	Not detectable

Requirement

There shall be no detectable discharge exceeding the declared sensitivity from the test object at 1,5 U_0.

Result

The object passed the test.

3.5 Tan δ measurement

Standard and date

Standard IEC 62067, Subclause 12.4.5
Test date 23 March 2015

Environmental conditions

Ambient temperature 21 °C

Characteristic test data

Temperature of test object 97 °C
Length of test object 16,25 m
Standard capacitor 57,38 pF

Assembly	Voltage applied, 50 Hz (kV)	Capacitance of main loop [1] (µF/km)	Tan δ
Cable system	127	0,161	$1,5 \times 10^{-4}$
[1] for information only			

Requirement

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

Result

The object passed the test.

3.6 Heating cycle voltage test

Standard and date

Standard IEC 62067, Subclause 12.4.6
Test dates 24 March to 20 May 2015

Environmental conditions

Ambient temperature 20-22 °C

Characteristic test data

Heating method conductor current
Stabilized temperature 97 °C
Diameter of U-bend 3365 mm

No. of heating cycles	Required steady conductor temperature (°C)	Heating current during steady condition (A)	Heating cycle			Voltage	
			Heating		Cooling		
			Total duration (h)	Duration of conductor at steady temperature (h)	Total duration (h)	Total duration (h)	Voltage applied 2 U_0 (kV)
20	95-100	approx. 1678	≥ 8	≥ 2	≥ 16	24	254

Requirement

No breakdown shall occur.

Result

The object passed the test.

3.7 Partial discharge test at ambient temperature

Standard and date

Standard	IEC 62067, Subclause 12.4.4
Test date	20 May 2015

Environmental conditions

Ambient temperature	21 °C

Characteristic test data

Temperature of test object	21 °C
Circuit	direct
Calibration	5 pC
Noise level at 1,5 U_0	2,5 pC
Declared sensitivity	5 pC
Required sensitivity	≤ 5 pC
Centre frequency	134 kHz
Bandwidth (Δf)	100 kHz
Test frequency	50 Hz
Coupling capacitor	833 pF

Assembly	Voltage applied, 50 Hz		Duration	Partial discharge level
	... x U_0	(kV)	(s)	(pC)
Cable system	1,75	222,3	10	-
	1,5	190	-	Not detectable

Requirement

There shall be no detectable discharge exceeding the declared sensitivity from the test object at 1,5 U_0.

Result

The object passed the test.

3.8 Lightning impulse voltage test

Standard and date

Standard IEC 62067, Subclause 12.4.7.2
Test date 21 May 2015

Environmental conditions

Ambient temperature 22 °C

Characteristic test data

Temperature of test object 97 °C
Specified test voltage 1050 kV

Testing arrangement		Polarity	Voltage applied	No. of impulses	See figure on next pages
Voltage applied to	Earthed		(% of test voltage)		
Conductor	Metal screens	Positive	50	1	1 (waveshape)
			65	1	2
			80	1	2
			100	10	3 and 4
Conductor	Metal screens	Negative	50	1	5 (waveshape)
			65	1	6
			80	1	6
			100	10	7 and 8

Requirement

The assembly shall withstand without failure or flashover 10 positive and 10 negative voltage impulses.

Result

The object passed the test.

Lightning impulse test with positive voltage

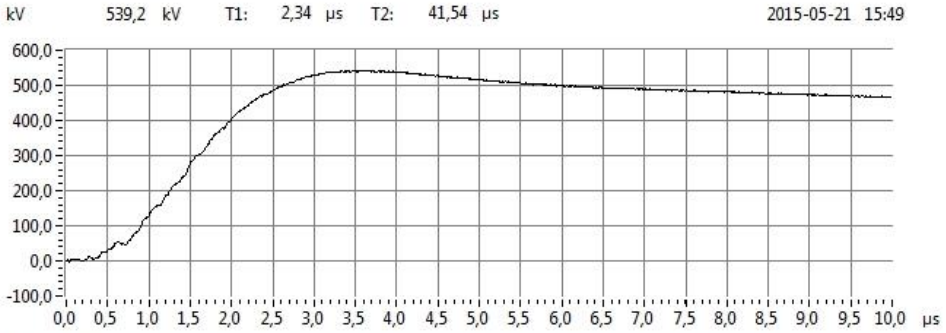


Fig. 1: Waveshape +50% of test voltage

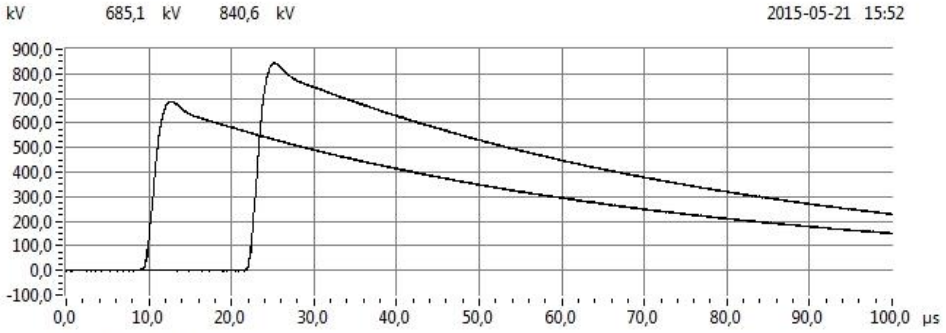


Fig. 2: +65% and +80% of test voltage

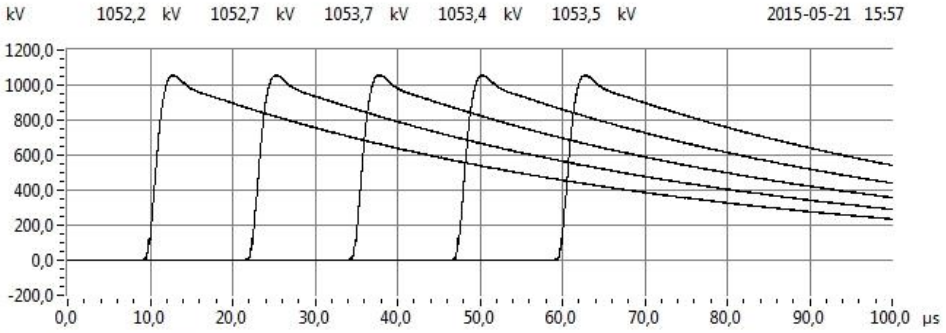


Fig. 3: +100% of test voltage

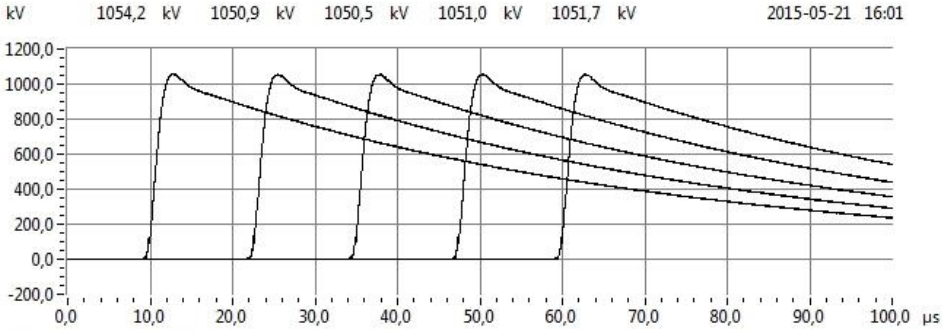


Fig. 4: +100% of test voltage

Lightning impulse test with negative voltage

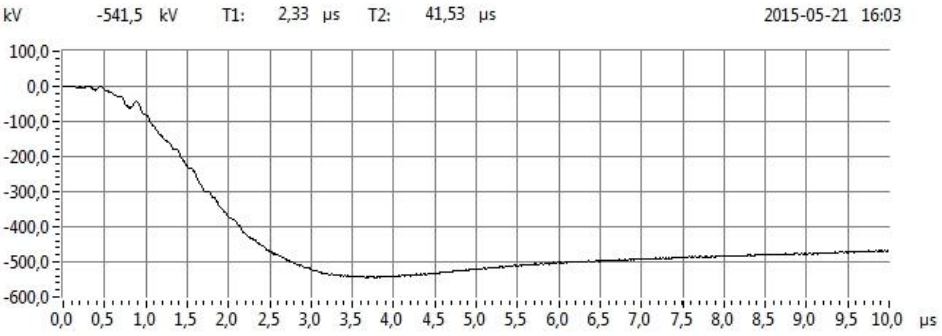


Fig. 5: Waveshape -50% of test voltage

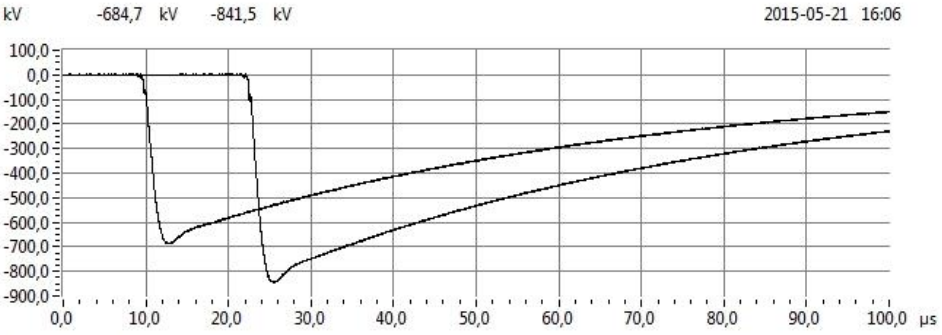


Fig. 6: -65% and -80% of test voltage

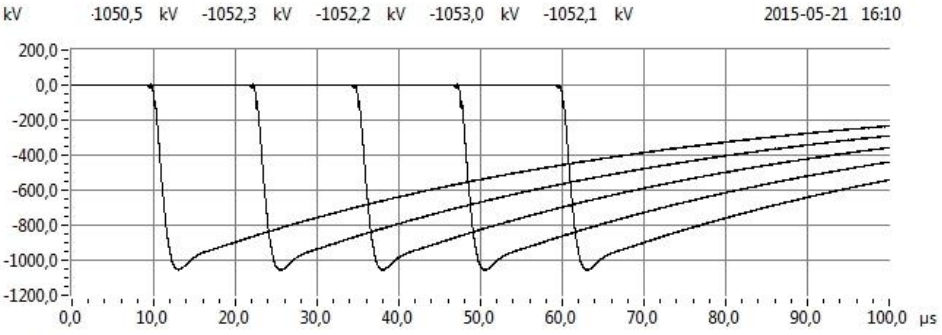


Fig. 7: -100% of test voltage

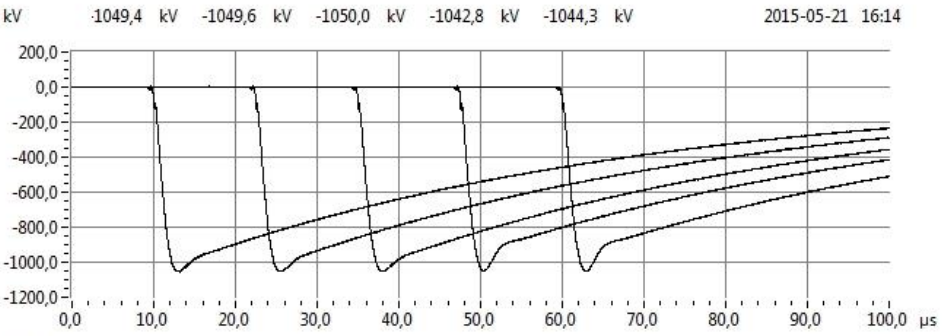


Fig. 8: -100% of test voltage

3.9 Power frequency voltage test

Standard and date

Standard IEC 62067, Subclause 12.4.7.2
Test date 22 May 2015

Environmental conditions

Ambient temperature 21 °C

Characteristic test data

Temperature of test object 21 °C

Testing arrangement		Voltage applied, 50 Hz		Duration
Voltage applied to	Earth connected to	… x U_0	(kV)	(min)
Conductors	Metal screens	2	254	15

Requirement

No breakdown of the insulation shall occur.

Result

The object passed the test.

3.10 Examination of cable

Standard and date

Standard	IEC 62067, Subclause 12.4.8.1
Test date	26 May 2015

Requirement

Examination of the cable shall reveal no signs of deterioration (e.g. electrical degradation, leakage, corrosion or harmful shrinkage) which could affect the system in service operation.

Result

No signs of electrical degradation, leakage, corrosion or harmful shrinkage which could affect the system in service operation were detected.

3.10.1 **Photograph of cable**

After examination of the cable

3.11 Examination of cable with a longitudinally applied metal tape or foil, bonded to the oversheath

Standard and date

Standard IEC 62067, Subclause 12.4.8.2

Test date 27 May 2015

Characteristic test data

Length of cable sample 1 m

Item	Unit	Requirement	Measured/determined
Visual examination	-	No cracks or separations	No cracks or separations
Adhesion strength of metal foil	N/mm	≥ 0,5	0,5
Peel strength of overlapped metal foil	N/mm	≥ 0,5	1,0

Result

The object passed the test.

3.13 Resistivity of semi-conducting screens

Standard and date

Standard IEC 62067, Subclause 12.4.9
Test date 1 April 2015

Characteristic test data

Temperature during ageing 100 °C
Duration 7 x 24 h
Resistivity measured at 90 ± 2 °C

Item	Unit	Requirement	Measured/determined
Conductor screen			
– without ageing	Ωm	≤ 1000	34
– after ageing	Ωm	≤ 1000	19
Insulation screen			
– without ageing	Ωm	≤ 500	1
– after ageing	Ωm	≤ 500	1

Result

The object passed the test.

4 NON-ELECTRICAL TYPE TESTS ON CABLE COMPONENTS AND ON COMPLETE CABLE

4.1 Check of cable construction

Standard and date

Standard IEC 62067, Subclause 12.5.1

Test date 17 March 2015

Item	Unit	Requirement	Specified	Measured/determined
Conductor				
Diameter of conductor	mm	≤ 37,6	34,5	34,5
Number of segments	-	-	1	1
Number of wires	-	≥ 53	61	61
Diameter of wires	mm	-	4,31	4,19
Resistance at 20 °C	Ω/km	≤ 0,0221	≤ 0,0221	0,0219
Semi-conducting water blocking layer (black)				present
Number of layers	-	-		Cannot be determined
Thickness of layers	mm	-		
Width of layers	mm	-		
Semi-conducting conductor screen				
Nominal thickness	mm	-	1,4	-
Average thickness	mm	-	1,4	1,6
Minimum thickness	mm	-	1,0	1,2
Outer diameter of conductor screen	mm	-	approx.. 37,5	37,8
Insulation				
Nominal thickness	mm	-	22,0	-
Average thickness	mm	-	-	21,7
Minimum thickness [t_{min}]	mm	-	-	21,1
Maximum thickness [t_{max}]	mm	-	-	22,1
($t_{max} - t_{min}$) / t_{max}	-	≤ 0,10	-	0,04
Semi-conducting insulation screen				
Nominal thickness	mm	-	1,4	-
Average thickness	mm	-	-	1,4
Minimum thickness	mm	-	> 1,2	1,2
Outer diameter of insulation screen	mm	-	-	85,0

Item	Unit	Requirement	Specified	Measured/determined
Semi-conducting water blocking layer (black)				
Number of layers	-	-	1	1
Thickness of layers	mm	-	1,0	0,97
Width of layers	mm	-	70	68
overlap	%		30	26
Copper screen				
Number of Cu wires	-	-	77	77
Diameter of Cu wires	mm	-	1,43	1,42
Dimensions of Cu tape	mm	-	0,1 x 20	0,07 x 19,83
Cross-section of Cu screen	mm^2	-	123,67	
Diameter over Cu screen	mm	-	-	Approx. 89,5
Semi-conducting water blocking layer (white)				
Number of layers	-	-	-	1
Thickness of layers	mm	-	0,3	Approx. 0,3
Width of layers	mm	-	-	57,3
overlap	%			30
Metal foil bonded to the oversheath	-	-	yes	yes
Material		Aluminium laminated tape		present
Nominal thickness	mm	-	0,2	
Oversheath				
Nominal thickness	mm	-	4,0	-
Average thickness	mm	-	-	4,30
Minimum thickness	mm	≥ 3,30	-	3,86
Outer diameter	mm	-	100,1	98,7
Graphite coating	-	-	yes	yes
Colour of the oversheath	-	-	black	black
Marking on oversheath	CEI 62067 – GRTE/CEEG – EL SEWEDY CABLES ALG – 800 CU – PR – 22 - CUIVER – 127/220 (72.5) kV – 2012 – Lot 2 - 1			

Result

The object passed the test.

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

Standard and date

Standard IEC 62067, Subclause 12.5.2

Test date 7 April 2015

Characteristic test data

Temperature during ageing 135 ± 3 °C

Ageing duration 7 x 24 h (19 March to 26 March 2015)

Item	Unit	Requirement	Measured/determined
Without ageing			
Tensile strength	N/mm^2	≥ 12,5	28,2
Elongation at break	%	≥ 200	559
After ageing in air oven			
Tensile strength			
– value after ageing	N/mm^2	-	27,3
– variation	%	± 25 max.	-3
Elongation at break			
– value after ageing	%	-	568
– variation	%	± 25 max.	2

Result

The object passed the test.

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

Standard and date

Standard IEC 62067, Subclause 12.5.3

Test date 3 April 2015

Characteristic test data

Temperature during ageing 110 ± 2 °C

Ageing duration 10 x 24 h (23 March to 2 April 2015)

Item	Unit	Requirement	Measured/determined
Without ageing			
Tensile strength	N/mm^2	≥ 12,5	38,1
Elongation at break	%	≥ 300	864
After ageing in air oven			
Tensile strength			
– value after ageing	N/mm^2	-	28,9
– variation	%	-	-24
Elongation at break			
– value after ageing	%	≥ 300	774
– variation	%	-	-10

Result

The object passed the test.

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

Standard and date

Standard IEC 62067, Subclause 12.5.4

Test date 3 April 2015

Characteristic test data

Temperature during ageing 100 ± 2 °C

Ageing duration 7 x 24 h (17 March to 24 March 2015)

Insulation

Item	Unit	Requirement	Measured/determined
Without ageing			
Tensile strength	N/mm^2	≥ 12,5	28,2
Elongation at break	%	≥ 200	559
After ageing in air oven			
Tensile strength			
value after ageing	N/mm^2	-	33,2
variation	%	± 25 max.	18
Elongation at break			
value after ageing	%	-	602
variation	%	± 25 max.	8

Oversheath

Item	Unit	Requirement	Measured/determined
Without ageing			
Tensile strength	N/mm^2	≥ 12,5	38,1
Elongation at break	%	≥ 300	864
After ageing in air oven			
Tensile strength			
value after ageing	N/mm^2	-	35,3
variation	%	-	-7
Elongation at break			
value after ageing	%	≥ 300	785
variation	%	-	-9

Result

The object passed the test.

4.5 Pressure test at high temperature on oversheath

Standard and date

Standard IEC 62067, Subclause 12.5.6

Test date 25 March 2015

Characteristic test data

Temperature 110 ± 2 °C

Heating time 6 h

Item	Unit	Requirement	Measured/determined
Depth of indentation	%	≤ 50	4

Result

The object passed the test.

4.6 Hot set test for XLPE insulation

Standard and date

Standard IEC 62067, Subclause 12.5.10
Test date 19 March 2015

Characteristic test data

Air temperature 200 ± 3 °C
Time under load 15 min
Mechanical stress 20 N/cm^2

Item	Unit	Requirement	Measured/determined
Elongation under load	%	≤ 175	63
Permanent elongation after cooling	%	≤ 15	-6

Result

The object passed the test.

4.7 Measurement of carbon black content of black PE oversheaths

Standard and date

Standard IEC 62067, Subclause 12.5.12

Test date 7 April 2015

Item	Unit	Requirement	Measured/determined
Carbon black content	%	2,5 ± 0,5	2,2

Result

The object passed the test.

4.8 Water penetration test

Standard and date

Standard IEC 62067, Subclause 12.5.14
Test dates 21 May to 3 June 2015

Environmental conditions

Ambient temperature 20-22 °C

Characteristic test data

Length of cable sample 8 m
Water height 1 m above cable centre
Heating method conductor current

No. of heating cycles	Required steady conductor temperature (°C)	Heating current during steady condition (A)	Heating cycle		
			Heating		Cooling
			Total duration (h)	Duration of conductor at steady temperature (h)	Total duration (h)
10	95 - 100	approx. 1675	≥ 8	≥ 2	≥ 16

Item	Unit	Requirement	Measured/determined
Water penetration under sheath	cm	≤ 400	Side 1, 12 cm Side 2, 13 cm
Water penetration conductor	cm	≤ 400	Side 1, 27 cm Side 2, 29 cm

Note

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

Result

The object passed the test.

4.8.1 Photograph of test set-up of water penetration test

4.9 Tests on components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath

Standard and date

Standard IEC 62067, Subclause 12.5.15

Test date 8 April 2015

Characteristic test data

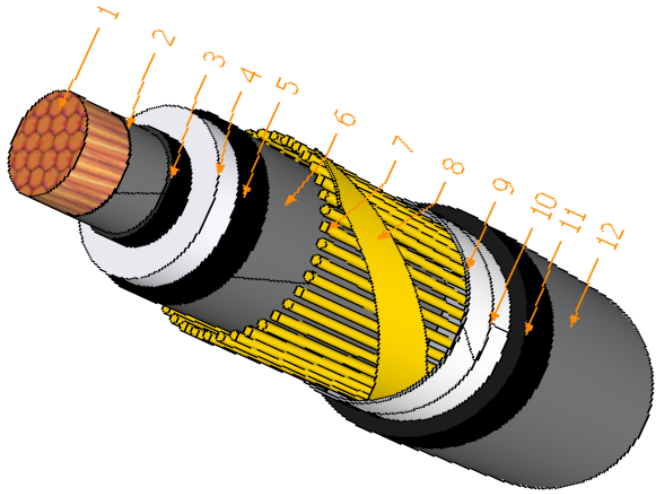
Length of cable sample 1 m

Item	Unit	Requirement	Measured/determined
Visual examination	-	No cracks or separations	No cracks or separations
Adhesion strength of metal foil	N/mm	≥ 0,5	0,5
Peel strength of overlapped metal foil	N/mm	≥ 0,5	0,8

Result

The object passed the test.

5 DRAWINGS



Size :	**1X 800**	*mm²*	*Type :*	**CU/XLPE/CW/HDPE**	
Voltage:	**127/ 220**	*kV*	*Standard:*	**IEC 62067,60228**	
Code :	**DB8-TX01-K70-17-00**		**ELSEWEDY CABLES**		
Sr.	Description			thickness *mm*	Diameter mm
1.	*Copper Conductor*				**34.5**
2.	**Semi conductive Tape**			**0.1**	
3.	**Extruded Inner semi conductive**			**1.4**	
4.	**XLPE insulation**			**22**	
5.	**Extruded Outer semi conductive**			**1.4**	
6.	**Semi conductive water blocking tape**			**0.3**	
7.	**Copper wires screen**			**77 x 1.43**	
8.	**Open Helix copper tape**			**0.1**	
9.	**Non conductive water blocking tape**			**0.3**	
10.	Aluminum laminated tape			**0.05/0.2/0.05**	
11.	**High density poly ethylene *(HDPE)***			**4**	
12.	**Graphite Coating**				**Approx.100.3**
Not to Scale	*Drawn by* *Mr. Hussieny ahmed*		*Approved by* ***Eng.*** *Ayman El kholy*		

6 MEASUREMENT UNCERTAINTY

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 x 10^{-5}
Partial discharge measurement:	
– < 10 pC	2 pC
– 10 to 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 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 x 10^{-4} I_i/I_u and 290 μrad
Calibration of voltage transformers	1,6 x 10^{-4} U_i/U_u and 510 μrad
Measurement of conductivity	5%
Measurement of temperature:	
– -50 to -40 °C	3 K
– -40 to125 °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%