Industry & Facilities Division	Page: 1/12
	☐ Interim ☒ Final

INSPECTION REPORT Nr 164

BV Job nr: EGY.09.02.15.40

PROJECT: N/A.	***Ref:*** ---
BV Client: EL SEWEDY CABLES EGYPT	***P/o nr: N/A***
Manufacturer: EL SEWEDY CABLES EGYPT	***P/o nr: N/A***
Inspection requested by: EL SEWEDY CABLES EGYPT	

SUPPLY / SUBJECT OF INSPECTION	ITEM / TAG Nr	QTY
Type tests for 1x500 mm^2 CU/XLPE/LEAD/LLDPE – 87/150 KV	-	1 sample

DOCUMENTS OF REFERENCE *: See continuation sheet for additional documents:* ☐ *Yes* ☒ *No*				
Title	Reference n°	Rev.	Approved by	Date
IEC 60840	-	-	CLIENT	-

INSPECTIONS :

Inspection place & Date or Period:
El Sewedy Factory, 10th of Ramadan City, period from 08/09/2010 to 08/10/2010.

Stage of inspection **:**

- ☐ Before manufacturing
- ☐ During manufacturing
- ☒ Final
- ☐ Packing

Kind of inspection:

- ☐ Pre-inspection meeting
- ☒ Witnessing tests
- ☒ Final inspection
- ☒ Document review
- ☐ Expediting & vendor assessment
- ☐ Packing

(for details see continuation sheet)

Stamping **:**

☒ No ☐ ☐

Results of inspection **:** ☒ Satisfactory ☐ Unsatisfactory

Non Conformities Reports (NCR):

o NCR's issued during reported period : None

o List of outstanding NCR's: None.

Main Conclusions & Remarks: (for details see continuation sheet)

All tests performed on the sample have satisfactory results.

Next visit scheduled**: none.**

INSPECTION REPORT Nr 140

(continued)

BV Job nr: EGY.09.02.15.40

Description of the inspections carried out:

- **Introduction** *:* El Sewedy Cables Egypt has requested Bureau Veritas Egypt to witness type tests for 1x500*mm²* *CU/XLPE/LEAD/LLDPE – 87/150 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 IEC60840.
- **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	IEC 60840 clause 12.3.3 & 12.3.4	08/09/2010	08/09/2010
2	Tan delta measurement	IEC 60840 clause 12.3.5	09/09/2010	09/09/2010
3	Heating cycle voltage test	IEC 60840 clause 12.3.6	15/09/2010	04/10/2010
4	Partial discharge test at ambient temperature	IEC 60840 clause 12.3.4	05/10/2010	05/10/2010

5	Partial discharge test at high temperature	IEC 60840 clause 12.3.4	05/10/2010	05/10/2010
6	Impulse test followed by a voltage test	IEC 60840 clause 12.3.7	07/10/2010	07/10/2010
7	Check of cable construction	IEC 60840 clause 12.4.1	08/09/2010	08/09/2010
8	Determination of the mechanical properties of insulation before and after ageing	IEC 60840 clause 12.4.2	09/09/2010	16/09/2010
9	Determination of the mechanical properties of sheath before and after ageing	IEC 60840 clause 12.4.3	09/09/2010	19/09/2010
10	Additional ageing test on pieces of complete cables	IEC 60840 clause 12.4.4	09/09/2010	16/09/2010
11	Hot set test for XLPE insulation	IEC 60840 clause 12.4.10	08/09/2010	08/09/2010
12	Measurement of carbon black content	IEC 60840 clause 12.4.12	08/09/2010	09/09/2010
13	Shrinkage test for XLPE insulation	IEC 60840 clause 12.4.13	08/09/2010	08/09/2010
14	Shrinkage test for LLDPE sheath	IEC 60840 clause 12.4.14	08/09/2010	09/09/2010
15	Volume resistivity for semi-conductive screens	IEC 60840 Clause 12.3.9	17/09/2010	17/09/2010
16	Water penetration test	IEC 60840 Clause 12.4.18	20/09/2010	30/09/2010

ELECTRICAL TYPE TESTS

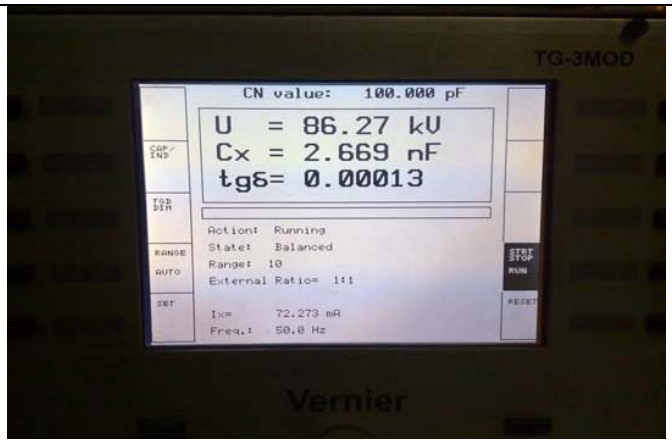
A sample of complete cable 12 m in length was subjected to the following tests successively.

1. Bending test followed by partial discharge test

The sample was bent around the hub of a drum (diameter = 2880 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. After this, the sample was subjected to a partial discharge test. The partial discharge was measured between conductor and metallic screen. The partial discharge measured was 1.07pC. The result was acceptable.

2. Tan delta measurement

The sample was heated using a heating current until temperature reached 5 °C to 10 °C above the maximum conductor temperature in normal operation (90 °C + 5-10°C). The tan delta was then measured with an alternating voltage of 87 kV at the above mentioned temperature, and the measured value was 1.3 $x10^{-4}$. The result was acceptable.



3. <u>Heating cycle test</u>

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 (90 °C + 5-10°C). The heating cycle was of 24 hours duration (8 hours heating period and 16 hours cooling period). The conductor's 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 174kV was applied.

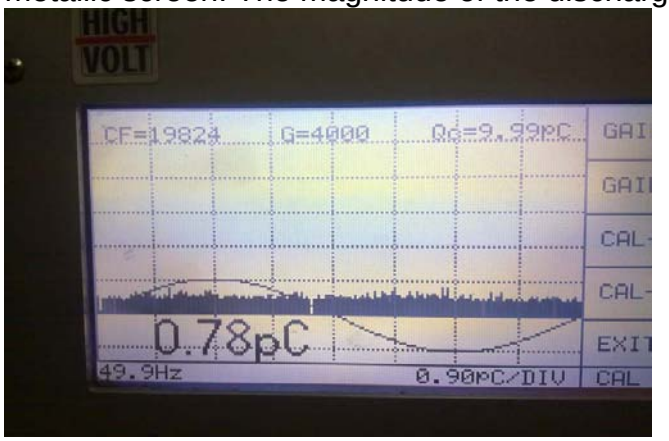
4. <u>Partial discharge test at ambient temperature</u>

After completion of heating cycle test, the sample was subjected to a partial discharge testing in accordance with clause 12.3.4 of IEC 60840. 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 U0 for 10 sec. then slowly reduced to 1.5 U0. The partial discharge measured was 1.37pC. The result was acceptable.

5. <u>Partial discharge test at high temperature</u>

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 (90

°C + 5-10°C) and the conductor temperature was maintained within the stated temperature limits for 2 hours. The sample was subjected to a partial discharge test in accordance with clause 12.3.4 of IEC 60840. The partial discharge was measured between the conductor & the metallic screen. The magnitude of the discharge at 131 KV was 0.78 pC**.**



6. <u>Impulse test followed by a voltage test.</u>

The test was performed at temperature 5 °C to 10 °C above the maximum conductor temperature in normal operation (90 °C + 5-10°C). The voltage applied had a peak value of 750 kV. 10 positive and 10 negative voltage impulses were applied without failure.

After the impulse test, the sample was subjected, at ambient temperature, to a power frequency voltage test for 15 minutes. The test voltage was 218 kV. No breakdown of the insulation or flashover occurred.

NON-ELECTRICAL TYPE TESTS

1. Check of cable construction

Cable construction was checked as per below table and was found acceptable.

Item	Unit	Required	Measured/ Determined	Result
Conductor (IEC 60228 Class2) No. of wires Diameter of conductor	 Mm	 61 26.6	 61 26.64	 Passed Passed
Thickness of insulation Average Thickness Min. Thickness Eccentricity Thickness of insulation screen (av./min.) Thickness of conductor screen (av./min.)	 mm mm % mm mm	 20 18 15 1.2/1.1 1.2/1.1	 20.63 20.59 0.19 1.45/1.35 1.35/1.32	 Passed Passed Passed Passed Passed
Taping: **Dimension of SCWBT**	mm	1x70x1.5	1x70x1.5	Passed
Thickness of metallic sheath (LEAD) Average Thickness Min. Thickness	 mm mm	 3.7 3.6	 3.73 3.6	 Passed Passed
Thickness of sheath Average Thickness Min. Thickness	 mm mm	 3.7 3.1	 4.32 4.03	 Passed Passed

2. Determination of the mechanical properties of insulation before and after ageing

Ten Dumb-bell test pieces were prepared from insulation, and then five pieces were subjected to ageing in an oven at a temperature of 135°C ± 3 °C for 7 days.

Minimum tensile strength, minimum elongation at break for insulation before ageing, as well as maximum tensile strength variation and maximum elongation at break variation for insulation after ageing passed the requirements of IEC 60840. Results are expressed in the below table:

Item	Unit	Required	Measured
Before ageing			
1- tensile strength min.	N/mm^2	≥12.5	18.89
2-elongation min.	%	≥200	651.15

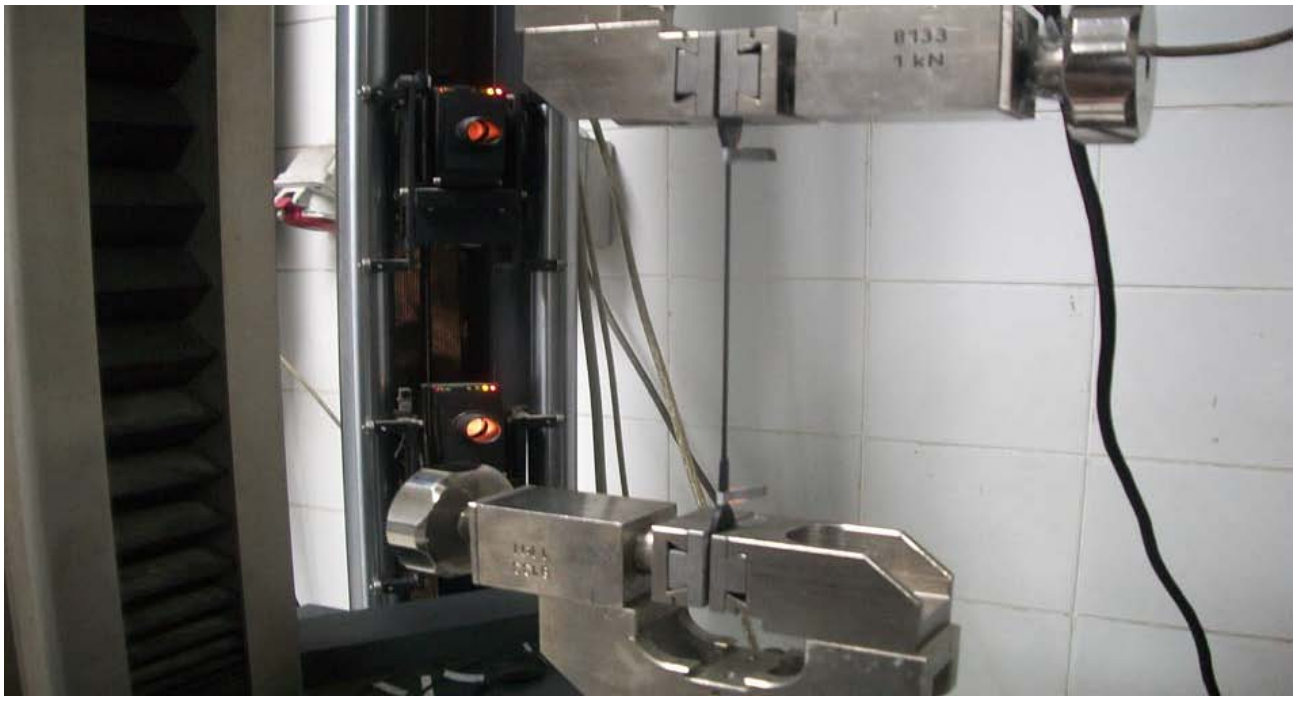
After ageing 1- tensile strength • Value after ageing min. • Variation Max. 2- Elongation At Break • Value after ageing min. • Variation Max.	 N/mm^2 % % %	 N.A ± 25 N.A ± 25	 18.97 +15.41 661.05 +4.56

3. <u>Determination of the mechanical properties of sheath before and after ageing.</u>

Ten Dumb-bell test pieces were prepared from sheath, and then five pieces were subjected to ageing in an oven at a temperature of 100°C ± 2 °C for 10 days.

Minimum tensile strength, minimum elongation at break for sheath before ageing, as well as minimum elongation at break for sheath after ageing passed the requirements of IEC 60840. Results are expressed in the table below:

Item	Unit	Required	Measured
Before ageing 1- tensile strength min. 2-elongation min.	 N/mm^2 %	 ≥10 ≥300	 20.74 1027.95
After ageing Minimum Of Elongation.	 %	 300	 893.6



4. Additional ageing test on pieces of complete cables

Three pieces of complete cable about 200mm long were taken, and suspended vertically in the oven at a temperature of 100°C ± 2 °C for 7 days. After the heating period, Dumb-bell test pieces were prepared from samples of sheath and insulation removed from the conductors, cutting it open in the direction of the axis of the core. Dumb-bell test pieces from sheath and insulation before ageing treatment were also prepared, as described in 8.1.4 of IEC 60811-1-2 Maximum variation of tensile strength, and elongation of XLPE insulation, as well as minimum elongation at break for LLDPE oversheath passed the requirements of IEC 60840. The results are expressed in the table below:

Item	Unit	Required	Measured
Insulation • Max. variation of tensile strength	%	±25	- 6.30
• Max. variation of elongation	%	±25	-0.02
Oversheath • Min. elongation at break	%	300	925.82

5. Hot set test for XLPE insulation

Three dumb-bell test pieces were prepared from insulation and suspended in an oven at 200 °C with weights attached to the lower grip to exert a force of 20N/cm2 for a period of 15 minutes. Maximum elongation under load was measured and was found 73%, 65% & 60%. The weights were then removed and test pieces were left to recover in the oven for 5 minutes, and then allowed to cool to ambient temperature. Maximum permanent elongation after cooling was measured and was found 3.5%, 3% & 3%.

The results meet the requirements of IEC 60840.

6. Measurement of carbon black content

Carbon black content of LLDPE sheath was measured using the direct combustion method as described in IEC 60811-4-1 and was found 2.85%. The result meets requirement of IEC 60840 clause 12.4.12.2.

7. Shrinkage test for XLPE insulation

A 300mm sample of each core was taken and all coverings were removed. The test length of 200mm was marked on the middle part of the core, and then the insulation was cut and removed from both ends 5mm away from the mark. The test piece was supported horizontally in an air oven at a temperature of 130°C ± 3 °C for 6 hour, and then allowed to cool in air to room temperature. The distance between the two marks was measured. Maximum shrinkage was found 2.36%. The result meets the requirement of IEC 60840.

8. Shrinkage test for LLDPE sheath

A 50cm sample was taken. The test pieces were then put into an oven pre-heated at 80°C ±2 °C for five heating cycles, 5 hours each, allowing the each piece to cool to room temperature between cycles. The distance between the two marks was measured at the end of the cycles. Maximum shrinkage was found 2%. The result meets the requirement of IEC 60840.

9. 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 12.4.4 of IEC 60840.

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 60840 Annex D, and the assembly was placed in an assembly pre-heated to the specified temperature (90°C ±2 °C) for 30 minutes. The resistance between the electrodes was measured, and the volume resistivity was calculated. The results were found acceptable as follows:

Item	Unit	Required	Measured
Before ageing			
• Insulation screen	Ω.m	≤500	0.056
• Conductor screen	Ω.m	≤1000	1.78
After ageing			
• Insulation screen	Ω.m	≤500	0.952
• Conductor screen	Ω.m	≤1000	8.35

10. Water Penetration test

This test was performed on a 6 meter sample which has been subjected to the bending test and placed horizontally. A ring approximately 50mm wide was removed from the center of the length, removing all layer external to the insulation screen.

The sample was placed in the tube which was filled in 5 minutes with water at ambient temperature. The sample was allowed to stand for 24 h. Then the sample was subjected to 10 heating cycle. The conductor was heated until it has reached a steady temperature 5 °C to 10 °C above the maximum conductor temperature in normal operation.

During each cycle, the heating was applied for 8 hours. The conductor temperature was maintained within the stated temperature limits for at least 2 h of each heating period. This was followed by 16 h of natural cooling.

During the period of testing, no water emerged from the ends of the test piece.

- **Results of Inspection**: ***All tests have been performed with satisfactory results.***
- **Problems pending** : None

ANNEXES ☒ *Yes* ☐ *No*

Inspected by:

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Mostafa El Sayed

Akram Mortada Akram Mortada

Date of issue: 04/11/2010

Inspection centre: BV CAIRO

BUREAU VERITAS CAIRO(34) MIDDLE EAST REGION

Checked by:

Name: Medhat Mounir

Signature

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