



Interim  
 Final

## INSPECTION REPORT Nr 191

**BV Job nr: EGY.09.02.15.40**

<b>PROJECT:</b> type test for 1x 2500 mm <sup>2</sup> - CU/XLPE /CW/LEAD/HDPE 130/230 kV	<b>Ref:</b> ---
<b>BV Client:</b> EL SEWEDY CABLES EGYPT	<b>P/o nr:</b> N/A
<b>Manufacturer:</b> EL SEWEDY CABLES EGYPT	<b>P/o nr:</b> N/A
<b>Inspection requested by:</b> EL SEWEDY CABLES EGYPT	

SUPPLY / SUBJECT OF INSPECTION	ITEM / TAG Nr	QTY
1x2500 mm <sup>2</sup> - CU/XLPE /CW/LEAD/HDPE 130/230 kV	-	1 sample

**DOCUMENTS OF REFERENCE :** See continuation sheet for additional documents:  Yes  No

Title	Reference n°	Rev.	Approved by	Date
IEC 62067	-	--	Client	--
Kahrama specs.	GTC/372/2010	--	Client	--
IEC 60811-1-3	-	--	Client	--
IEC 60502	-	--	Client	--
IEC 60840	-	--	Client	--
BS 7912	-	--	Client	--

<p><b>INSPECTIONS :</b></p> <p><b><u>Inspection place &amp; Date or Period:</u></b>                  El Sewedy Factory, 10<sup>th</sup> of Ramadan City, period from 06/11/2010 to 06/12/2010</p> <p><b><u>Stage of inspection :</u></b></p> <p><input type="checkbox"/> Before manufacturing  <input type="checkbox"/> During manufacturing  <input checked="" type="checkbox"/> Final  <input type="checkbox"/> Packing</p> <p><b><u>Kind of inspection:</u></b></p> <p><input type="checkbox"/> Pre-inspection meeting  <input checked="" type="checkbox"/> Witnessing tests  <input checked="" type="checkbox"/> Final inspection  <input type="checkbox"/> Document review  <input type="checkbox"/> Expediting &amp; vendor assessment  <input type="checkbox"/> Packing</p> <p style="text-align: right;">(for details see continuation sheet) </p> <p><b><u>Stamping :</u></b></p> <p><input checked="" type="checkbox"/> No <input type="checkbox"/> <input type="checkbox"/></p>	<p><b><u>Results of inspection :</u></b> <input checked="" type="checkbox"/> Satisfactory <input type="checkbox"/> Unsatisfactory</p> <p><b><u>Non Conformities Reports (NCR):</u></b></p> <p>o NCR's issued during reported period : None</p> <p>o List of outstanding NCR's: None.</p> <p><b><u>Main Conclusions &amp; Remarks:</u></b> (for details see continuation sheet)</p> <p>All tests performed on the sample have satisfactory results.</p> <p><b><u>Next visit scheduled:</u></b> none.</p>
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## INSPECTION REPORT Nr 191

(continued)

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### Description of the inspections carried out:

- **Introduction:** El Sewedy Cables have requested Bureau Veritas Egypt to witness type tests for *1\*2500 mm<sup>2</sup> CU/XLPE/CW/LEAD/HDPE – 130/230 KV* at El Sewedy Cables factory located in Tenth of Ramadan City – Egypt. Further to this request, Bureau Veritas Egypt has attended the tests performed as mentioned in the time test schedule presented by El Sewedy Cables (see below).
- **Applicable Documents & Status of Approval :** Tests performed according to IEC62067.
- **Details of inspection activities carried out with respect to scope of work. Surveillance with reference to ITP** The tests have been performed according to the following schedule.

No.	Name of test	Applied code	Start date	End date
1	Bending test followed by partial discharge test	clause 12.4.4 & 12.4.5 of IEC 62067	06/11/2010	07/11/2010
2	Tan delta measurement	clause 12.4.6 of IEC62067	08/11/2010	08/11/2010
3	Heating cycle followed by partial discharge test	clause 12.4.7 of IEC 62067	09/11/2010	29/11/2010
4	Partial discharge test at ambient temperature	clause 12.4.5 of IEC 62067	30/11/2010	30/11/2010
5	Partial discharge test at high temperature	IEC 62067 clause 12.4.5	30/11/2010	30/11/2010

6	Lighting impulse voltage test followed by power frequency voltage test	clause 12.4.9 of IEC 62067	02/11/2010	02/11/2010
7	Resistivity of semi-conducting screens	Clause 12.4.11 of IEC 62067	14/11/2010	22/11/2010
8	Check of cable construction	clause 12.5.1 of IEC 62067	11/11/2010	11/11/2010
9	Tests for determining the mechanical properties of insulation before and after ageing	Clause 12.5.2 of IEC 62067	23/11/2010	30/11/2010
10	Tests for determining the mechanical properties of oversheath before and after ageing	Clause 12.5.3 of IEC 62067	14/11/2010	24/11/2010
11	Ageing tests on pieces of complete cable to check compatibility of materials	Clause 12.5.4 of IEC 62067	14/11/2010	21/11/2010
12	Pressure test at high temperature on oversheath	Clause 12.5.6 of IEC 62067	20/11/2010	20/11/2010
13	Hot set test for XLPE insulation	Clause 12.5.10 of IEC 62067	11/11/2010	11/11/2010
14	Measurement of carbon black content of black PE oversheaths	Clause 12.5.12 of IEC 62067	20/11/2010	20/11/2010
15	Water penetration test	Clause 12.5.14 & annex C of IEC 62067	21/11/2010	2/12/2010
16	Additional tests	Client requirement	05/12/2010	06/12/2010

## **ELECTRICAL TYPE TESTS**

A sample of complete cable 26 m in length was subjected to the following tests successively.

### **1. Bending test followed by partial discharge test**

The sample was bent around the hub of a drum (diameter = 5000 mm) at ambient temperature for one complete turn. Then it was unwound and the process repeated in reverse direction. This cycle of operation was carried out three times.

<b>Outer diameter of cable (D [mm])</b>	<b>Outer diameter of Conductor (d [mm])</b>	<b>Maximum permissible bending Diameter <math>25 (D + d) + 5\%</math> (mm)</b>	<b>Hub diameter of drum (mm)</b>	<b>Observations</b>
141.1	65	5410	5000	PASS

After this, the sample was subjected to a partial discharge test. The partial discharge was measured between the conductor and metallic screen. The voltage was applied between the conductor & metallic screen. The voltage was raised up to  $1.75 U_0$  for 10 sec. then slowly reduced to  $1.5 U_0$ . The magnitude of the discharge was not exceeding 5 pC at  $1.5U_0$  (195 KV). and was found to be acceptable.

<b>Applied Voltage (kV)</b>	<b>Measured Partial Discharge (pC )</b>	<b>Max Allowable PD (pC )</b>	<b>Result</b>
195	1.9	5	PASS

### **2. Tan delta measurement**

The sample was heated using a heating current until temperature reached  $5\text{ }^{\circ}\text{C}$  to  $10\text{ }^{\circ}\text{C}$  above the maximum conductor temperature in normal operation ( $95\text{ }^{\circ}\text{C}$  to  $100\text{ }^{\circ}\text{C}$ ). The tan delta was then measured with an alternating voltage of 130 kV at the above mentioned temperature, and the measured value was acceptable.

Applied voltage (kV)	Conductor Temperature (°C)	Measured Value of Tan $\delta$	Max Allowable value for Tan $\delta$	Result
130	97	$1.6 \times 10^{-4}$	$10 \times 10^{-4}$	PASS

### 3. Heating cycle test voltage test

The sample was heated by passing a current through the conductor until it reached a steady temperature 5 °C to 10 °C above the maximum conductor temperature in normal operation (95°C to 100°C). The heating cycle was of 24 hours duration. The conductor temperature was maintained within the above limits for at least 2 hours of each heating period. This was followed by 16 hours of natural cooling in air. This cycle was carried out twenty times. During the whole of the test period, a voltage of  $2U_0$  (260 kV) was applied to the assembly.

No. of Heat-cycles	Required Conductor Temperature (T) (°C)	Heating		Cooling	Result
		Total Heating Time (h)	Duration Conductor at 95 °C (h)	Cooling Time (h)	
20	95-100	8	2	16	PASS

### 4. Partial discharge test at ambient temperature

After completion of heating cycle test, the test object was subjected to a partial discharge testing accordance with clause 12.4.5 of IEC 62067. The partial discharge was measured between the conductor and metallic screen. The voltage was applied between the conductor & metallic screen. The voltage was raised up to  $1.75 U_0$  for 10 sec. then slowly reduced to  $1.5 U_0$ . The magnitude of the discharge was not exceeding 5 pC at  $1.5U_0$  (195 KV) .

Applied Voltage (kV)	Measured Partial Discharge (pC)	Max Allowable PD (pC)	Result
195	2	5	PASS

## 5. Partial discharge test at high temperature

The sample was heated up by passing a current through the conductor until the conductor reached a steady temperature of 95 °C to 100 °C and the conductor temperature was maintained within the stated temperature limits for 2 hours. The test object was subjected to a partial discharge test in accordance with clause 12.4.5 of IEC 62067. The voltage was raised gradually to and held at 1.75 U<sub>0</sub> for 10 sec. and then slowly reduced to 1.5 U<sub>0</sub>. The partial discharge was measured between the conductor & the metallic screen. The magnitude of the discharge at 1.5U<sub>0</sub> (195 KV) was not exceeding 5 pC.

Applied Voltage (kV)	Measured Partial Discharge (pC)	Max Allowable PD (pC)	Result
195	1.5	5	PASS

## 6. Lighting impulse voltage test followed by power frequency voltage test

This test was performed on the sample at a conductor temperature of 90 °C + 5-10°C.

The impulse voltage applied had a peak value of 1050 kV. The cable withstood without failure 10 positive and 10 negative voltage impulses.

Voltage and Polarity (kV)	Description	No. of voltage impulse	Result
+1050	Wave shape: 1.2/50 μ s	10	PASS
-1050	Wave shape: 1.2/50 μ s	10	PASS

After the impulse test, the sample was subjected, at ambient temperature, to a power frequency voltage test for 15 minutes. The test voltage was 260 kV. No breakdown of the insulation occurred.

Test Voltage KV	Duration (Min)	Result
260	15	PASS

## 7. Measurement of resistivity of semi-conducting screens

One test piece was prepared from a 150mm sample of complete cable before ageing, and another from sample of a cable which has been subjected to ageing as described in clause 12.5.4 of IEC 62067.

From each sample, the conductor screen test piece was prepared by cutting a sample of core in half longitudinally and removing the conductor and separator. The insulation screen test piece was prepared by removing all the covering from the sample of the core. Four electrodes were applied to the screens as per IEC 62067 Annex B, and the assembly was placed in an assembly pre-heated to the specified temperature (90°C) for 30 minutes. The resistance between the electrodes was measured, and the volume resistivity was calculated. The results were found acceptable for both samples. The results were found as follows:

Item	Unit	Required	Measured
Before ageing			
• Insulation screen	Ω.m	≤500	26
• Conductor screen	Ω.m	≤1000	79
After ageing			
• Insulation screen	Ω.m	≤500	27
• Conductor screen	Ω.m	≤1000	29

## NON-ELECTRICAL TYPE TESTS

### 1. Check of cable construction

The examination of the conductor and measurements of insulation, oversheath and metallic sheath thicknesses was carried out in accordance with clauses 10.4, 10.6 and 10.7 of IEC 62067. The result is acceptable.

Conductor examination: Annealed Copper conductor, 2500 mm<sup>2</sup> cross-section area, 5 segments+ central segment, 65 mm in diameter

Measurement of thickness of insulation:

Item		Unit	Specified	measured	Result
<b>Insulation thickness</b>	<b>nom.</b>	mm	23	23.3	Pass
	<b>Min.</b>	mm	20.7	22.96	Pass

Additionally,  $(t \text{ max} - t \text{ min}) / t \text{ max.} = 0.02$

Measurement of thickness of oversheath:

Item		Unit	Specified	measured	Result
<b>Oversheath thickness</b>	<b>Nom.</b>	mm	4.5	5.1	Pass
	<b>Min.</b>	mm	3.7	4.8	pass

Measurement of thickness of metallic sheath:

Item		Unit	Specified	measured	Result
<b>Lead sheath thickness</b>	<b>Nom.</b>	mm	3.5	3.52	Pass
	<b>Min.</b>	mm	3.2	3.31	pass



**2. Tests for determining the mechanical properties of insulation before and after ageing**

Item	unit	requirement	measured	Result
Without aging				
- Tensile strength	N/mm <sup>2</sup>	≥12.5	23.1	pass
- Elongation	%	≥200	506.4	pass
Ageing treatment:				
-Temperature	°C	135 ±3		
-Duration	Days	7		
After ageing in air oven				
- Tensile strength	N/mm <sup>2</sup>	NA	20.9	
-Maximum variation	%	± 25	- 9.5	pass
After ageing in air oven				
- Elongation	%	NA	543.9	
- Maximum Variation	%	± 25	7.4	pass

The result meets the requirements of IEC 62067 clause 12.5.2

**3. Tests for determining the mechanical properties of overshooth before and after ageing**

Item	unit	requirement	measured	Result
Without aging				
- Tensile strength	N/mm <sup>2</sup>	≥12.5	24.4	pass
- Elongation	%	≥300	905.3	pass
Ageing treatment:				
-Temperature	°C	110 ±2		
-Duration	Days	10		
After ageing in air oven				
- Elongation	%	≥300	467	pass

The result meets the requirements of IEC 62067 clause 12.5.3

#### 4. Ageing tests on pieces of complete cable to check compatibility of materials

Item	unit	requirement	measured	Result
Without ageing, insulation				
- Tensile strength	N/mm <sup>2</sup>	≥12.5	23.1	pass
- Elongation	%	≥200	506.4	pass
Without ageing, oversheath				
-tensile strength	N/mm <sup>2</sup>	≥12.5	24.4	pass
-elongation	%	≥300	905.3	pass
Ageing treatment: -Temperature -Duration	°C Days	100 ±2 7		
After ageing in air oven, insulation				
- Tensile strength	N/mm <sup>2</sup>	N/A	22.4	pass
-Maximum variation	%	± 25	- 3.1	
After ageing in air oven, insulation				
- Elongation	%	N/A	538.6	pass
- Maximum Variation	%	± 25	6.36	
After ageing in air oven, oversheath				
-tensile strength	N/mm <sup>2</sup>	N/A	--	
-Maximum variation	%	NA	--	
After ageing in air oven, oversheath				
-elongation	N/mm <sup>2</sup>	≥300	506.8	Pass
-maximum variation	%	N/A	--	

The result meets the requirements of IEC 62067 clause 12.5.4

#### 5. Pressure test at high temperature on oversheath

Pressure test sampling has been performed in accordance with IEC 60811-3-1 clause 8.2. A compression force calculated as in 8.2.4 of IEC 60811-3-1 was applied using an indentation device as described in 8.1.3 of IEC 60811-3-1. The test samples were then put in an oven at

110°C ± 2°C for a period of 6 hours. The test pieces were then rapidly cooled under load by spraying the test piece with cold water. The test pieces were then removed from the apparatus after cooling, and then further cooling by immersion in cold water. Indentation was measured using a measuring projector as described in 8.1.7 of IEC 60811-3-1, and was found to meet the requirements of 8.2.8 of IEC 60811-3-1.

Item	unit	requirement	measured	result
Indentation	%	≤ 50	15.2	pass

#### 6. Hot set test for XLPE insulation

item	unit	requirement	measured	result
-Temperature	C°	200 ± 3		
-Duration	min.	15		
- Elongation under load	%	≤175	65	pass
- permanent Elongation	%	≤15	3.1	pass

#### 7. Measurement of carbon black content of HDPE oversheath

item	unit	requirement	measured	result
- Carbon black content	%	2.5± 0.5	2.58	pass

#### 8. Water penetration test

A 8 m length of cable was subjected to water penetration test as per sampling procedure C.1 of Annex C of IEC 62067. The sample was subjected to the bending test as described in clause 12.4.4 of IEC 62067. A ring approximately 50 mm wide was removed from the centre of the length. This ring comprised all the layers external to the insulation screen. The sample was put in a water penetration device and left to stand for 24 hours, and then subjected to 10 heating cycles by passing current through the conductor, until the conductor reached a steady temperature 5°C to 10°C above the maximum conductor temperature in normal operation. The heating cycle was of 8 hours duration. The conductor temperature was maintained within the

stated temperature limits for at least 2 hours of each heating period. This was followed by 16 hours of natural cooling.

During the whole test period, no water emerged from the ends of the test sample. The result is acceptable.

## **ADDITIONAL TESTS**

### **•Measurement of insulation purity**

Test procedures according to KAHRAMAA Specs. GTC/372/2010 (Technical specifications for 220KV XLPE insulated cables & accessories)

A sample approximately 50mm long shall be taken from the cable core. This sample shall be cut into 25 wafers approximately 2mm thick. The entire area of each wafer shall be examined with a minimum 15 power magnification microscope by transmitted light.

The insulation shall be free from:

- a. Any void larger than 0.02mm, and no more than 10 voids in any area of 10mm x 10mm.
- b. Black and metallic particles larger than 0.08mm.
- c. Any contaminant (opaque material that is not homogeneous crosslinked polyethylene) larger than 0.125mm
- d. Any translucent material that is larger than 0.6mm

Result: satisfactory

### **•Measurement of insulation & screen moisture content**

Test procedures according to KAHRAMAA Specs. GTC/372/2010 (Technical specifications for 220KV XLPE insulated cables & accessories)

The moisture content of the insulation and the screen shall be measured using Karl Fischer titration method. Three measurements shall be taken from each of the two screens and the insulation.

Less than 150ppm of moisture should be detected in the extruded insulation.

Less than 500ppm shall be detected in the screens.

Result:

For insulation 90.27ppm, 92.73ppm, 98.62ppm

For outer screen 338.73ppm, 345.42ppm, 331.62ppm

For inner screen 83.14ppm, 85.92ppm, 83.7ppm

#### **•Measurement of semiconducting screen protrusions**

Test procedures according to KAHRAMAA Specs. GTC/372/2010 (Technical specifications for 220KV XLPE insulated cables & accessories)

The semiconducting and insulation screens shall be examined on the wafer samples. The contact surface between the screen and the insulation shall be cylindrical, smooth and free from protrusions and irregularities which extend more than 0.03mm into the insulation.

The outer screen of the cable core shall be removed from a 0.5m sample length. The sample shall be rendered transparent by immersion in a suitable heated fluid. The screen shall be examined for the presence of screen defects.

Result: satisfactory.

#### **•Impact test**

Test procedures according to BS 7912

The test shall be carried out at  $(20 \pm 15)^{\circ}\text{C}$  and performed by dropping a metallic weight of 5 Kg from a height of 1m on a cable sample 1m in length. One impact shall be successively made at five different points along the cable. The distance between two impact points shall exceed 100mm. At the impact point, the weight shall have a  $90^{\circ}$  corner angle with a 2mm radius of curvature. After the test, the sample shall be visually inspected and there shall be no evidence of:

Oversheath penetration;

Damage to the semiconducting screen i.e. penetration, loss of adhesion;

Permanent thinning of the insulation.

Result: satisfactory.

#### **•Shrinkage test for insulation**

Test procedures according to IEC 60811-1-3 and acceptance criteria according to IEC 60840

Oven temperature:  $130^{\circ}\text{C}$

Duration: 6 hrs

Max. permissible shrinkage: 4%

Result: the percentage shrinkage 1%

**•Shrinkage test for sheath**

Test procedures according to IEC 60811-1-3 and acceptance criteria according to IEC 60502

Oven temperature: 80°C

heating, duration: 5 hrs

heating, cycles: 5

Max. permissible shrinkage: 3%

Result: the percentage shrinkage 1%

➤ **Results of Inspection:** All tests have been performed with satisfactory results.

➤ **Problems pending :** None

ANNEXES  Yes  No

**Inspected by:**

Name: Akram Mortada

Mohamed Hamdy

Date of issue: 08/12/2010

**Inspection centre:** BV CAIRO



**Checked by:**

Name: Medhat Mounir

Signature

Distribution:  CLIENT  MANUFACTURER