AUTORISATION D'EMPLOI

N° 0005E2023

Identification du fabricant	
Nom ou raison sociale	**EL SEWEDY CABLES Algérie**
Adresse N° tél / N° fax :	**Zone Industrielle Ain Defla Algérie**

- Vu l'autorisation d'emploi provisoire **N° 0064E2021** délivrée en date du**02/12/2021** par la CAEMEG (PV de réunion CAEMEG N° **06/CAEMEG/2021** du **02/12/2021**)
- Vu le comportement satisfaisant en exploitation durant l'année de mise en exploitation du matériel ci-dessous désigné

La Commission (PV de la CAEMEG N° **01/CAEMEG/2023 du 17/01/2023**) accorde une autorisation d'emploi d'une durée de quatre (04) années pour l'utilisation, sur les réseaux de Distribution d'électricité, du matériel suivant :

Identification du fabricant	
Désignation	Transformateur de distribution à huile hermetique,30 kV,630 kVA,type Oval
Normes ou spécifications	CEI 60076 , Specification Technique
Type ou référence	630KVA-30-0.4
Fabricant	EL SEWEDY CABLES Algérie
Unité de production	Zone Industrielle Ain Defla Algérie

- *Le fabricant demeure seul responsable du maintien des caractéristiques et performances de ce matériel pour sa fabrication en série industrielle.*
- *Cette autorisation ne soustrait pas le fabricant des essais contractuels qui pourraient être demandés par l'utilisateur, lors de la réception ou à la livraison du matériel fourni à ce dernier.*
- *La présente autorisation ne donne aucun droit, à son titulaire, au bénéfice d'une quelconque part de marché, pour ce type de matériel, auprès des filiales du groupe Sonelgaz. Pour ce faire, le fabricant doit participer aux appels d'offres lancés par ces dernières ou toutes autres dispositions conformes à la réglementation des marchés en vigueur.*
- *En outre, la récurrence de l'absence de participation du fabricant aux appels d'offres, lorsqu'il est sollicité par les filiales du groupe Sonelgaz, entraineront le retrait automatique de cette autorisation, et ce sans préjudice de tous dommages et intérêts qui pourraient être réclamés par le fabricant.*

Date d'effet : 17/01/2023

Date d'expiration : 16/01/2027

Le Directeur Qualification et Laboratoires

EZZIANE

F. EZZIANE

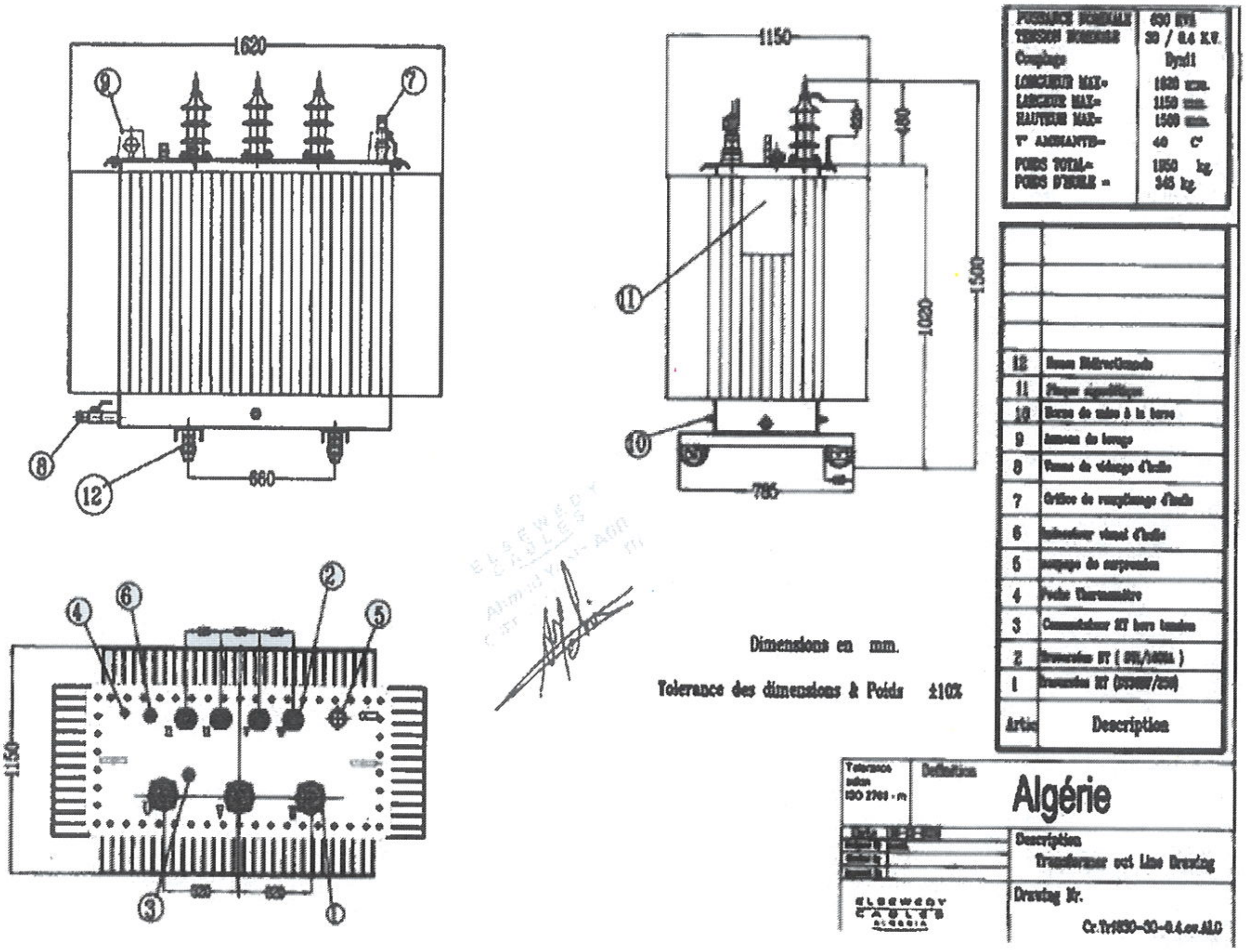
Sonelgaz-Services, Direction Qualification et Laboratoires
Adresse : Route National N°38 - Gué de Constantine - Alger, Algérie
Tél. : 023.61.25.28
Société du Groupe SONELGAZ

Fiche technique jointe à l'autorisation d'emploi N°0005/E/2023 du 17/01/2023
Transformateur de distribution hermétique 630 kVA 30/ 0.4 kV, type Oval
de fabrication EL SEWEDY-Algérie

Caractéristiques Techniques	Spécification	Fabricant
Pays	Algérie	
Fabricant	EL SEWEDY - Algérie	
Usine de fabrication	Zone d'activités Ain Defla - Algérie	
Normes de références	CEI 60076 1-5 et spécification Sonelgaz STS 160 12/2000	
Lieu d'installation	Intérieur	
Type de transformateur	Hermétique	
Mode de refroidissement	ONAN	
Nature du diélectrique	Huile minérale	
Type d'enroulement HTA	Fil cuivre émaillé	
Type d'enroulement BT	Fil méplat cuivre	
Fréquence	50Hz	
Prise de réglage	±2x2.5%	
Tension secondaire à vide	400V	
Tension la plus élevée pour le matériel	36kV	
Tension d'isolement BT masse	10kV	
Tension d'isolement à fréquence industrielle	70kV	
Tension d'isolement à l'onde de choc HTA	170kV	
Courant à vide	2,9 %	2.9 %
Pertes à vide	1400 W	1400 W
Tension de court circuit à 75°	6%	6%
Pertes en court circuit à 75°C	8820 W	8820 W
Couplage	Dyn11	Dyn11
Température ambiante	40°C	40°C
Echauffement moyen des enroulements	65 K	65 K
Echauffement maximum de l'huile	60 K	60 K
Niveau de bruit	69 dB	69 dB
Type de bornes HTA	Porcelaine ou embrochable	Porcelaine ou embrochable
Type de bornes BT	Porcelaine	Porcelaine
Distances entre les traversées HTA	320 mm	320 mm
Encombrements et masse maximum		
Longueur	1750 mm	1620 mm
Largeur	980 mm	1150 mm
Hauteur	1900 mm	1500 mm
Masse d'huile		345 kg
Masse totale	2070 kg	1950 kg
Dispositions des bornes BT	Sur le couvercle	Sur le couvercle
Repérage des bornes	Symboles sur le couvercle	Par plaques métalliques sur le couvercle

2/3

Schéma joint à l'autorisation d'emploi N°0005/E/2023 du 17/01/2023
Transformateur de distribution hermétique 630 kVA 30/ 0.4 kV, type Oval
de fabrication EL SEWEDY-Algérie



3/3

الشركة الجزائرية للكهرباء والغاز - الخدمات
Société Algérienne de l'Electricité et du Gaz - Services

AUTORISATION D'EMPLOI N° 0009E2023

Identification du fabricant

Nom ou raison sociale	EL SEWEDY CABLES Algérie
Adresse N° tél / N° fax :	Zone Industrielle Ain Defla Algérie

- Vu l'autorisation d'emploi provisoire N° **0068E2021** délivrée en date du**02/12/2021** par la **CAEMEG** (PV de réunion CAEMEG N° **06/CAEMEG/2021** du **02/12/2021**)
- Vu le comportement satisfaisant en exploitation durant l'année de mise en exploitation du matériel ci-dessous désigné

La Commission (PV de la CAEMEG N° **01/CAEMEG/2023 du 17/01/2023**) accorde une autorisation d'emploi d'une durée de quatre (04) années pour l'utilisation, sur les réseaux de Distribution d'électricité, du matériel suivant :

Identification du fabricant

Désignation	Transformateur de distribution à huile hermetique,30 kV,1000 kVA
Normes ou spécifications	CEI 60076 , Specification Technique
Type ou référence	1000KVA-30-0.4
Fabricant	EL SEWEDY CABLES Algérie
Unité de production	Zone Industrielle Ain Defla Algérie

- Le fabricant demeure seul responsable du maintien des caractéristiques et performances de ce matériel pour sa fabrication en série industrielle.

- Cette autorisation ne soustrait pas le fabricant des essais contractuels qui pourraient être demandés par l'utilisateur, lors de la réception ou à la livraison du matériel fourni à ce dernier.

- La présente autorisation ne donne aucun droit, à son titulaire, au bénéfice d'une quelconque part de marché, pour ce type de matériel, auprès des filiales du groupe Sonelgaz. Pour ce faire, le fabricant doit participer aux appels d'offres lancés par ces dernières ou toutes autres dispositions conformes à la réglementation des marchés en vigueur.

- En outre, la récurrence de l'absence de participation du fabricant aux appels d'offres, lorsqu'il est sollicité par les filiales du groupe Sonelgaz, entraineront le retrait automatique de cette autorisation, et ce sans préjudice de tous dommages et intérêts qui pourraient être réclamés par le fabricant.

Date d'effet : 17/01/2023

Date d'expiration : 16/01/2027

Le Directeur Qualification et Laboratoires

F. SEZIANE

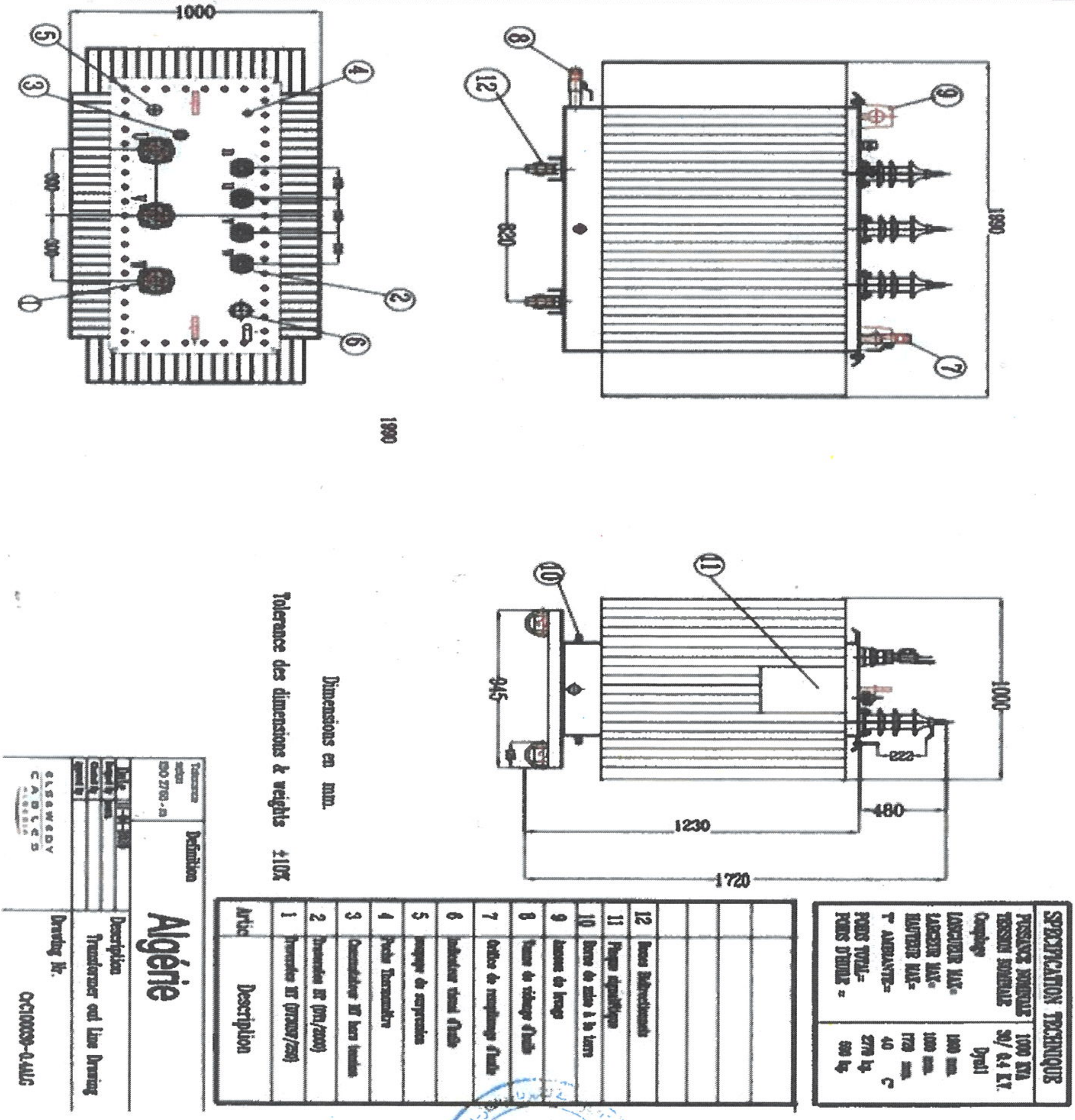
Sonelgaz-Services, Direction Qualification et Laboratoires
Adresse : Route National N°38 - Gué de Constantine - Alger, Algérie
Tél. : 023.61.25.28
Société du Groupe SONELGAZ

Fiche technique jointe à l'autorisation d'emploi N°0009/E/2023 du 17/01/2023
Transformateur de distribution hermétique 1000 kVA 30/ 0.4 kV
de fabrication EL SEWEDY-Algérie

Référence du Fabricant	
Pays	Algérie
Fabricant	EL SEWEDY CABLES -Algérie
Usine de fabrication	Zone d'activités Ain DEFLA -Algérie
Caractéristiques Techniques	
Normes de références	CEI 60076 1-5
Lieu d'installation	Extérieur ou intérieur
Type de transformateur	Hermétique
Mode de refroidissement	ONAN
Nature du diélectrique	Huile minérale
Type d'enroulement MT	cuivre
Type d'enroulement BT	Cuivre
Fréquence	50 Hz
Puissance nominale	1000 KVA
Prise de réglage	±2x2,5%
Tension secondaire à vide	400 V
Tension la plus élevée pour le matériel	1 KV
Tension d'isolement BT masse	10 kv
Tension primaire	30 KV
Tension la plus élevée pour le matériel	36 KV
Tension d'isolement à fréquence industrielle(1 min)	70 kv
Tension d'isolement à l'onde de choc MT	170 kv
Courant nominal au primaire	19.25 A
Courant nominal au secondaire	1443.4 A
Pertes à vide	1900 w
Tension de court-circuit à 75°	6 %
Pertes en court-circuit à 75° C	13000 w
Couplage	Dyn11
Température ambiante	40C°
Echauffement moyen des enroulements	65 C°
Echauffement maximum de l'huile	60 C°
Type de bornes MT	porcelaine
Type de bornes BT	porcelaine
Encombrements et masse maximum	
Longueur max	1990 mm
Largeur max	1000 mm
Hauteur max	1720
mm Masse d'huile	590 Kg
Masse totale	2770 kg
Dispositions des bornes BT	Sur le couvercle
Repérage des bornes	Par plaques métalliques sur le couvercle

Direction Qualification & Laboratoires Sonelgaz - Services
Société Algérienne de l'Electricité et du Gaz-Services

Schéma joint à l'autorisation d'emploi N°0009/E/2023 du 17/01/2023
Transformateur de distribution hermétique 1000 kVA 30/ 0.4 kV
de fabrication EL SEWEDY-Algérie



مديرية التاهيل والمختبرات
Direction Qualification & Laboratoires
3/3

الشركة الجزائرية للكهرباء والغاز - الخدمات
Société Algérienne de l'Electricité et du Gaz - Services

AUTORISATION D'EMPLOI

N° : 0111E2022

Identification du fabricant	
Nom ou raison sociale	**El Sewedy Câble Algérie**
Adresse : N° tél / N° fax : Email :	**Zone Industrielle de Ain Defla - Algérie** **Tel : 027 59 15 85 / Fax : 027 51 20 68** **algeria@elsewedy.com**

- Vu l'autorisation d'emploi **N° 0123/2019** délivrée en date du **24/06/2019** par la CARAMEG (PV de réunion **N°03/2019 du 24/06/2019**)
- Vu le comportement satisfaisant en exploitation durant les trois (03) années de mise en exploitation du matériel ci-dessous désigné

La Commission (PV de la CAEMEG N° **04/CAEMEG/2022 du 09/08/2022**) reconduit l'autorisation d'emploi pour une durée de quatre (04) années pour l'utilisation, sur les réseaux de Distribution d'électricité, du matériel suivant :

Identification du matériel	
Désignation	Câbles BT en Cu type U1000 R2V : (2x6, 4x6, 2x10, 4x10, 4x25, 4x50, 3x70+35, 3x95+50, 3x150+70, 1x120 et 1x240) mm^2.
Normes ou spécifications	CEI 60502-1
Type ou référence	U1000 R2V
Fabricant	El Sewedy Câble Algérie
Unité de production	Zone Industrielle de Ain Defla - Algérie

- *Le fabricant demeure seul responsable du maintien des caractéristiques et performances de ce matériel pour sa fabrication en série industrielle.*
- *Cette autorisation ne soustrait pas le fabricant des essais contractuels qui pourraient être demandés par l'utilisateur, lors de la réception ou à la livraison du matériel fourni à ce dernier.*
- *La présente autorisation ne donne aucun droit, à son titulaire, au bénéfice d'une quelconque part de marché, pour ce type de matériel, auprès des filiales du groupe Sonelgaz. Pour ce faire, le fabricant doit participer aux appels d'offres lancés par ces dernières ou toutes autres dispositions conformes à la réglementation des marchés en vigueur.*
- *En outre, deux absences successives de participation du fabricant aux appels d'offres, lorsqu'il est sollicité par CAMEG ou les filiales du groupe, entraineront le retrait automatique de cette autorisation, et ce sans préjudice de tous dommages et intérêts qui pourraient être réclamés par le fabricant.*

Date d'effet : 09/08/2022

Date d'expiration : 08/08/2026

Le Directeur Qualification et Laboratoires

Direction Qualification & Laboratoires
Sonelgaz - Services
Société Algérienne de l'Electricité et du Gaz

F. EZZIANE

Sonelgaz-Services, Direction Qualification et Laboratoires
Adresse : Route National N°38 - Gué de Constantine - Alger, Algérie
Tél. : 023.61.25.28
Société du Groupe SONELGAZ

Fiche technique jointe à l'Autorisation d'Emploi N°0111E2022 du 09 août 2022 du Câble BT en Cuivre isolé au PR type U1000R2V de fabrication EL SEWEDY CABLE - ALGERIE

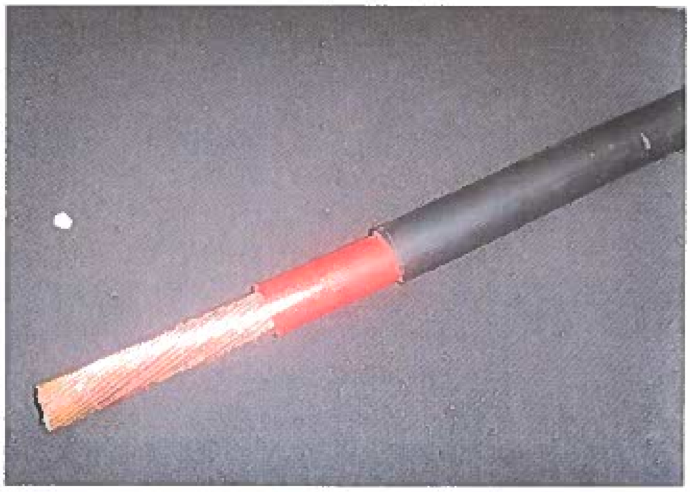
Caractéristiques techniques

Caractéristiques	Unité	Valeurs			
Section	mm^2	4×50	3×70 + 35	3× 95 + 50	3×150 + 70
Ame conductrice					
- Composition :		Cuivre	Cuivre	Cuivre	Cuivre
- Diamètre sur conducteur :					
- Phase	mm	8.2	10.1	11,3	14,5
- Neutre	mm	-	7.0	8,2	10
- Résistance linéique à 20°C (Ph/N)	Ω/km	0,387	0,268/0,524	0,193/0,387	0,124/0,268
Enveloppe isolante					
- Isolant XLPE		Oui	Oui	Oui	Oui
- Epaisseur nominale isolant (Ph/N)	mm mm	1	1,1/0.9	1,1/1	1,4/1,1
Diamètre sur isolant (Ph/N)	mm	11	12.3/8.7	13,1/10,2	17,5/12,4
Gaine de bourrage					
- Bourrage		Oui	Oui	Oui	Oui
Gaine extérieure					
- Gaine PVC		Oui	Oui	Oui	Oui
- Epaisseur nominale	mm	1.8	1.9	2.1	2.3
Câble terminé					
- Rayon de courbure	mm	235	265	285	350

2/3

Photo jointe à l'Autorisation d'Emploi N°0111E2022 du 09 août 2022 du Câble BT en Cuivre isolé au PR type U1000R2V de fabrication EL SEWEDY CABLE - ALGERIE

Câbles BT isolés au PR 3x 95 + 50



Câbles BT isolés au PR 1x240

- **Marquage :**

- Empreinte du fabricant : ELSEWEDY CABLE ALG

- Référence : Cu /PR / PVC

- Année de fabrication : xxxx

- Norme : CEI 502

3/3

केन्द्रीय विद्युत अनुसंधान संस्थान
(भारत सरकार की सोसाइटी, विद्युत मंत्रालय)
प्रो.सर.सी.वी. रामन रोड, सदाशिवनगर डाक घर, पो.बा.सं. 8066, बेंगलूरु – 560 080
CENTRAL POWER RESEARCH INSTITUTE
(A.Govt.of India Society, Ministry of Power)
Prof. Sir C.V. Raman Road, Sadashivanagar Post Office, P.B. No. 8066, Bengaluru - 560 080 India
वेब सइट / website :http://www.cpri.in

E-mail : meena@cpri.in

CABLES & DIAGNOSTIC DIVISION

CABLES LAB

CDD/CAB/1/2018-19 **Date: 03.05.2019**

ELSEWEDY ELECTRIC ALGERIE
Siège social: 153, Rue Ali Khoudja, El Biar – Alger
Unités de production: Zone industrielle Ain Defla – Algeria

Kind Attention : **Mr. OULDSAID Hammou, CHEF DE SERVICE ACHATS.**
Sub: Type Test on 1X 240 sq.mm 18/30 kV Cable

Dear Sir,

With reference to above, type test on 1X 240 sq.mm 18/30 kV cable as per IEC 60502-2 has been completed and Our test report No. CPRIBLRCAB19T0136 Dated: 29.04.2019 is enclosed.

In order to prevent tampering of test report, CPRI has introduced hologram on the first page of the test report with effect from 01.10.2007.

Any discrepancy in these test reports may be brought to notice within forty five days from the date of issue of test reports. Please acknowledge the receipt of the test report.

Thanking you

Yours faithfully

(K.P.Meena)
Joint Director

CPRI

TEST REPORT

Central Power Research Institute

(A Govt.of India Society,)
P.B. No.8066, Sadashivanagar Post Office
Prof. Sir.C.V. Raman Road,
Bangalore - 560 080(INDIA)

CENTRAL POWER RESEARCH INSTITUTE

CPRI

TYPE TEST CERTIFICATE

Test Certificate Number	:	**CPRIBLRCAB19T0136 Dated: 29.04.2019**
Name and Address of the Customer	:	Elsewedy Electric Algeria, Zone Industrielle Aindefla 44000- Algeria
Name and Address of the Manufacturer	:	Elsewedy Electric Algeria, Zone Industrielle Aindefla 44000- Algeria
Particulars of Sample Tested	:	18/30 (36) kV, 1C x 240 sq.mm XLPE insulated, PE sheathed cable
		Conductor : Stranded Circular Compacted Aluminium (Class 2)
		Size : 240 sq.mm
		Number of cores : One
		Insulation : XLPE
		Metallic screen : Copper wires with Helix copper tape
		Armour : Unarmoured
		Outer sheath : HDPE
		Embossing/Marking: ELSEWEDY CABLES 1 X 240 MM2 18/30 KV AL/XLPE/CWS/HDPE SECHE SOUS ATMOSPHERE D'AZOTE IEC 60502-2 2019
Condition of sample on receipt	:	New
Type	:	Nil
Description of test sample	:	1 x 240 mm^2 Al/XLPE/CWS/PE 18/30(36) KV Cable
Serial Number	:	Nil
Number of Samples tested	:	One only
Date(s)of test(s)	:	23.03.2019 – 29.04.2019
CPRI sample Code Number	:	**CDDCAB19S0069**
Particulars of tests conducted	:	Type test
Test in accordance with Standard/ Specification	:	As per IEC 60502-2 – 2014
Sampling Plan	:	Nil
Customer's requirement	:	Nil
Deviation, if any	:	Nil
Name of the witnessing persons		
Customer's representative	:	Nil
Other than Customer's representative	:	Nil
Test subcontracted with address of the laboratory	:	None

Document constituting this Test Certificate (in words)		
Number of pages	:	Eight
Number of oscillograms	:	Four (One Sheet)
Number of graphs	:	Nil
Number of photos	:	Nil
Number of test circuit diagrams	:	Nil
Number of drawings	:	Nil

(THIRUMURTHY)
TEST ENGINEER

(K.P.MEENA)
JOINT DIRECTOR
Approved by

TYPE TEST CERTIFICATE

Test Certificate No.: CPRIBLRCAB19T0136 Dated: 29.04.2019

1.0. TESTS ON CONDUCTOR:

TEST RESULTS

1.1. CONDUCTOR RESISTANCE TEST:

Resistance, Ω/km at 20^0 C	
Observed values	Specified value (maximum)
0.1212	0.125

1.2. CONDUCTOR EXAMINATION:

No. of wires in conductor	
Observed	Specified (Minimum)
34	30

2.0. TESTS ON INSULATION

2.1. THICKNESS OF INSULATION

Observed values, mm		Specified values, mm	
Minimum	Average	Minimum	Average
8.223	8.308	7.10	8.00

2.1.2. ECCENTRICITY OF INSULATION:

Observed, %	Specified, % (Maximum)
1.57	15.0

2.2. TENSILE STRENGTH AND ELONGATION AT BREAK OF XLPE INSULATION

2.2.1. BEFORE AGEING:

Observed values		Specified values (Minimum)	
Tensile strength, N/mm^2	Elongation at break, %	Tensile strength, N/mm^2	Elongation at break, %
18.85	492.00	12.5	200

2.2.2. AGEING:

Sample	Temperature	Duration
Dumb- bell Specimens	$135 \pm 3\ ^0$C	168 Hours

2.2.3. AFTER AGEING:

Observed values	
Tensile Strength, N/mm^2	Elongation at break, %
21.48	502.9

2.2.4. VARIATION OBSERVED FROM BEFORE AGEING:

Observed variation, %		Specified variation, % (maximum)	
Tensile strength	Elongation at break	Tensile strength	Elongation at break
13.97	2.22	± 25	± 25

(THIRUMURTHY)
TEST ENGINEER

TEST RESULTS

2.2.5. ADDITIONAL AGEING (COMPLETED CABLE AGEING):

Sample	Temperature	Duration
Complete cable piece	$100 \pm 2\,^0C$	168 Hours

2.2.6. AFTER COMPLETED CABLE AGEING:

Observed values	
Tensile strength, N/mm^2	Elongation at break, %
20.98	555.00

2.2.7. VARIATION OBSERVED FROM BEFORE AGEING:

Observed variation, %		Specified variation, % (maximum)	
Tensile strength	Elongation at break	Tensile strength	Elongation at break
11.33	12.80	± 25	± 25

2.3. WATER ABSORPTION TEST: (GRAVIMETRIC)

Temperature	Duration
$85 \pm 2\,^0C$	14 days
Water absorbed, mg/cm^2	
Observed values	Specified Value (Maximum)
0.056	1.0

2.4. SHRINKAGE TEST:

Temperature	Duration
130 ± 3^oC	1 hour

Shrinkage, %	
Observed values	Specified value (maximum)
0.53	4.0

2.5. HOT SET TEST:

Temperature : 200 ± 3^oC
Time under load : 15 minutes
Mechanical stress : 20 N/cm^2

Observed values, %		Specified values, % (maximum)	
Hot set elongation	Permanent set elongation	Hot set elongation	Permanent set elongation
75.11	1.15	175	15

(THIRUMURTHY)
TEST ENGINEER

TYPE TEST CERTIFICATE

Test Report No.: CPRIBLRCAB19T0136 Dated: 29.04.2019

TEST RESULTS

3.0. TESTS ON SEMICONDUCTING SCREEN:

3.1.1. TEST FOR THICKNESS OF SEMICONDUCTING SCREENS:

Observed Nominal values, mm		Observed minimum values, mm	
Insulation screen	Conductor screen	Insulation screen	Conductor screen
0.993	0.781	0.772	0.768

3.1.2. RESISTIVITY OF SEMICONDUCTING SCREENS (Before Ageing):

Observed Resistivity in Ω-m		Specified Resistivity in Ω-m (Maximum)	
Insulation screen	Conductor screen	Insulation screen	Conductor screen
49.468	13.887	500	1000

3.1.3. RESISTIVITY OF SEMICONDUCTING SCREENS (After Ageing):

Observed Resistivity in Ω-m		Specified Resistivity in Ω-m (Maximum)	
Insulation screen	Conductor screen	Insulation screen	Conductor screen
53.558	16.521	500	1000

3. 2. STRIPPABILITY TEST FOR INSULATION SCREEN:

Force required to remove 10 mm strip for a length of 100 mm (N)		
Observed(N)		Specified (N)
Unaged Sample	Aged Sample	
31.35	15.00	4 - 45

4.0. TESTS ON OUTER SHEATH:

4.1. THICKNESS:

Observed, mm		Specified, mm	
Nominal	Minimum	Nominal	Minimum
2.49	2.34	2.30	---

4.2. TENSILE STRENGTH AND ELONGATION AT BREAK

4.2.1. BEFORE AGEING:

Observed		Specified (Minimum)	
Tensile strength, N/mm^2	Elongation at Break, %	Tensile strength, N/mm^2	Elongation at Break, %
20.49	692	12.5	300.0

4.2.2. AGEING:

Sample	Temperature	Duration
Dumb- bell Specimens	$110 \pm 2\ ^0C$	240 Hours

4.2.3. AFTER AGEING:

Observed		Specified
Tensile strength, N/mm^2	Elongation at break, %	Elongation at break, % (Minimum)
17.54	844	300.0

(THIRUMURTHY)
TEST ENGINEER

TEST RESULTS

4.2.4. COMPLETE CABLE AGEING:

Sample	Temperature	Duration
200 mm of Complete cable	100 ± 2 °C	168 Hours

4.2.5. AFTER COMPLETE CABLE AGEING:

Observed		Specified
Tensile strength ,N/mm^2	Elongation at break, %	Elongation at break, % (Minimum)
20.40	608.00	300.0

4.3. PRESSURE TEST AT HIGH TEMPERATURE:

Temperature	Duration
80±2° C	6 Hours

Indentation, %	
Observed	Specified (Maximum)
4.72	50

4.4. SHRINKAGE TEST:

Temperature	Heating Period	No. of Heating Cycles
80±2° C	5 Hours	5

Shrinkage, %	
Observed	Specified (Maximum)
0.49	3.0

4.5. CARBON BLACK COTENET:

Carbon Black Content, %	
Observed	Specified
2.61	2.5 ± 0.5 %

5.0. ELECTRICAL TESTS:

The following electrical tests were carried out in the order of sequence

5.1. BENDING TEST:

5.1.1. Outer Dia of conductor : 18.20 mm
5.1.2. Outer Dia. Of Cable : 44.0 mm
5.1.3. Diameter of test cylinder : 1250 mm
5.1.4. Number of bending cycles : Three

(THIRUMURTHY)
TEST ENGINEER

TYPE TEST CERTIFICATE

Test Report No.: CPRIBLRCAB19T0136 Dated: 29.04.2019

TEST RESULTS

5.2. PARIAL DISCHARGE TEST:

5.2.1. Length of the sample	: 11.00 meters
5.2.2. Sensitivity of the detector	: 5 pC
5.2.3. Method of connection	: High voltage applied to conductor and metallic screen grounded.
5.2.4. Measuring voltage (1.73 Uo)	: 30 kV ac
5.2.5. Specified discharge magnitude at 1.73Uo	: 5pC (maximum)
5.2.6. Observed Discharge magnitude	: Less than 5 pC

5.3. TAN DELTA MEASUREMENT AS A FUNCTION OF TEMPERATURE:

5.3.1. Temperature of the conductor during test	: $95^0 - 100^oC$
5.3.2. Test Voltage during measurement	: 2 kV ac
5.3.3. Specified tan delta at ambient temperature	: 0.004 (maximum)
5.3.4. Observed Capacitance in pF	: 2127.7 pF
5.3.5. Observed Tan delta at 98^0 C	: 0.00019

5.4. HEATING CYCLE TEST:

5.4.1. Conductor Temperature during Heating Cycle	: 95^oC - 100^0 C
5.4.2. Total Duration of heating cycle	: 8 hours
5.4.3. Heating period after attaining Temperature	: 2 hours
5.4.4. Natural Cooling Period	: 3 hours
5.4.5. Number of heating cycles	: 20 only

5.5. PARTIAL DISCHARGE TEST:

5.5.1. Length of the sample	: 11.00 meters
5.5.2. Sensitivity of the detector	: 5 pC
5.5.3. Method of connection	: High voltage applied to conductor and metallic screen grounded.
5.5.4. Measuring voltage (1.73 Uo)	: 30 kV ac
5.5.5. Specified discharge magnitude at 1.73Uo	: 5pC (maximum)
5.5.6. Observed Discharge magnitude	: Less than 5 pC

5.6. IMPULSE WITHSTAND TEST:

Test Voltage kV peak	Temperature of Conductor during Test (^{0}C)	Ambient Temperature, ^{0}C		No. of Impulses
		Dry Bulb	Wet Bulb	
170.0	95 - 100	27	23	10 Positive & 10 Negative

Test Connection	The impulse source was connected to the conductor (ends shorted) under test and the screen connected to ground.

Polarity	Shot Number	Oscillogram Number	Test Result
Positive	First	1	Withstood
	Tenth	10	
Negative	First	12	Withstood
	Tenth	21	

(OSCILLOGRAMS ENCLOSED)

(THIRUMURTHY)
TEST ENGINEER

TEST RESULTS

5.7. HIGH VOLTAGE TEST:

5.7.1. Test connection	: Between conductor and grounded copper screen
5.7.2. Test Voltage	: 63 kV ac
5.7.3. Duration of test	: Fifteen minutes
5.7.4. Ambient Temperature	: 29°C
5.7.5. Length of Sample	: 11.00 meters
5.7.6. Result	: No Breakdown, Withstood

5.8. HIGH VOLTAGE TEST:

5.8.1. Test connection	: Between conductor and grounded copper screen
5.8.2. Test Voltage	: 76 kV ac
5.8.3. Duration of test	: 4 Hours
5.8.4. Ambient Temperature	: 29°C
5.8.5. Length of Sample	: 11.00 meters
5.8.6. Result	: No Breakdown, WITHSTOOD

5.9. VISUAL EXAMINATION OF CABLE AFTER ALL ELECTRICAL TESTS:

No abnormalities were observed on cable after all Electrical tests.

6.0. LONGITUDINAL WATER TIGHTNESS TEST:

6.1. Bending test:

Three meters length of completed cable was subjected for bending test under the following parameters.

6.1.1.	Diameter of conductor	: 18.20 mm
6.1.2.	Diameter of Cable	: 44.00 mm
6.1.3.	Diameter of test cylinder	: 1250 mm
6.1.4.	Number of bending cycles	: Three

6.2. Three metre long cable was cut from the cable sample which has been subjected to the bending test, removed all external coverings up to insulation screen and placed horizontally. A ring approx. 50 mm wide removed from the center of the length up to the conductor. A suitable water enclosure with tube of 10 mm diameter was so arranged as to position the tube vertically above the ring. The enclosure was filled with water so that the water level in the tube was maintained at 1 metre height above the cable axis. The sample was subjected to heating cycle as given below, after allowing it to remain for 24 hours.

6.2.1.	Length of cable core	: 3 metres
6.2.2.	No. of heating cycles	: 10
6.2.3.	Total Duration of Heating cycle	: 8 hours
6.2.4.	Heating period after attaining Temperature	: 2 hours
6.2.5.	Temperature of the Conductor during heating cycle	: 95 - 100 ^{0}C
6.2.6.	Duration of cooling	: 3 hours

6.2.7. Result: **No traces of water were observed at the ends of the sample during the test and after the test. Withstood**

7.0 Conclusion: The sample meets the Type test requirement as per IEC 60502-2 – 2014 .

(THIRUMURTHY)
TEST ENGINEER

TYPE TEST CERTIFICATE

Test Report No.: CPRIBLRCAB19T0136 Dated: 29.04.2019

NOTE

a) The test results relate only to the item(s) tested.

b) Publication or reproduction of this report in any form other than by complete set of the whole report / certificate and in the language written is not permitted without the written consent of CPRI.

c) Any corrections / erasures invalidate this test report / certificate.

d) NABL has Accredited this laboratory as per IEC / ISO 17025-2005 standard, vide certificate no. TC-5452 for the tests carried out.

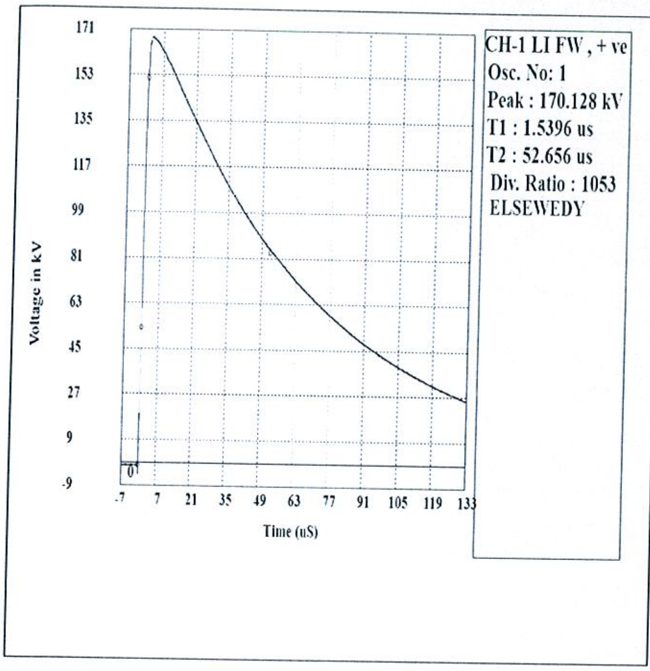
e) Any anomaly / discrepancy in the test report / certificate should be brought to our notice within 45 days from the date of issue

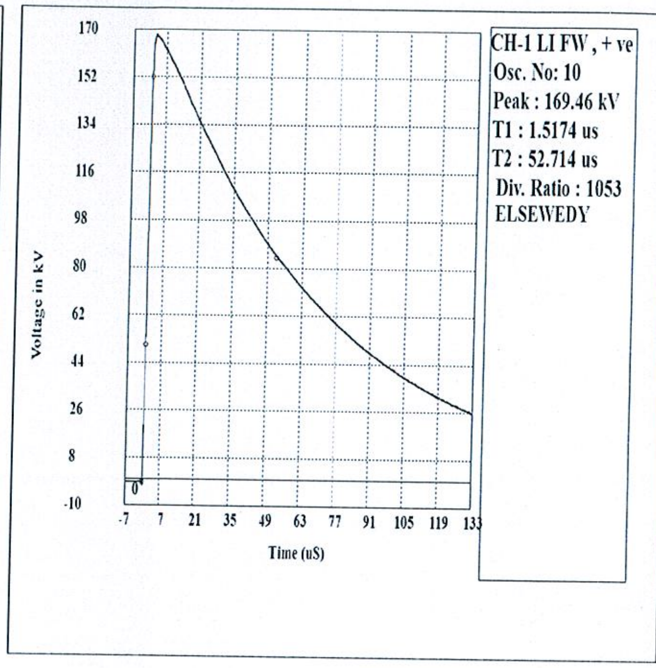
(THIRUMURTHY)
TEST ENGINEER

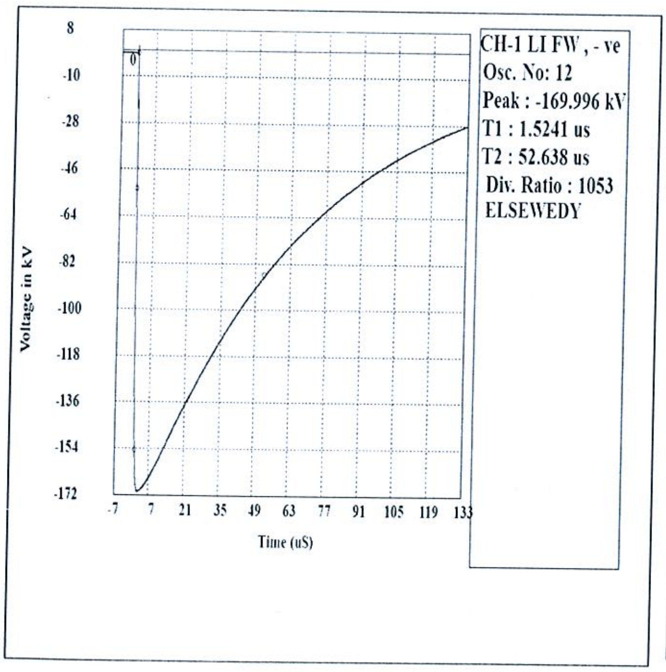
CENTRAL POWER RESEARCH INSTITUTE

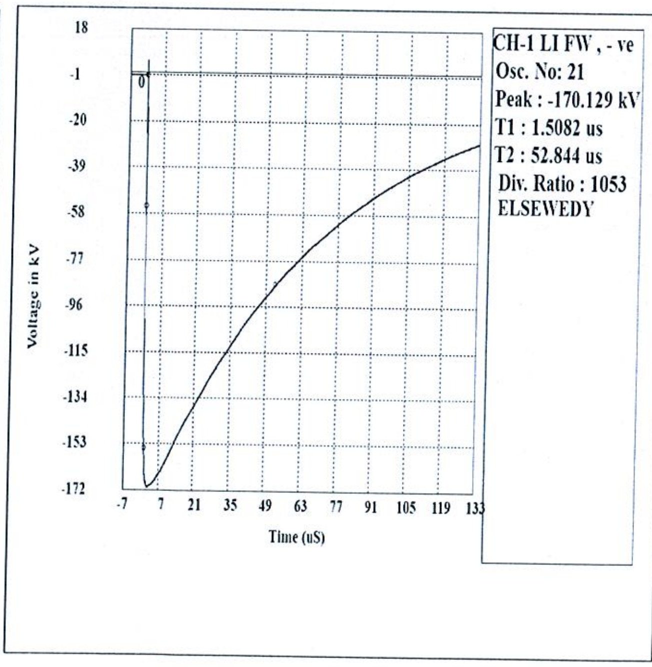
CPRI

Customer : M/s. ELSEWEDY ELECTRIC, ALGERIA
Type Test Certificate No. & Date : CPRIBLRCAB19T0136 Dated 29.04.2019
Sample Code : CDDCAB19S0069









(Thirumurthy)
Test Engineer

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

Version: 1

CONTENTS

page

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

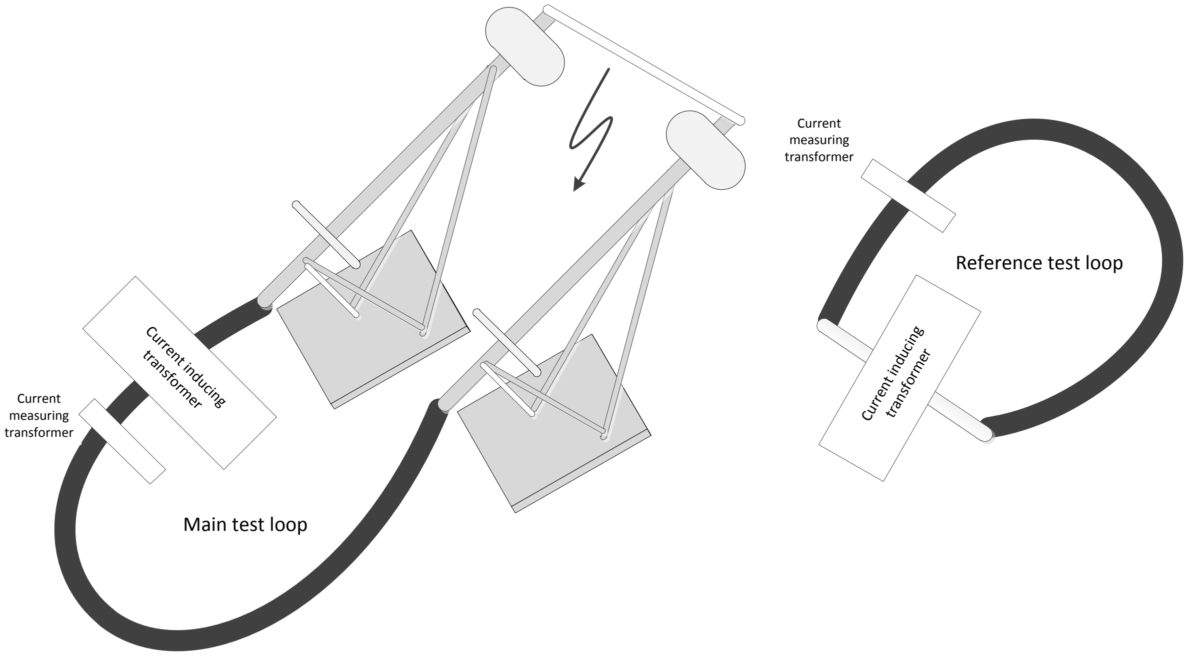
For the tests with the cable system at elevated temperature, a reference loop for temperature control of the conductor was installed and conductor current was used for heating. The reference cable was cut from the total cable length intended for the type test. This reference loop was installed close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

Version: 1

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 x 10^{-4}
[1)] for information only			

Requirement

The measured value shall not be higher than 10 x 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

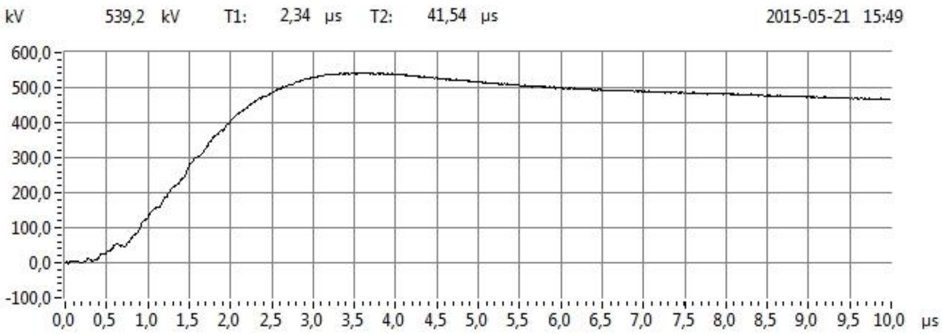


Fig. 1: Waveshape +50% of test voltage

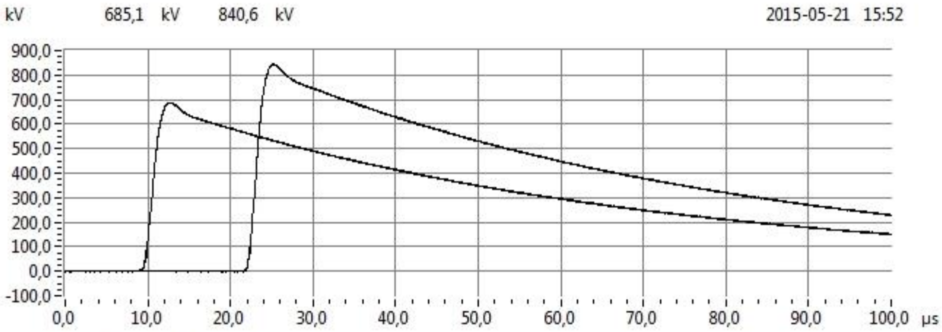


Fig. 2: +65% and +80% of test voltage

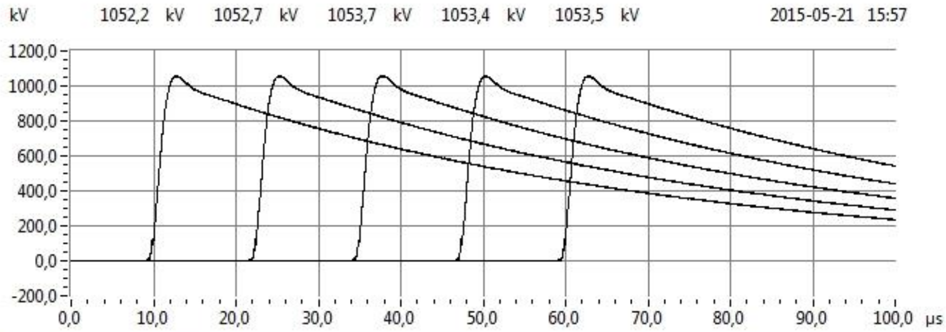


Fig. 3: +100% of test voltage

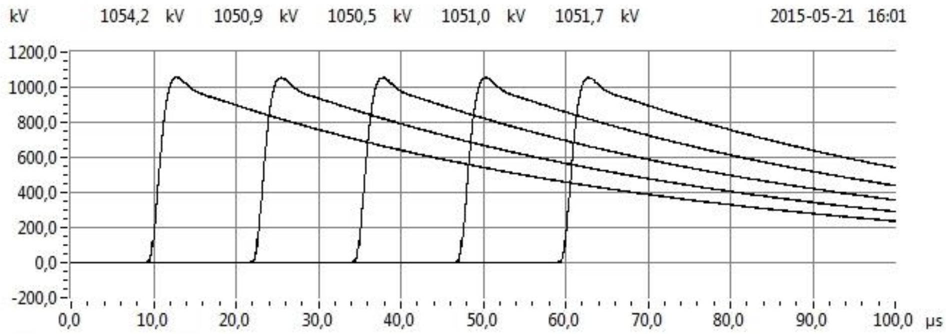


Fig. 4: +100% of test voltage

Lightning impulse test with negative voltage

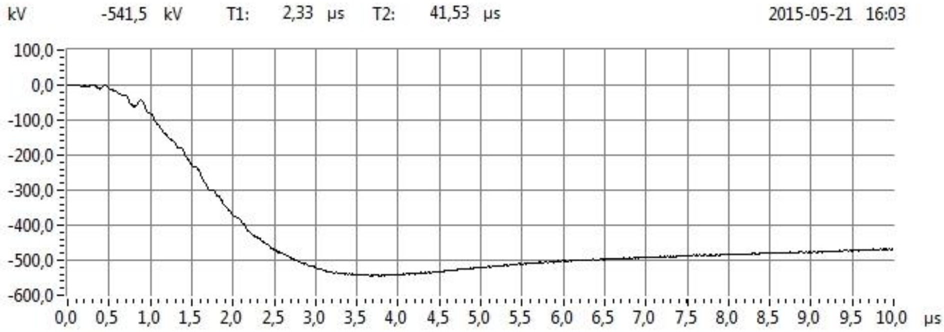


Fig. 5: Waveshape -50% of test voltage

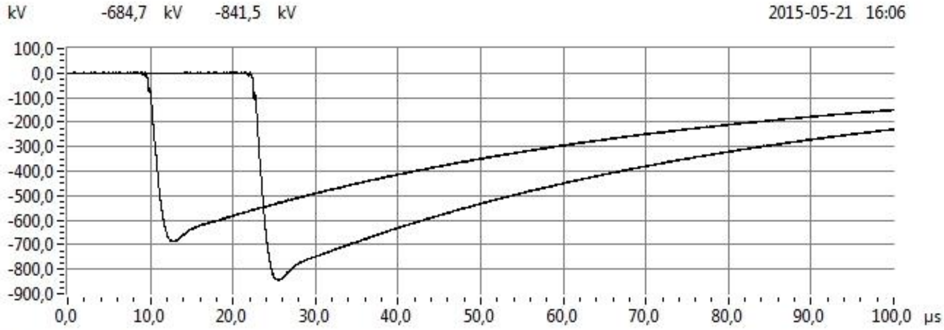


Fig. 6: -65% and -80% of test voltage

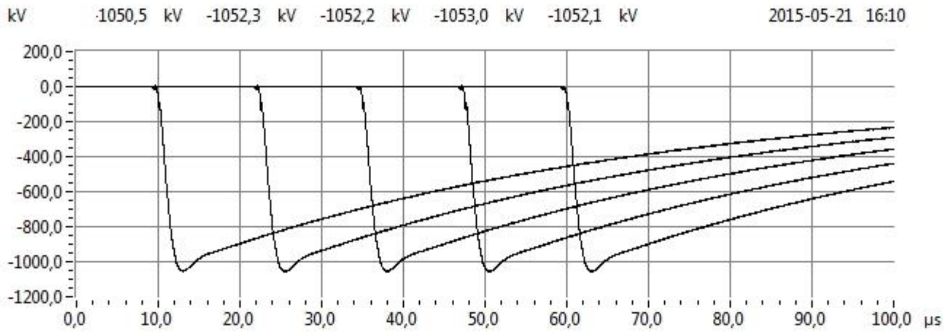


Fig. 7: -100% of test voltage

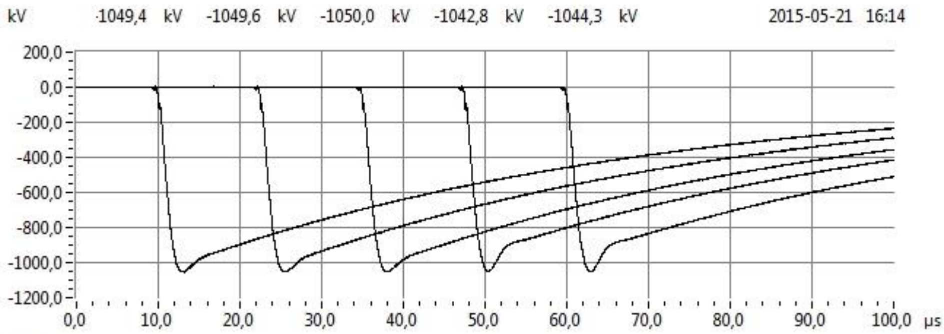


Fig. 8: -100% of test voltage

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

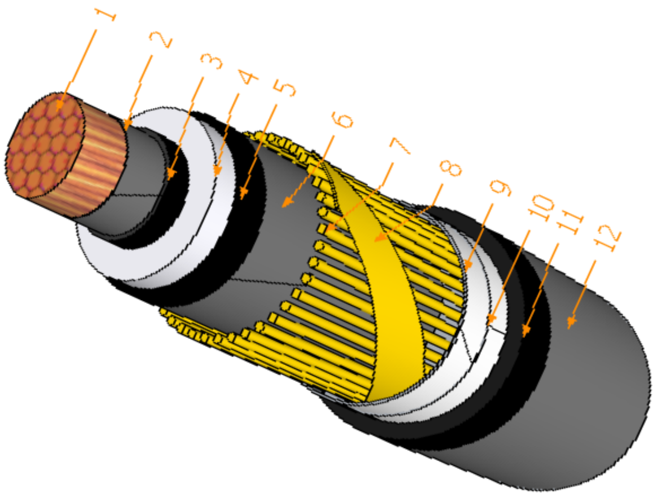
Length of cable sample 1 m

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%

KINECTRICS

TYPE TESTS ON AA/ACS 155/59 – 40.0 KA/0.25 S / SM-MFOA CABLE OPGW 400KV /48 FIBRES

TYPE TESTS ON 19.5 MM OPGW FOR EL SEWEDY CABLES, ALGERIA

K-419874-RC-0001 R00

Prepared for

El Sewedy Cables
Purchase Order # 15134

Issue Date

2017-Jul-21

Prepared by:	**Reviewed by:**	**Confirmed by:**	**Approved by:**
Corrine Dimnik, P. Eng.	André Maurice	Michael Kastelein	Zsolt Peter, Ph. D.
Principal Engineer	Engineer/Scientist	Lead Technologist	Department Manager
Transmission & Distribution Technologies	Transmission & Distribution Technologies	Transmission & Distribution Technologies	Transmission & Distribution Technologies
2017-Jul-21	2017-Jul-21	2017-Jul-21 Behalf of Mike KASTELEIN	2017-Jul-21

Revision History

Rev	Description:				
00	Original Issue.				
	Issue Date:	**Prepared by:**	**Reviewed by:**	**Confirmed by:**	**Approved by:**
	2017-Jul-21	Corrine Dimnik	André Maurice	Michael Kastelein	Zsolt Peter

Acknowledgements

The assistance of Mr. Hicham Farid, PhD. for the report preparation is greatly appreciated

Table of Contents

List of Figures

List of Tables

1 Introduction

A series of eleven (11) tests were performed on a fiber optical ground wire (OPGW) for El Sewedy Cables. The cable was manufactured by El Sewedy Cables Algeria, and is designated AA/ACS 155/59 – 40.0kA/0.25s / SM-MFOA OPGW 400kV / 48 fibers. The diameter of the cable is 19.5 mm and has a Rated Tensile Strength (RTS) of 114.08 kN. The cable was received in good condition on March 7, 2017. All tests were performed in accordance with the reference standards outlined below. The cable successfully met all the requirements in these specifications.

This document is a compilation of the individual test reports. Table 1-1 summarizes the test program and the order of the reports contained in this document. There are six (6) appendices located at the back of this document.

Table 1-1: Summary of Test Program

No.	Test	Test Date	Reference Standard
1.	Tensile Performance	April 27, 2017	IEC 60794-1-21:2015 Method E1 & IEC 60794-4-10:2014 Paragraph 8.3.2
2 & 3.	Stress-Strain & Ultimate Tensile Strength Tests	April 24, 2017	IEC 61089 Paragraphs 6.5.1, 6.5.2, & Annex B
4.	Sheave Test	April 25, 2017	IEC 60794-1-21:2015 Method E18B Procedure 1 & IEC 60794-4-10:2014 Paragraph 8.3.5
5.	Aeolian Vibration Test	April 24 – 27, 2017	IEC 60794-1-21:2015 Method E19 & IEC 60794-4-10:2014 Paragraph 8.3.6
6.	Creep Test	May 12 – June 23, 2017	IEC 61395
7.	Galloping Test	April 25 – 27 , 2017	IEC 60794-1-21:2015 Method E26 & IEC 60794-4-10:2014 Paragraph 8.3.8
8.	Temperature Cycle Test on Complete OPGW	April 24 – 28 , 2017	IEC 60794-1-22:2012 Method F1 & IEC 60794-4-10:2014 Paragraph 8.3.9
9.	Water Penetration Test	April 24, 2017	IEC 60794-1-22:2012 Method F5B & IEC 60794-4-10:2014 Paragraph 8.3.10
10.	Short Circuit Test	April 28, 2017	IEC 60794-1-24:2014 Method H1 & IEC 60794-4-10:2014 Paragraph 8.3.11
11.	Lightning Arc Test	April 25 & 27, 2017	IEC 60794-1-24:2014 Method H2, IEC 60794-4-10:2014 Paragraph 8.3.12 & Kinectrics Method

The tests were performed under Kinectrics ISO 17025 Certificate of Accreditation. A copy of Kinectrics ISO 17025 Certificate of Accreditation is included in Appendix E.

All tests were performed by Kinectrics International Inc. personnel at 800 Kipling Avenue, Unit 2, Toronto, Ontario, M8Z 5G5, Canada.

2 Tensile Performance

Test Date: April 27, 2017

Test Laboratory: Kinectrics International Inc.

Cable Manufacturer: El Sewedy Cables

End-User: Filiales Groupe SONELGAZ

Accessories: Dead-end wraps supplied by RIBE Part No. AW306192/RW214330LIS

Kinectrics Staff: Mr. Greg Brown
Mr. Aaron Duncan
Ms. Corrine Dimnik

Witnesses: Mr. Nabil Abdennour – GRTE
Mr. Said Hamoudi – CEEG
Mr. Riadh Fellouh – El Sewedy Cables Algeria
Mr. Miloud Aggoun – El Sewedy Cables Algeria

2.1 Test Objective and Standard

The objective of the Tensile Performance Test is to verify the performance of the optical fibers while the cable is subjected to the specified loading schedule.

The objective of the Ultimate Tensile Strength Test is to verify that the actual (ultimate) tensile strength of the OPGW cable meets or exceeds the Rated Tensile Strength (RTS) of the OPGW cable specified by the supplier.

The tests were performed in accordance with IEC 60794-1-21:2015 *"Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods"* Method E1, IEC 60794-4-10:2014 *"Optical fibre cables – Part 4-10: Family specification – Optical ground wires (OPGW) along electrical power lines"* Paragraph 8.3.2 and Kinectrics Method.

2.2 Test Set-up

2.2.1 Test Assembly and Apparatus

A schematic of the set-up for the Tensile Performance Test is illustrated in Figure 2-1. A photo of the actual test set-up is shown in Figure 2-2.

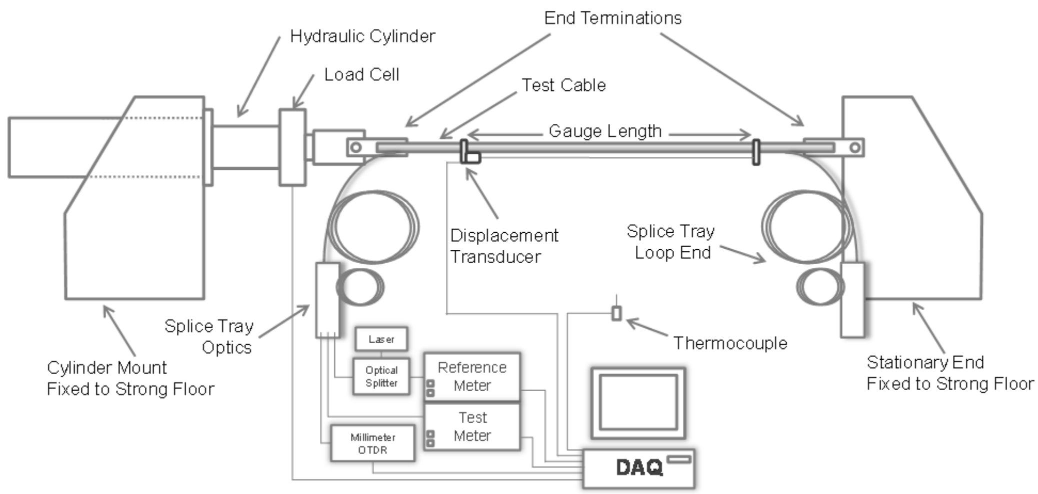


Figure 2-1: Set-up for Tensile Performance Test (Schematic)

Figure 2-2: Set-up for Tensile Performance Test (Actual Sample)

One (1) sample was terminated beyond both dead-end assemblies such that the optical fibers could not move relative to the OPGW. The cable and fiber terminations and the method to measure optical attenuation are described in Appendix C.

The OPGW sample was installed in a hydraulically activated horizontal test machine. The length of the cable between the load points of the dead-end assemblies was 13.56 m. A displacement transducer was fixed to the cable to measure cable elongation over an 8.00 m gauge length.

The test was carried out in a temperature-controlled laboratory at 22ºC ± 3ºC.

2.2.2 Optical Network

For the attenuation measurement, twenty four (24) of the forty eight (48) fibers were spliced together to form one continuous loop of 325.44 m (24 fibers x 13.56 m). The gauge length for attenuation measurements was taken to be the length under tension, from dead-end to dead-end.

Fiber elongation was measured using a millimeter resolution Optical Time Domain Reflectometer (OTDR) that measures the time of flight from the laser source to the receiver. By inputting the refractive index, the instrument converts the change in time of flight to change in length. For the fiber elongation measurement, four (4) fibers were spliced together to form one continuous loop of 110.88 m (4 fibers x (18.30 m + 9.42 m)). The gauge length for fiber elongation was taken to be the length of fiber from the start of each set of loops, plus half the length of each set of three (3) loops.

2.2.3 Instrumentation and Data Acquisition

The GPIB (General Purpose Interface Bus) output signals from the optical power meters, fiber elongation from the OTDR, air temperature, cable elongation, and the cable tension, as measured by the load cell, were monitored continuously using a digital data logging system. The sampling rate during loading was every two (2) seconds, and every ten (10) seconds during holds.

The measuring instruments and equipment used in this test are listed in Appendix D.

2.3 Test Procedure

The cable sample was subjected to the loading schedule outlined in IEC 60794-4-10:2014 Paragraph 8.3.2, as shown in Table 2-1. The loads were applied at a rate of 4.0 kN/minute. Optical attenuation, fiber elongation, air temperature, cable tension and cable elongation were recorded throughout the test.

Table 2-1: Loading Schedule for Tensile Performance Test

OPGW RTS = 114.08 kN			
Step	**% RTS**	**Load (kN)**	**Hold (Minutes)**
Pre	2%	2.3	-
1	70%	79.9	10
2	2%	2.3	-

Upon completion of Step 2, the cable strain transducer was removed. This constituted the end of the Tensile Performance Test.

The load was then reapplied at a rate of 22.8 kN/minute until the cable failed, to measure the Ultimate Tensile Strength for information purposes. Optical attenuation, fiber elongation and cable tension were recorded.

2.4 Test Results

The data has been corrected because the elongation measurement was taken to be zero at the preload. Using a straight-line regression of the stress-strain data while loading up to 70% RTS, it was calculated that the corrected strain at preload was 0.014% for the cable. After adding these corrections, the data can be extrapolated back to the Y-axis to zero. The corrected data is the actual cable's behaviour because the cable will have zero elongation only when it is under zero tension.

The load (cable tension) plotted against cable strain (%) and fiber strain (%) is shown in Figure 2-3. The strain margin is defined as the cable load (or cable strain) at which the fibers have elongated. Loading of the cable showed that the fiber began to strain between 100 kN and 105 kN, or between 88% and 92% of RTS. For purposes of calculating fiber strain, the gauge length is taken to be 110.88 m (4 fibers x (18.30 m + 9.42 m)).

The optical attenuation and load (cable tension) plotted against time is shown in Figure 2-4. The maximum increase in optical attenuation measured during the Tensile Performance Test up to 70% RTS was 0.052 dB/test fiber km. The permanent increase in optical attenuation measured after the 70% hold was 0.030 dB/test fiber km, which is considered no change within measurement uncertainty. The cable broke at 129.5 kN, or 113.9% RTS.

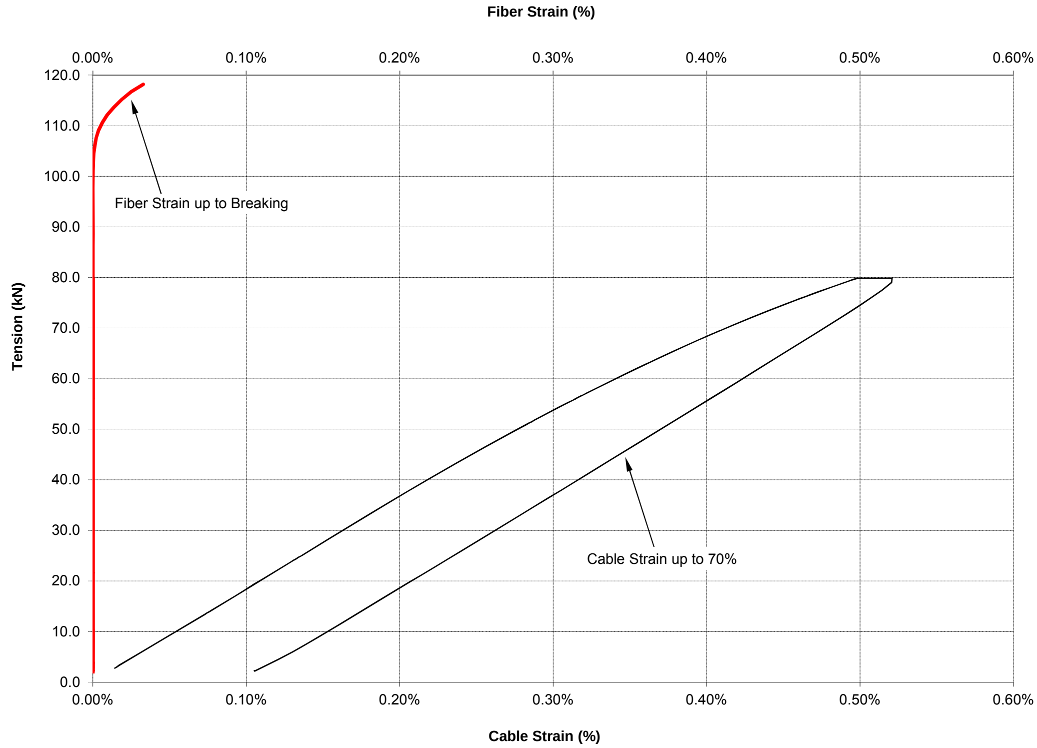


Figure 2-3: Cable Strain and Fiber Strain vs. Cable Tension

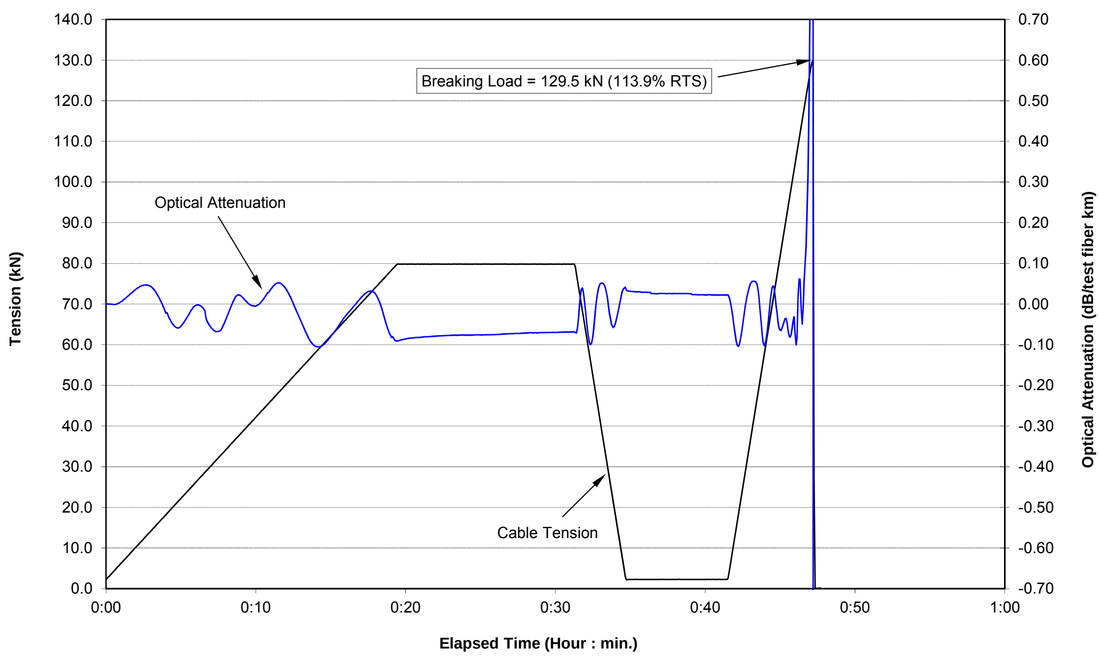


Figure 2-4: Load (cable tension) and Optical Attenuation vs. Time

2.5 Acceptance Criteria

As specified in IEC 60794-1-21:2015 Paragraph 3.5, the attenuation change and/or fiber strain of the sample shall not exceed the values given in the relevant specification.

As specified in IEC 60794-4-10:2014 Paragraph 8.3.2, on completion of the test the following criteria shall be considered:

i) Increase in optical attenuation greater than the limit stated in 8.3.1, before reaching MAT loading shall constitute failure;
   - As specified in 8.3.1: If optical attenuation is monitored during the test, a permanent or temporary increase in optical attenuation greater than 0.2 dB or 0.2 dB/km of test fibre, at 1550 nm nominal wavelength for single-mode fibres, shall constitute failure.

ii) A strain margin less than the specified value up to MAT shall constitute failure;
   - As specified by El Sewedy, the Maximum Allowable Tension (MAT) = 70% RTS = 79.86 kN.
   - The strain margin is defined as the cable load at which the fibers have elongated.

iii) Any permanent increase in optical attenuation after test shall constitute failure.
   - As specified in 60794-1-20 Paragraph 4.9.2: The total uncertainty of measurement shall be ≤ ±0.05 dB for attenuation or ± 0.05 dB/km for attenuation coefficient. Any measured value within this range shall be considered as “no change in attenuation”.

2.6 Conclusion

The cable, as tested, met the requirements for the Tensile Performance Test as specified in IEC 60794-1-21:2015 Paragraph 3.5 and IEC 60794-4-10:2014 Paragraph 8.3.2.

3 Stress-Strain and Ultimate Tensile Strength Tests

Test Date:	April 24, 2017
Test Laboratory:	Kinectrics International Inc.
Cable Manufacturer:	El Sewedy Cables
End-User:	Filiales Groupe SONELGAZ
Accessories:	Epoxy-resin Dead-ends
Kinectrics Staff:	Mr. Greg Brown Ms. Corrine Dimnik
Witnesses:	Mr. Nabil Abdennour – GRTE Mr. Said Hamoudi – CEEG Mr. Riadh Fellouh – El Sewedy Cables Algeria Mr. Miloud Aggoun – El Sewedy Cables Algeria

3.1 Test Objective and Standard

The objective of the Stress-Strain Test is to produce the stress-strain curves and final Modulus of Elasticity (MOE) for the OPGW cable. Monitoring the optical performance of the OPGW cable is not required during this test.

The objective of the Ultimate Tensile Strength Test is to verify that the actual (ultimate) tensile strength of the OPGW cable meets or exceeds the Rated Tensile Strength (RTS) of the OPGW cable specified by the supplier.

The tests were performed in accordance with IEC 61089 *"Round wire concentric lay overhead electrical stranded conductors"* Paragraphs 6.5.1, 6.5.2, and Annex B.

3.2 Test Set-up

3.2.1 Test Assembly and Apparatus

A schematic of the set-up for the Stress-Strain and Ultimate Tensile Strength Tests is illustrated in Figure 3-1. A photo of the actual test set-up is shown in Figure 3-2.

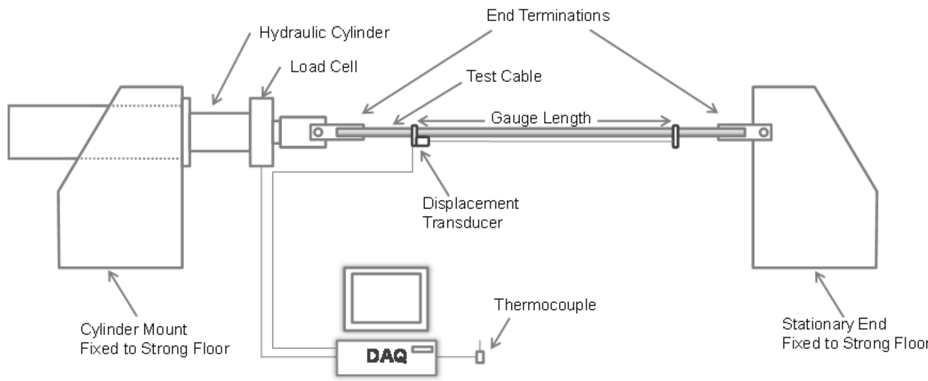


Figure 3-1: Set-up for Stress-Strain and Ultimate Tensile Strength Tests (Schematic)

Figure 3-2: Set-up for Stress-Strain Test (Actual Sample)

One (1) sample was prepared for the Stress-Strain Test by terminating the cable ends with epoxy-resin dead-ends. The OPGW sample was installed in a hydraulically activated horizontal test machine. The length of the cable between the load points of the dead-end assemblies was 14.03 m. A displacement transducer was fixed to the cable to measure cable elongation over a 10.0 m gauge length.

The test was carried out in a temperature-controlled laboratory at 22ºC ± 3ºC.

3.2.2 Optical Network

Optical measurements are not required for the Stress-Strain and Ultimate Tensile Strength Tests.

3.2.3 Instrumentation and Data Acquisition

The air temperature, cable elongation, and the cable tension as measured by the load cell, were monitored continuously using a digital data logging system. The sampling rate during loading was every two (2) seconds, and during holds, every ten (10) seconds.

The measuring instruments and equipment used in this test are listed in Appendix D.

3.3 Test Procedure

The cable sample was subjected to the loading schedule outlined in IEC 61089 Annex B, as shown in Table 3-1. The loads were applied at a rate of 17.1 kN/minute. Air temperature, cable tension and cable elongation were recorded throughout the test.

Table 3-1: Loading Schedule for Stress-Strain Test

OPGW RTS = 114.08 kN			
Step	**% RTS**	**Load (kN)**	**Hold (Minutes)**
Pre	2%	2.3	-
1	30%	34.2	30
2	2%	2.3	2
3	50%	57.0	60
4	2%	2.3	2
5	70%	79.9	60
6	2%	2.3	2
7	85%	97.0	60
8	2%	2.3	-

Upon completion of Step 8, the load was reduced and the cable strain transducer was removed. This constituted the end of the Stress-Strain Test.

The load was then reapplied at a rate of 22.8 kN/minute until the cable failed, to complete the Ultimate Tensile Strength Test. Air temperature and cable tension were recorded.

3.4 Test Results

The data has been corrected because the elongation measurement was taken to be zero at the preload. Using a straight-line regression of the stress-strain data while loading up to 30% RTS, it was calculated that the corrected strain at preload was 0.020% for the cable. After adding these corrections, the data can be extrapolated back to the Y-axis to zero. The corrected data is the actual cable's behavior because the cable will have zero elongation only when it is under zero tension.

The load (cable tension) plotted against all cable strain data taken is shown in Figure 3-3.

The Modulus of Elasticity (MOE) of the cable can be determined from the stress-strain curve. The MOE is the slope of the unloading segment of the 85% RTS curve. The MOE for the cable is approximately 85.64 kN/mm^2.

Load (cable tension) plotted against time is shown in Figure 3-4. The cable broke at 125.2 kN, or 109.7% RTS.

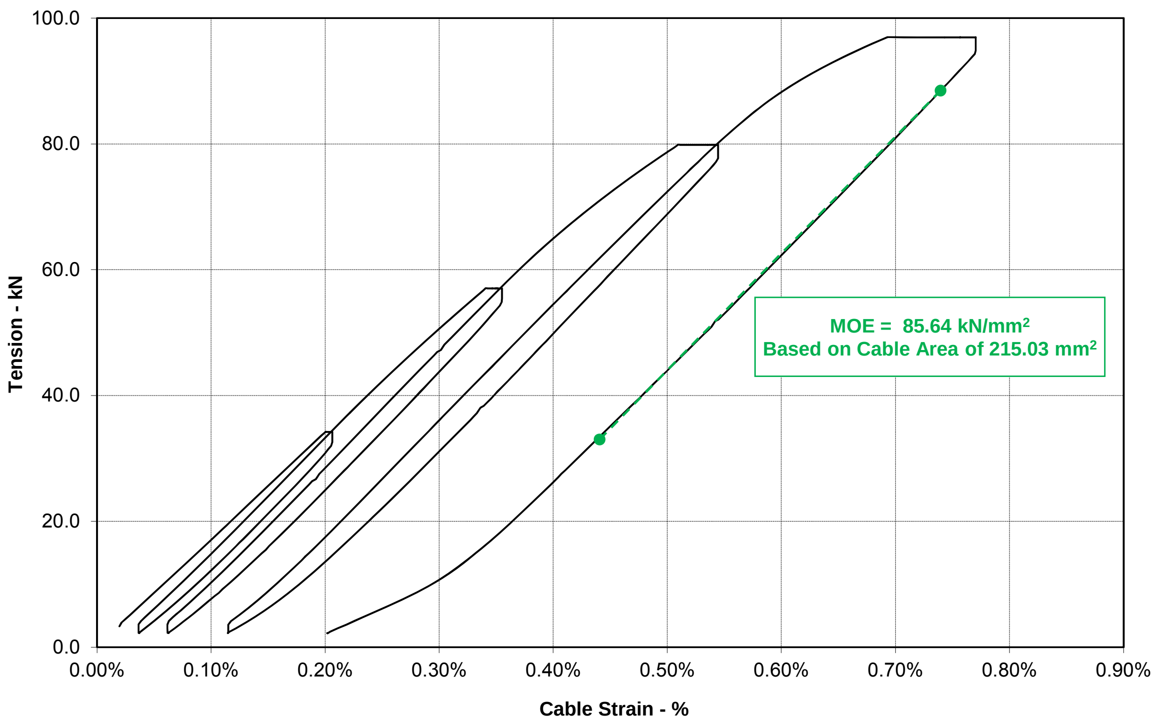


Figure 3-3: Load (cable tension) vs. Cable Strain during Stress-Strain Test

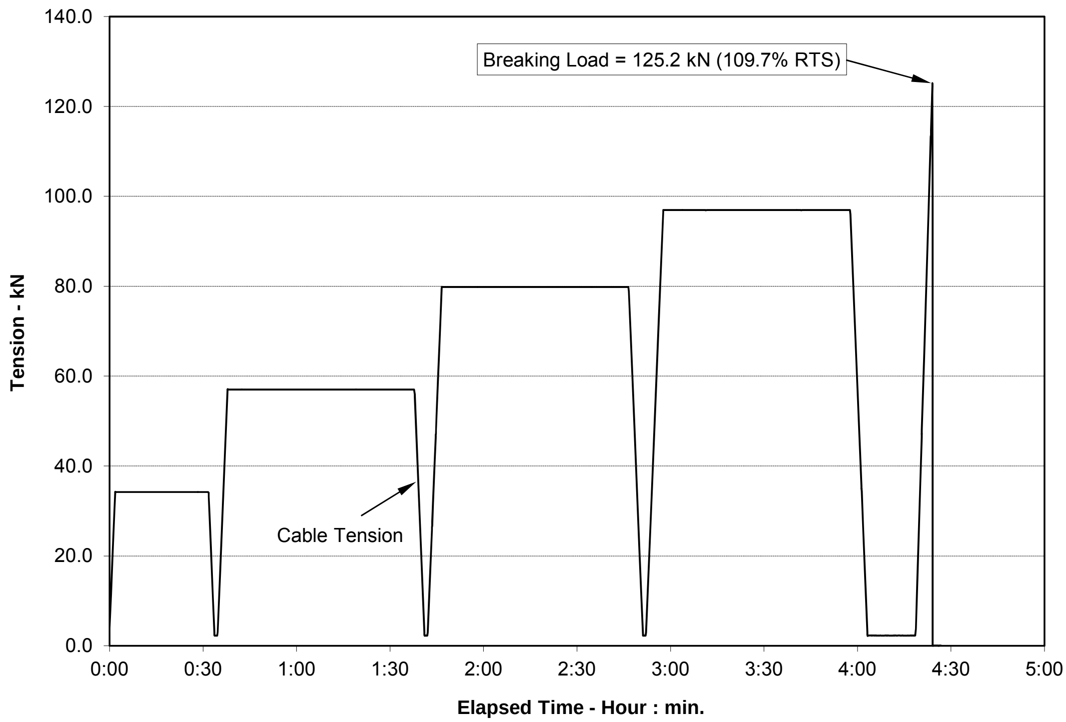


Figure 3-4: Loading History for the Stress-Strain Test

3.5 Acceptance Criteria

There are no acceptance criteria for the Stress-Strain Test stated in IEC 61089 Paragraph 6.5.1 or Annex B. The test is performed for information purposes only.

As specified in IEC 61089 Paragraph 6.5.2, the conductor shall withstand, without the fracture of any wire not less than 95% of their rated tensile strength.

3.6 Conclusion

The results for the Stress-Strain Test are presented for information purposes.

The cable, as tested, met the requirements for the Ultimate Tensile Strength Test as specified in IEC 61089 Paragraph 6.5.2.

4 Sheave Test

Test Date: April 25, 2017

Test Laboratory: Kinectrics International Inc.

Cable Manufacturer: El Sewedy Cables

End-User: Filiales Groupe SONELGAZ

Accessories: Dead-end wraps supplied by RIBE Part No. AW306192/RW214330LIS

Kinectrics Staff: Mr. Michael Colbert
Ms. Corrine Dimnik

Witnesses: Mr. Nabil Abdennour – GRTE
Mr. Said Hamoudi – CEEG
Mr. Riadh Fellouh – El Sewedy Cables Algeria
Mr. Miloud Aggoun – El Sewedy Cables Algeria

4.1 Test Objective and Standard

The objective of the Sheave Test is to determine the ability of the cable to withstand passing over a sheave a number of times without significant damage to the cable or significant increase in optical attenuation.

The test was performed in accordance with IEC 60794-1-21:2015 Method E18B Procedure 1, IEC 60794-4-10:2014 Paragraph 8.3.5 and Kinectrics Method.

4.2 Test Set-up

4.2.1 Test Assembly and Apparatus

A schematic of the set-up for the Sheave Test is illustrated in Figure 4-1.

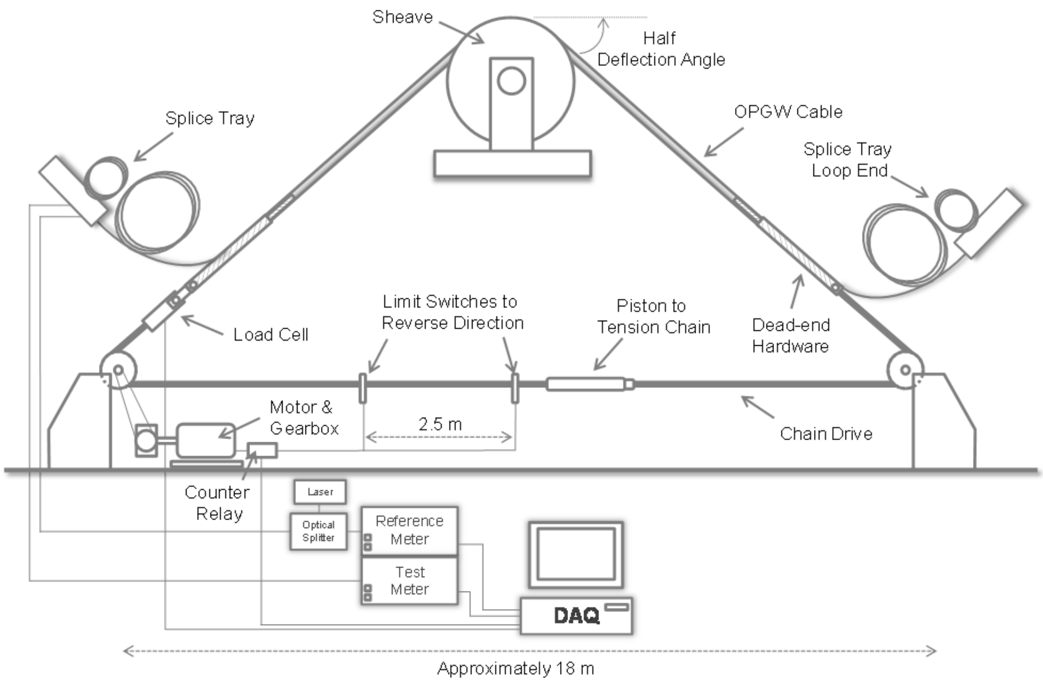


Figure 4-1: Set-up for Sheave Test (Schematic)

The length of cable between the dead-end load points was approximately 13.7 m. The target tension of the cable was 17.1 kN or 15% ± 1% of the cable's RTS. The inside diameter of the sheave was 773 mm. The total angle of the cable over the sheave was 31.3°. The set-up allowed 2.5 m of cable to travel through the sheave at a speed of 0.157 m/sec. A load cell was installed at one end to measure the tension in the cable

The test was carried out in a temperature-controlled laboratory at 22ºC ± 3ºC.

4.2.2 Optical Network

One (1) OPGW sample was terminated beyond both dead-end assemblies such that the optical fibers could not move relative to the OPGW. The cable and fiber terminations and the method to measure optical attenuation are described in Appendix C.

For the attenuation measurement, twenty-four (24) of the forty-eight (48) fibers were spliced together to form one continuous loop of 328.8 m (24 fibers x 13.7 m). The gauge length for attenuation measurements was taken to be the length under tension, from dead-end to dead-end.

4.2.3 Instrumentation and Data Acquisition

The GPIB (General Purpose Interface Bus) output signals from the optical power meters, and the cable tension, as measured by the load cell, were monitored continuously using a digital data logging system. The sampling rate was every one (1) second during the test.

The measuring instruments and equipment used in this test are listed in Appendix D.

4.3 Test Procedure

Before the first pull, the midpoint and both ends of a two (2) meter test length were located and marked. A total length of 2.5 m was pulled 20 cycles over the sheave (i.e. 20 times forward and 20 times backward). A digital caliper was used to measure the maximum and minimum cable diameters at the three (3) locations before applying load; after applying load and before the 1st cycle; and after the 20th cycle.

The dissection and visual examination of the cable components within the two and half (2.5) meter test section were performed after the test. The outer cable strands were removed in the test section and the diameters of all components were measured.

4.4 Test Results

Optical attenuation, cable tension and accumulated test cycles are plotted against time and are shown in Figure 4-2. The maximum temporary increase in optical attenuation measured during the test was 0.094 dB/test fiber km. The maximum permanent increase in optical attenuation measured after the test was 0.070 dB/test fiber km. The number of forward/backward cycles over the sheave can be seen as cyclic variations in the cable tension.

The measured cable diameters before tensioning, after tensioning and before 1st cycle, and after 20 cycles are shown in Table 4-1.

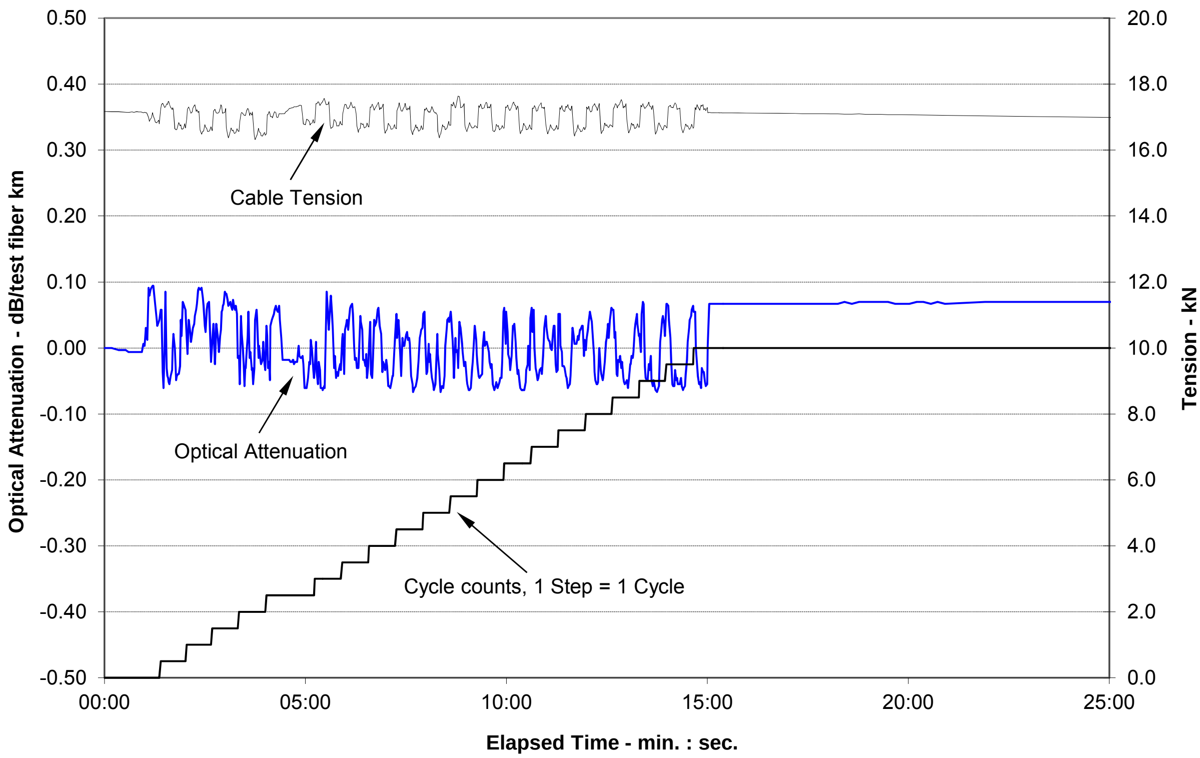


Figure 4-2: Cable Tension, Cycle Counts and Optical Attenuation vs. Time

Table 4-1: Measured Cable Diameters

No. of Cycles	North Diameter		Center Diameter		South Diameter	
	Max (mm)	Min (mm)	Max (mm)	Min (mm)	Max (mm)	Min (mm)
Before Tension	19.64	19.46	19.64	19.48	19.68	19.48
Before 1st Cycle	19.67	19.44	19.63	19.43	19.61	19.41
After 20th Cycle	19.50	19.40	19.58	19.33	19.61	19.33
Calculated Ovality After 20th Cycle (%)	0.3%		0.6%		0.7%	

The maximum cable distortion from the measured diameters, with reference to the "Before 1st Cycle" was 0.17 mm. The corresponding diameters were 19.67 mm and 19.50 mm and were measured in the North-Max location after the 20th cycle. The maximum ovality of the cable was 0.7%. The corresponding diameters were 19.61 mm and 19.33 mm and were measured in the South location after the 20th cycle.

The cable sample was dissected upon completion of this test. The measured diameters of the stainless steel tube are shown in Table 4-2. The nominal diameter of the stainless steel tube is 3.85 mm.

Table 4-2: Measured Stainless Steel Tube Diameters

Measurement	Location						
	North	**1/3**	**2/3**	**Center**	**1/3**	**2/3**	**South**
Maximum Diameter (mm)	3.88	3.86	3.87	3.87	3.87	3.92	3.89
Minimum Diameter (mm)	3.83	3.84	3.82	3.85	3.84	3.78	3.83
Calculated Ovality (%)	0.6%	0.3%	0.7%	0.3%	0.4%	1.8%	0.8%

The maximum distortion of the tube from the nominal diameter was 0.07 mm. The corresponding diameters were 3.92 mm and 3.78 mm and were measured in the 2/3 location. The maximum ovality of the optical unit was 1.8%. The corresponding diameters were 3.92 mm and 3.78 mm, and were measured in the 2/3 location after the 20th cycle.

The ovality of the cable and optical unit are calculated by the following equation:

$$Ovality = \frac{(d_{max} - d_{min})}{(d_{max} + d_{min})} \times 100$$

[The remainder of this page intentionally left blank.]

4.5 Acceptance Criteria

As specified in IEC 60794-1-21:2015 Paragraph 33.5, under visual examination without magnification there shall be no damage to the sheath and/or to the cable elements. If specified, any permanent increase in attenuation after the test shall not exceed the value specified in the detail specification.

As specified in IEC 60794-4-10:2014 Paragraph 8.3.5, on completion of the test the following criteria shall be considered:

- The maximum allowable ovality (MAOC) of the cable and optical unit(s) shall be not greater than 20 %.
- The change in attenuation of monitored optical fibers shall comply with the general optical requirements stated in 8.3.1.
    - As specified in 8.3.1: a permanent increase in optical attenuation greater than 0.2 dB/km of test fiber, at 1550 nm nominal wavelength for single-mode fibers, shall constitute failure.
- Under visual inspection, the OPGW section subjected to sheave test shall not show cracking, bird caging, nor breaking of any element.

4.6 Conclusion

The cable, as tested, met requirements for the Sheave Test as specified in with IEC 60794-1-21:2015 Paragraph 33.5 and IEC 60794-4-10:2014 Paragraph 8.3.5.

[The remainder of this page intentionally left blank.]

5 Aeolian Vibration Test

Test Date:	April 24 – 27, 2017
Test Laboratory:	Kinectrics International Inc.
Cable Manufacturer:	El Sewedy Cables
End-User:	Filiales Groupe SONELGAZ
Accessories:	Dead-end wraps supplied by RIBE Part No. AW306192/RW214330LIS Suspension assembly supplied by RIBE Range 19.4 – 23.1 mm
Kinectrics Staff:	Mr. Greg Brown Mr. Aaron Duncan Ms. Corrine Dimnik
Witnesses:	Mr. Nabil Abdennour – GRTE Mr. Said Hamoudi – CEEG Mr. Riadh Fellouh – El Sewedy Cables Algeria Mr. Miloud Aggoun – El Sewedy Cables Algeria

5.1 Test Objective and Standard

The objective of the Aeolian Vibration Test is to assess the fatigue performance of the OPGW and the optical characteristics of the fibers under typical Aeolian vibrations.

The test was performed in accordance with IEC 60794-1-21:2015 Method E19, IEC 60794-4-10:2014 Paragraph 8.3.6 and Kinectrics Method.

5.2 Test Set-up

5.2.1 Test Assembly and Apparatus

A schematic of the set-up for the Aeolian Vibration Test is illustrated in Figure 5-1. The test was performed on the span designated KB019-Fence.

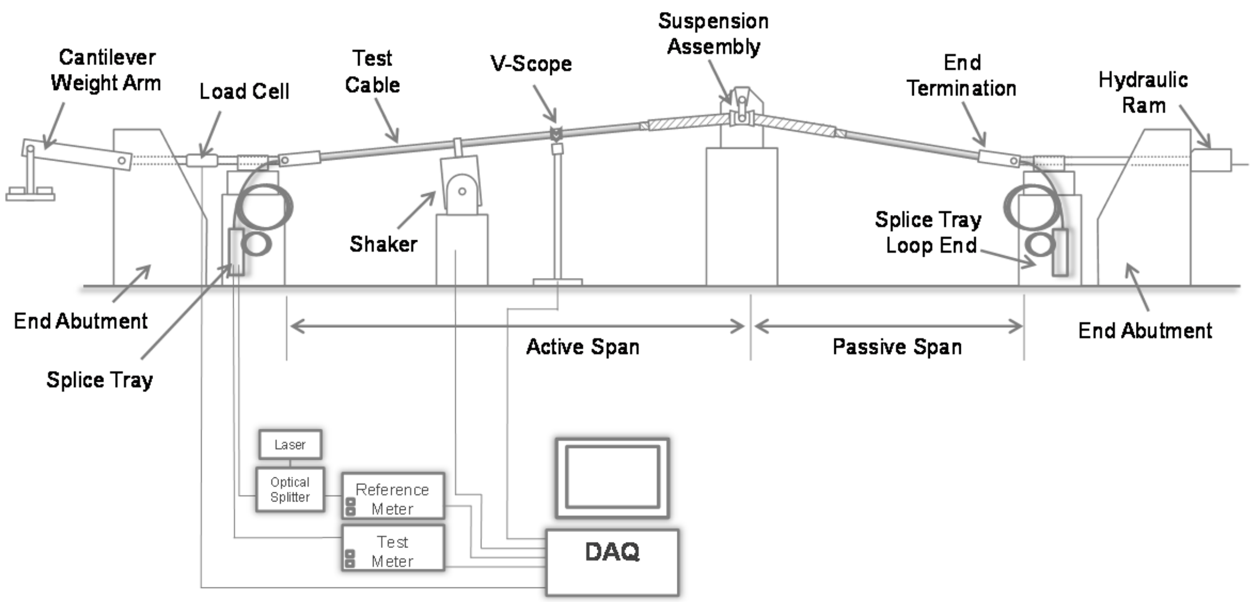


Figure 5-1: Set-up for Aeolian Vibration Test (Schematic)

The OPGW was contained between two (2) intermediate abutments. The active span cable length was 20.45 m and the passive span cable length was 10.06 m for a total cable length of 30.51 m between the loading wedges of the dead-end clamps. Fixed end abutments were used to load and maintain tension in the fiber optic cable. The initial target tension of 28.52 kN is 25% of the cable's RTS. This was applied using a cantilever weight arm on one of the end abutments.

The dead-end assemblies were installed between the intermediate abutments. The suspension assembly was supported at a height such that the static sag angle of the cable to horizontal was 1.53 degrees in the active span and 2.45 degrees in the passive span.

The free loop antinode amplitude of the cable was measured at the second free loop from the suspension assembly towards the shaker.

An electronically controlled shaker was used to excite the cable in the vertical plane. The shaker armature was securely fastened to the cable so that it was perpendicular to the cable in the vertical plane. The shaker was located in the span to allow a minimum of six (6) vibration loops between the suspension assembly and the shaker.

The test was carried out in a temperature-controlled laboratory at 22ºC ± 3ºC.

5.2.2 Optical Network

One (1) OPGW sample was terminated beyond both dead-end assemblies such that the optical fibers could not move relative to the OPGW. The cable and fiber terminations and the method to measure optical attenuation are described in Appendix C.

For the attenuation measurement, twenty-four (24) of the forty-eight (48) fibers were spliced together to form one continuous loop of 732.24 m (24 fibers x 30.51 m). The gauge length for attenuation measurements was taken to be the length under tension, from dead-end to dead-end.

5.2.3 Instrumentation and Data Acquisition

A laser micrometer and calibrated V-Scope were used to measure the free loop antinode amplitude. A load cell was used to measure the cable tension. A hand-held digital protractor was used to measure the exit angle of the cable from the suspension clamp. A thermocouple was used to measure the air temperature.

The GPIB (General Purpose Interface Bus) output of the optical power meters, peak-to-peak free loop amplitude, vibration frequency, number of cycles, cable tension and air temperature were recorded every five (5) minutes by a digital data logging system. The peak-to-peak free loop amplitude was manually recorded on a daily basis.

The measuring instruments and equipment used in this test are listed in Appendix D.

5.3 Test Procedure

The OPGW was tensioned to 28.52 kN or 25% of the cable RTS and the initial optical measurement was recorded, and the exit angles of the cable from the suspension clamp were measured.

The initial target vibration frequency was 42.56 Hz, which is the frequency produced by a 4.5 m/s wind (i.e., frequency = 830 ÷ diameter of the OPGW in mm). The actual vibration frequency was the system resonance that was nearest to the target frequency and also provided good system stability.

The target free loop peak-to-peak antinode amplitude was 6.50 mm (0.256 inch) or one third of the OPGW diameter. This amplitude was maintained at this level in the second free loop from the suspension assembly towards the shaker. The amplitudes in the passive span and the section between the shaker and the dead-end in the active span were maintained at levels no greater than one third of the cable diameter.

The OPGW was subjected to 10 million vibration cycles.

Optical measurements were taken for at least fifteen (15) minutes after the completion of the vibration cycles.

Upon completion of the test, the OPGW and supporting hardware were dissected and inspected for signs of cracking or breaking. The diameter of the OPGW cable and stainless steel tubes were measured after the test.

5.4 Test Results

The average values of all the data recorded are listed in Table 5-1. The visual recordings of the V-Scope are listed in Table 5-2.

A plot of peak-to-peak free loop antinode amplitude and optical attenuation versus vibration cycles is shown in Figure 5-2. The maximum temporary increase in optical attenuation measured during the test was 0.010 dB/test fiber km. The permanent increase in optical attenuation measured at the end of the test (after the fifteen minute hold) was less than 0.005 dB/test fiber km.

Table 5-1: Aeolian Vibration Test – Average Values of Results

Parameter	Average Value
OPGW Tension	28.8 kN
Vibration Frequency	42.95 Hz
Peak-to-peak Amplitude	6.70 mm (0.26 inch)
Air Temperature	23.0 ^{o}C

Table 5-2: Visual Recordings of V-Scope

Date	Time	Number of Cycles	V-Scope Measured (in p-p)	V-Scope Calculated (mm p-p)
April 24, 2017	15:04	8,676	0.26	6.60
April 24, 2017	17:44	417 k	0.27	6.86
April 25, 2017	6:51	2,477 k	0.26	6.60
April 25, 2017	14:11	2,859 k	0.26	6.60
April 26, 2017	10:08	5,941 k	0.27	6.86
April 27, 2017	14:56	10,000 k	Test Complete	--

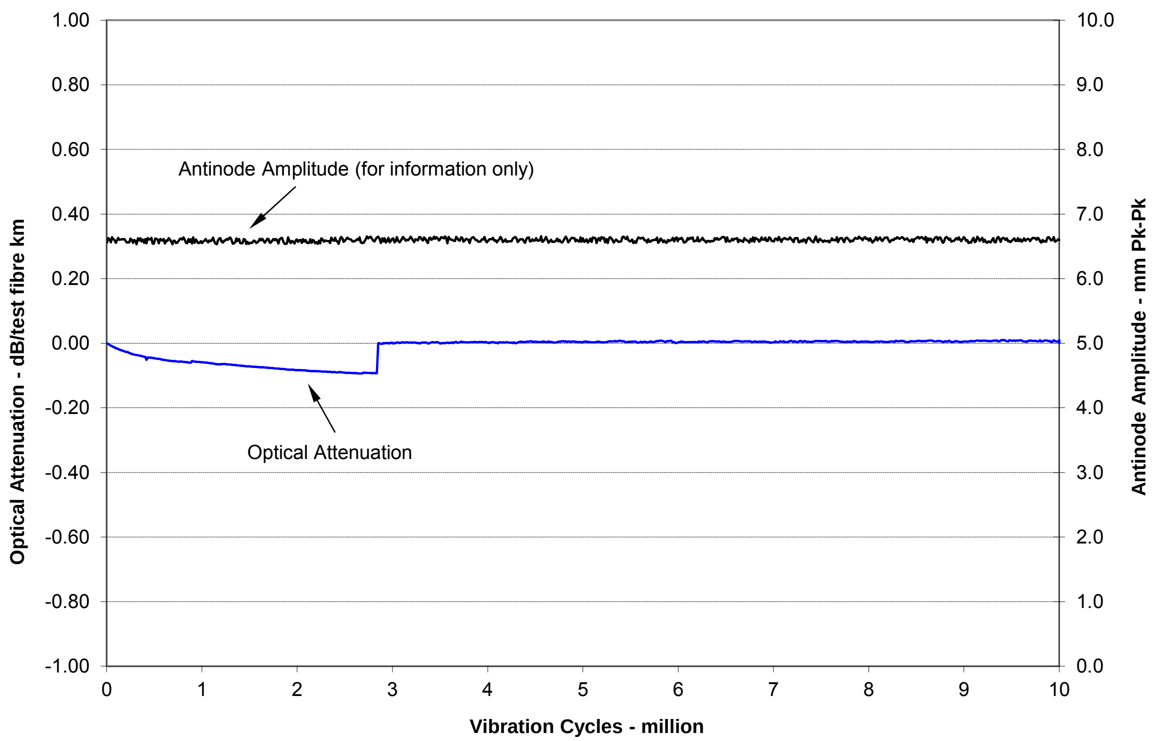


Figure 5-2: Aeolian Vibration Test – Amplitude and Optical Attenuation vs. Vibration Cycles

After completion of 10 million cycles, the cable and supporting hardware were dissected and visually examined. A photo of the dissected suspension assembly is shown in Figure 5-3. The results of the dissection are recorded in Table 5-3. The ovality of the cable and optical unit were measured, with the diameters recorded in Table 5-4 and Table 5-5.

Table 5-3: Aeolian Vibration Test – Dissection Results

Component Inspected		Active Side	Passive Side
Suspension Assembly	Outer Armor Rods	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
	Metallic Housing	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
	Neoprene Insert	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
OPGW Cable Under Suspension Assembly	1st (Outer) Layer of OPGW: AA Wires	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
	2nd Layer of OPGW: AA Wire	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
	2nd Layer of OPGW: ACS Wires	Signs of light fretting with no significant material loss on the ACS wires, no breaks, cracks or failure.	Signs of light fretting with no significant material loss on the ACS wires, no breaks, cracks or failure.
	2nd Layer of OPGW: Stainless Steel Optical Unit	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
	Center Wire: ACS Wires	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
Dead-end	Outer Armor Rods	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
	Inner Reinforcing Rods	Signs of light fretting with no significant material loss, no breaks, cracks or failure.	Signs of light fretting with no significant material loss, no breaks, cracks or failure.
OPGW Cable Under Dead-end Hardware	1st (Outer) Layer of OPGW: AA Wires	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
	2nd Layer of OPGW: AA Wire	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
	2nd Layer of OPGW: ACS Wires	Signs of light fretting with no significant material loss on the ACS wires, no breaks, cracks or failure.	Signs of light fretting with no significant material loss on the ACS wires, no breaks, cracks or failure.
	2nd Layer of OPGW: Stainless Steel Optical Unit	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
	Center Wire: ACS Wires	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.

Table 5-4: Aeolian Vibration Test – Ovality Measurements Under Suspension Assembly

Component Measured		Measurement	Active Side	Center	Passive Side
OPGW Cable Under Suspension Assembly	Complete OPGW	Maximum Diameter (mm)	19.86	19.80	19.78
		Minimum Diameter (mm)	19.64	19.50	19.63
		Calculated Ovality (%)	0.6%	0.8%	0.4%
	Stainless Steel Tube	Maximum Diameter (mm)	3.88	3.86	3.88
		Minimum Diameter (mm)	3.85	3.84	3.83
		Calculated Ovality (%)	0.4%	0.3%	0.6%

Table 5-5: Aeolian Vibration Test – Ovality Measurements Under Dead-ends

Component Measured		Measurement	Active Side	Passive Side
OPGW Cable Under Dead-end Hardware	Complete OPGW	Maximum Diameter (mm)	19.79	19.69
		Minimum Diameter (mm)	19.57	19.53
		Calculated Ovality (%)	0.6%	0.4%
	Stainless Steel Tube	Maximum Diameter (mm)	3.89	3.91
		Minimum Diameter (mm)	3.81	3.84
		Calculated Ovality (%)	1.0%	0.9%

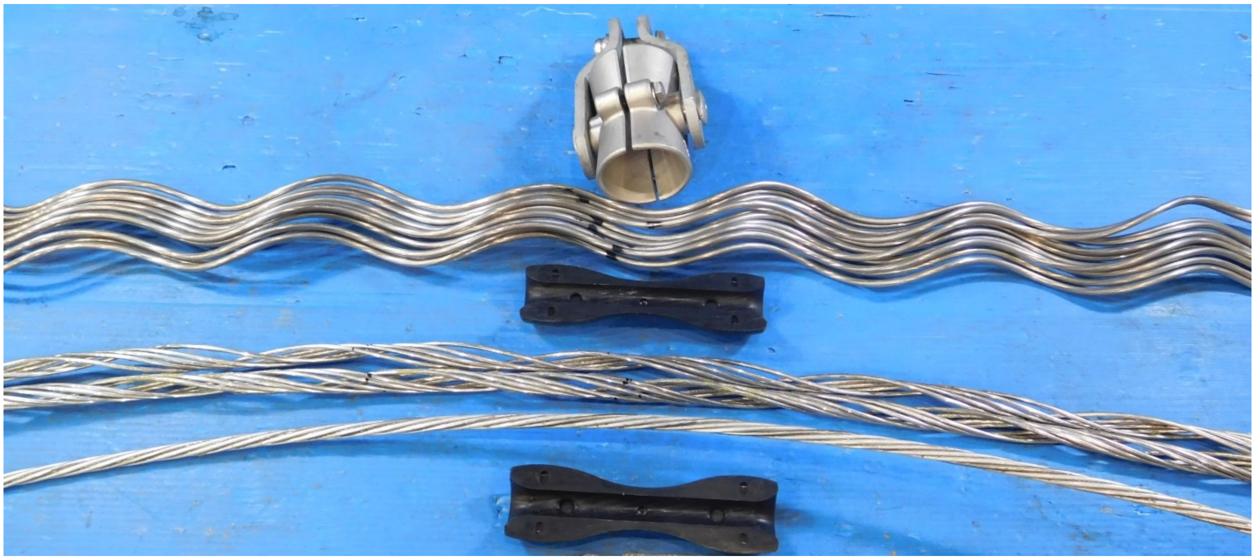


Figure 5-3: Aeolian Vibration Test Dissection Results – Suspension Assembly

5.5 Acceptance Criteria

As specified in IEC 60794-1-21:2015 Paragraph 24.5, any sign of temporary or permanent damage to the cable or any of the component parts greater that the value specified in the detail specification shall be a failure. Any short term fluctuations or long term changes in attenuation, if specified, shall not exceed the specified range.

As specified in IEC 60794-4-10:2014 Paragraph 8.3.6, on completion of the test the following criteria shall be considered:

- Any visible damage to the cable or to any of the cable elements shall be considered as a test failure.
- MAOC of the optical unit shall be 20% of the measured diameter of the optical unit.
- The change in attenuation of monitored optical fibers shall comply with the general optical requirements stated in 8.3.1.
    - As specified in 8.3.1: a permanent or temporary increase in optical attenuation greater than 0.2 dB/km of test fiber, at 1550 nm nominal wavelength for single-mode fibers, shall constitute failure.

5.6 Conclusion

The cable, as tested, met the requirements for the Aeolian Vibration Test as specified in with IEC 60794-1-21:2015 Method E19, and IEC 60794-4-10:2014 Paragraph 8.3.6.

6 Creep Test

Test Date:	May 12 – June 23, 2017
Test Laboratory:	Kinectrics International Inc.
Cable Manufacturer:	El Sewedy Cables
End-User:	Filiales Groupe SONELGAZ
Accessories:	Epoxy-resin Dead-ends
Kinectrics Staff:	Mr. Michael Kastelein Mr. Sevac Titizian Ms. Corrine Dimnik
Witnesses:	None

6.1 Test Objective and Standard

The objective of the Creep Test is to measure the room temperature long-term tensile creep properties of the cable. The data from this test may be used to assist in the calculation of sags and tensions during the design of overhead transmission lines.

The test was performed in accordance with IEC 61395 *"Overhead electrical conductors – Creep test procedures for stranded conductors"*.

6.2 Test Set-up

6.2.1 Test Assembly and Apparatus

A schematic of the set-up for the Creep Test is illustrated in Figure 6-1. A photo of the actual test set-up is shown in Figure 6-2. The test was performed on the span designated KB019-South-West.

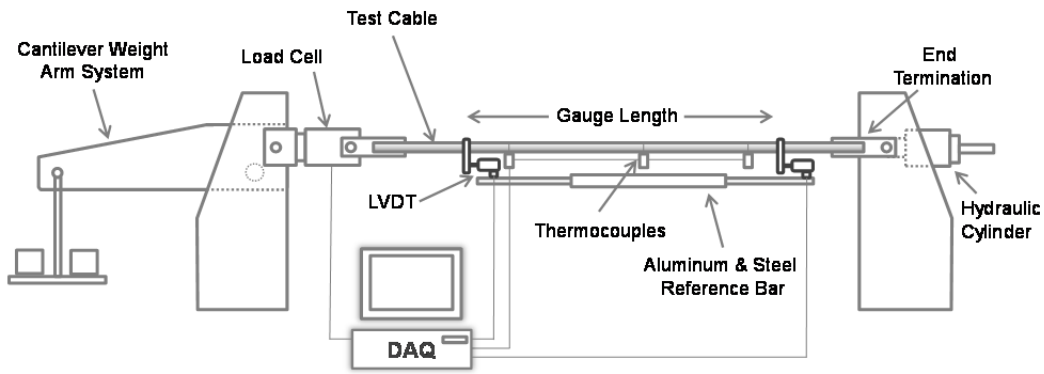


Figure 6-1: Set-up for Creep Test (Schematic)

Figure 6-2: Set-up for Creep Test (Actual Sample)

One (1) sample was prepared for the Creep Test by terminating the cable ends with epoxy-resin dead-ends. The cable length between dead-end clamps was 13.89 meters. Two (2) flat metal "paddles" were installed on the cable 8.002 meters apart, centered midway between the ends of the cable. Two (2) calibrated linear variable differential transducers (LVDT) with 0.04 mm resolution were installed on a steel-aluminum reference bar. The reference bar was assembled to have the same thermal coefficient of linear expansion as the cable.

The tension was maintained for the duration of the test using a cantilever weight arm system. The weight arm system was equipped with a linear actuator to increase or decrease the load automatically as necessary.

The temperature of the cable sample was measured at three (3) locations using thermocouples positioned in the outer layer of the cable. The thermocouples were located at the center of the span and at both ends of the gauge length.

The test was carried out in a temperature-controlled laboratory, with the average temperature for the duration of the test within 20ºC ± 2ºC.

6.2.2 Optical Network

Optical measurements are not required for the Creep Test.

6.2.3 Instrumentation and Data Acquisition

The cable elongation, tension and temperature were measured by the LVDTs, load cell and thermocouples respectively. These three (3) parameters were monitored continuously using a digital data logging system. The data logging rate was such to record points evenly spaced on a logarithmic scale.

The measuring instruments and equipment used in this test are listed in Appendix D.

6.3 Test Procedure

The cable was pre-tensioned to approximately 2.3 kN, or 2% of the cable's RTS, in order to straighten the test sample and install the LVDTs. The cable was then loaded using a cantilever weight arm system to achieve a target tension of 20% RTS ± 2% within five (5) minutes. Once the target tension was achieved, the cantilever weight arm system ensured near constant tension for the duration of the test. The loading rate was kept linear to avoid impacting or overloading the sample. The LVDTs, load cell and thermocouples were read automatically using the digital data logging system for duration of the test.

6.4 Test Results

As stated in IEC 61395, the long-term tensile creep of a cable under constant tension is taken to be the permanent strain occurring between one (1) hour and the specified test time. The specified test time for this test was 1,000 hours.

A log-log plot of strain versus elapsed time recorded by the LVDTs is shown in Figure 6-3.

On completion of the test, a best-fit straight line was fitted to the LVDT data and was extrapolated to ten (10) years (87,600 hours). The equation of the line is:

$$\text{Strain} = A \times (\text{Hours})^{B}$$

where	A =	Y-intercept =	3.7863E-05 ε
	B =	slope =	0.22363

The initial creep value (defined at 1 hour) using the fitted line is:
(Strain at 1 hr) = 3.786E-05 ε

The creep during the test using the fitted line is:
(Strain at 1000 hr) - (Strain at 1 hr) = 1.775E-04 - 3.786E-05 = 1.396E-04 ε

The 10-year (87,600 hrs) creep using the fitted line is:
(Strain at 87,600 hr) - (Strain at 1 hr) = 4.825E-04 - 3.786E-05 = 4.446E-04 ε

The 1,000 hour creep resulted in strain of 139.6 mm/km; and the 10-year creep projects a strain of 444.6 mm/km.

[The remainder of this page intentionally left blank.]

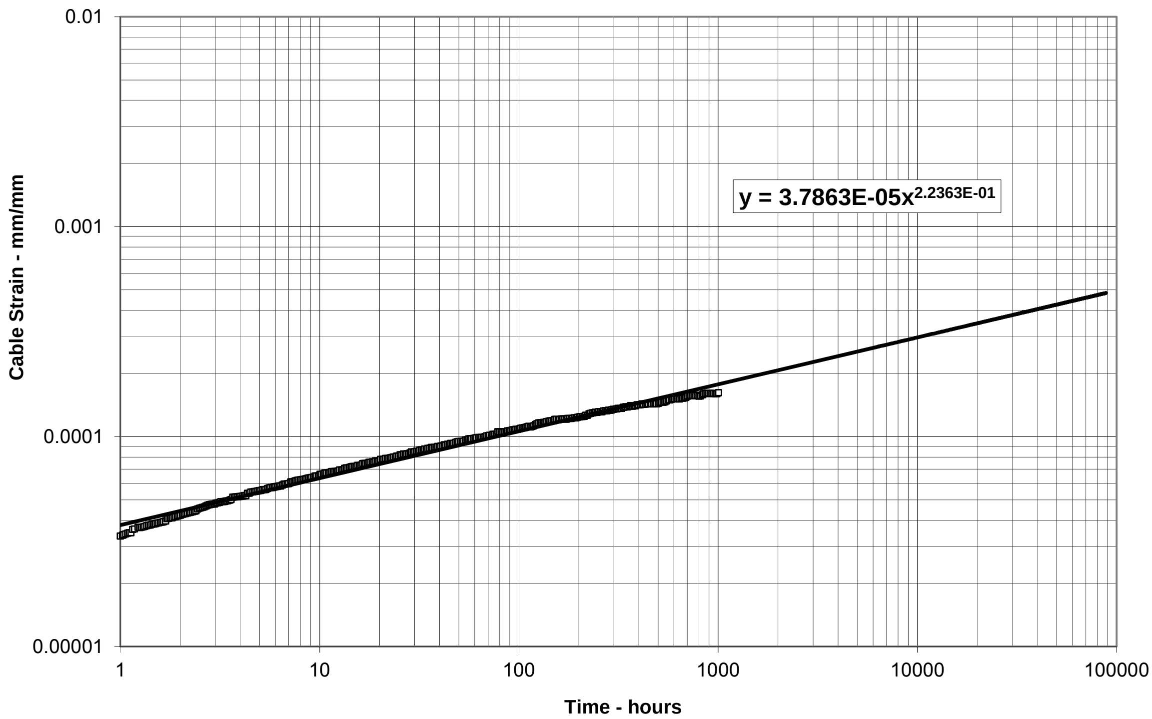


Figure 6-3: Creep Test Results (Cable Strain vs. Time)

6.5 Acceptance Criteria

There are no acceptance criteria for the Creep Test stated in IEC 61395. The results are presented for information purposes.

6.6 Conclusion

The primary purpose of the Creep Test is to determine the long-term creep characteristics of the OPGW cable. The data from this test may be used to assist in the calculation of sags and tensions during the design of overhead transmission lines.

7 Galloping Test

Test Date:	April 25 – 27, 2017
Test Laboratory:	Kinectrics International Inc.
Cable Manufacturer:	El Sewedy Cables
End-User:	Filiales Groupe SONELGAZ
Accessories:	Dead-end wraps supplied by RIBE Part No. AW306192/RW214330LIS Suspension assembly supplied by RIBE Range 19.4 – 23.1 mm
Kinectrics Staff:	Mr. Greg Brown Mr. Daniel Marleau Ms. Corrine Dimnik
Witnesses:	Mr. Nabil Abdennour – GRTE Mr. Said Hamoudi – CEEG Mr. Riadh Fellouh – El Sewedy Cables Algeria Mr. Miloud Aggoun – El Sewedy Cables Algeria

7.1 Test Objective and Standard

The objective of the Galloping Test is to assess the fatigue performance of the OPGW and the optical characteristics of the fibers under typical galloping conditions.

The test was performed in accordance with IEC 60794-1-21:2015 Method E26, IEC 60794-4-10:2014 Paragraph 8.3.8 and Kinectrics Method.

7.2 Test Set-up

7.2.1 Test Assembly and Apparatus

A schematic of the set-up for the Galloping Test is illustrated in Figure 7-1. The test was performed on the span designated KB019-South.

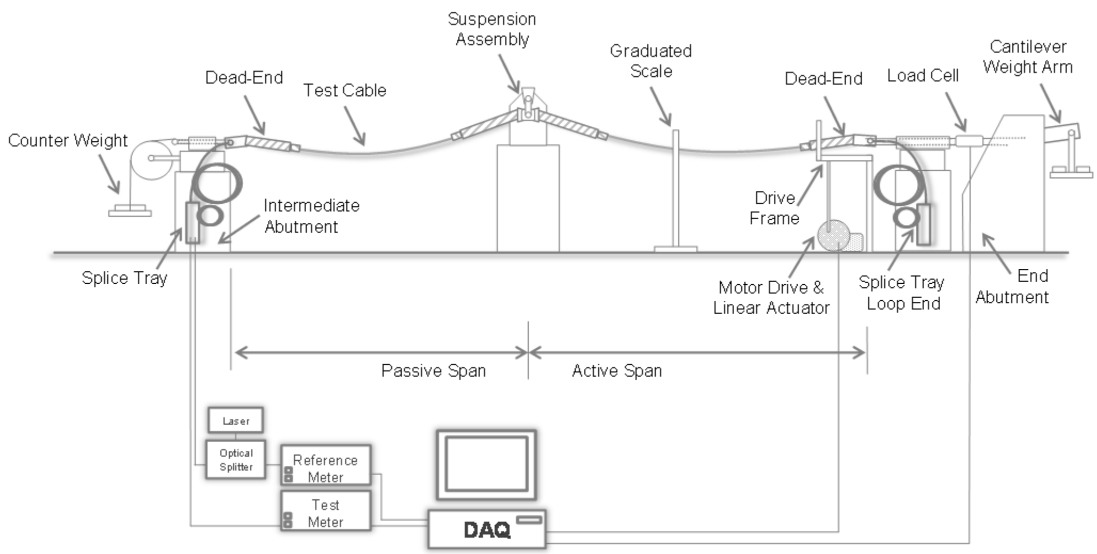


Figure 7-1: Set-up for Galloping Test (Schematic)

The OPGW was contained between two (2) intermediate abutments. The active span cable length was 20.35 m and the passive span cable length was 20.45 m for a total cable length of 40.80 m between the loading points of the dead-end clamps. Fixed end abutments were used to load and maintain tension in the fiber optic cable. The initial target tension of between 4.0 kN and 8.0 kN is 5% to 10% of the Maximum Allowable Tension (MAT) of 79.86 kN, or 70% RTS. A lower value was used, in order to achieve the target free loop motion. The tension was applied using a cantilever weight arm on one of the end abutments, and a sheave wheel and a counter weight at the other end abutment. The end abutments allowed horizontal motion of the test sample by way of linear bearings.

The dead-end assemblies were installed between the intermediate abutments. The suspension assembly was supported at a height such that the static sag angle of the cable to horizontal was approximately 0.2 degrees in the active span.

The free loop antinode amplitude of the cable was measured at a point midway between the suspension assembly and the dead-end. This was achieved by manually observing a graduated scale supported next to the cable.

A motor drive and linear actuator, attached to a drive frame, were used to excite the cable in the vertical plane. The drive frame was loosely fastened to the cable to sustain the galloping motion. The drive frame was located in the span to create a single vibration loop in the active span.

The test was carried out in a temperature-controlled laboratory at 22ºC ± 3ºC.

7.2.2 Optical Network

One (1) OPGW sample was terminated beyond both dead-end assemblies such that the optical fibers could not move relative to the OPGW. The cable and fiber terminations and the method to measure optical attenuation are described in Appendix C.

For the attenuation measurement, twenty-four (24) of the forty-eight (48) fibers were spliced together to form one continuous loop of 979.2 m (24 fibers x 40.8 m). The gauge length for attenuation measurements was taken to be the length under tension, from dead-end to dead-end.

7.2.3 Instrumentation and Data Acquisition

A graduated scale was used to measure the free loop antinode amplitude. A load cell was used to measure the cable tension. A hand-held digital protractor was used to measure the exit angle of the cable from the suspension clamp.

The GPIB (General Purpose Interface Bus) output of the optical power meters, vibration frequency, number of cycles, and cable tension were recorded every five (5) minutes by a digital data logging system. The peak-to-peak free loop amplitude and vibration frequency were manually recorded on a daily basis.

The measuring instruments and equipment used in this test are listed in Appendix D.

7.3 Test Procedure

The OPGW was tensioned to approximately 2.0 kN or 2.5% of the cable MAT and the exit angles of the cable from the suspension clamp were measured.

The target free loop peak-to-peak antinode amplitude was 0.8 m, or 1/25th of the active span length between the dead-end and suspension assembly (i.e. 1/25th of 20 m). This amplitude was maintained at this level in the active side, single-loop mode. The amplitude in the passive span was maintained at a level no greater than the amplitude in the active span.

The OPGW was subjected to 100,000 galloping cycles.

Optical measurements were taken for at least fifteen (15) minutes after the completion of the vibration cycles.

Upon completion of the test, the OPGW and supporting hardware were dissected and inspected for signs of cracking or breaking.

7.4 Test Results

The average values of all the data recorded are listed in Table 7-1. A plot of peak-to-peak free loop antinode amplitude and optical attenuation versus vibration cycles is shown in Figure 7-2. The maximum temporary increase in attenuation measured during the test was 0.008 dB/test fiber km. The permanent attenuation measured at the end of the test (after the fifteen minute hold) was less than 0.005 dB/test fiber km.

Table 7-1: Galloping Test – Average Values of Results

Parameter	Average Value
OPGW Tension	1.8 kN
Vibration Frequency	1.14 Hz
Peak-to-peak Amplitude in Active Span	1.1 m
Peak-to-peak Amplitude in Passive Span	0.5 m

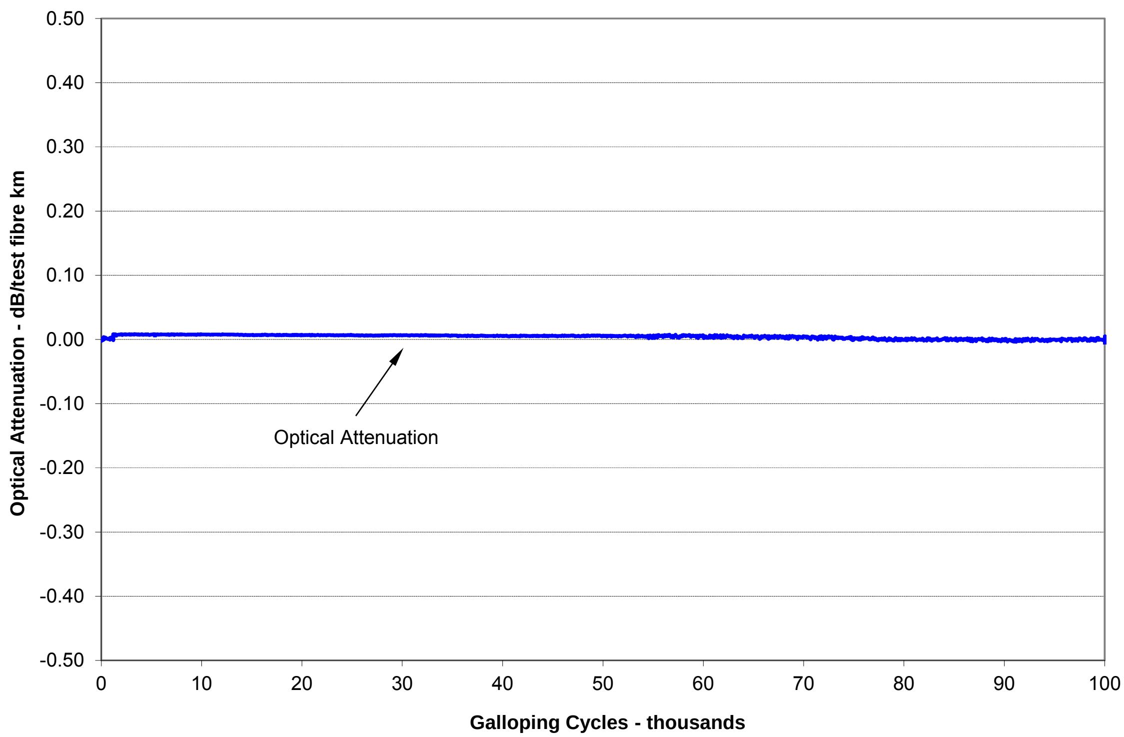


Figure 7-2: Galloping Test – Optical Attenuation vs. Vibration Cycles

After completion of 100,000 cycles, the cable and supporting hardware were dissected and visually examined. A photo of the dissected suspension assembly is shown in . The results of the dissection are recorded in Table 7-2.

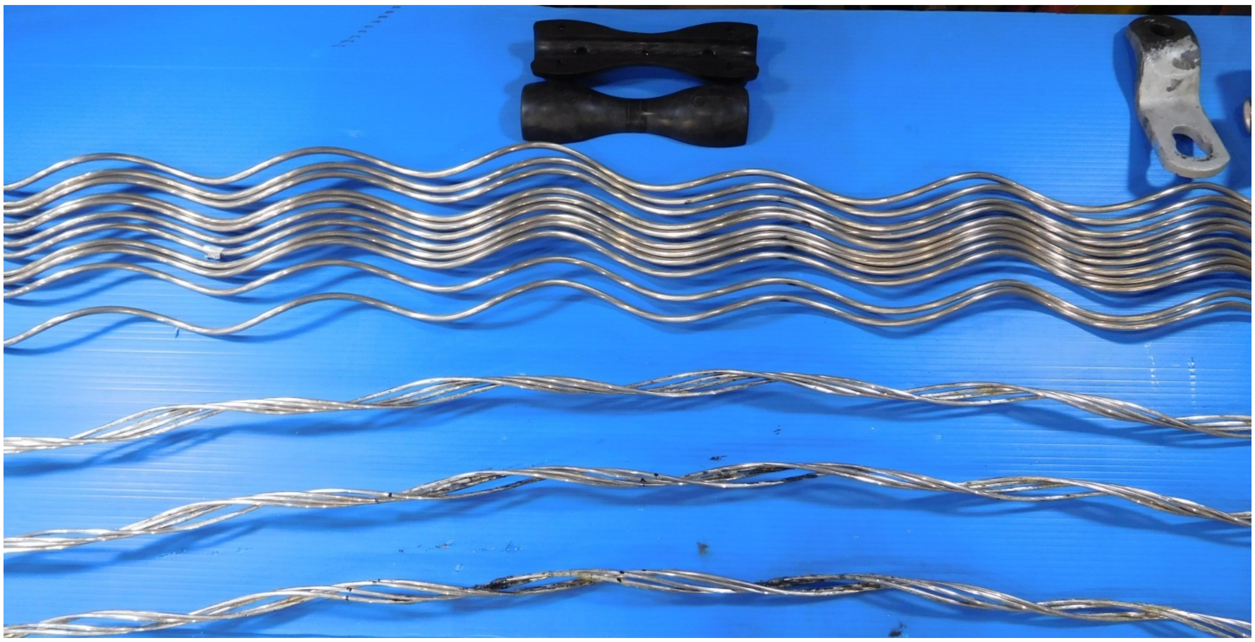


Figure 7-3: Galloping Test Dissection Results – Suspension Assembly

[The remainder of this page intentionally left blank.]

Table 7-2: Galloping Test – Dissection Results

Component Inspected		Active Side	Passive Side
Suspension Assembly	Outer Armor Rods	Signs of light fretting with no significant material loss, no cracks, breaks or failures.	Signs of light fretting with no significant material loss, no cracks, breaks or failures.
	Metallic Housing	Signs of light fretting with no significant material loss, no cracks, breaks or failures.	Signs of light fretting with no significant material loss, no cracks, breaks or failures.
	Neoprene Insert	Signs of light fretting with no significant material loss, no cracks, breaks or failures.	Signs of light fretting with no significant material loss, no cracks, breaks or failures.
OPGW Cable Under Suspension Assembly	1st (Outer) Layer of OPGW: AA Wires	Signs of light fretting with no significant material loss, no cracks, breaks or failures.	Signs of light fretting with no significant material loss, no cracks, breaks or failures.
	2nd Layer of OPGW: AA Wire	Signs of light fretting with no significant material loss, no cracks, breaks or failures.	Signs of light fretting with no significant material loss, no cracks, breaks or failures.
	2nd Layer of OPGW: ACS Wires	Signs of light fretting with no significant material loss on the ACS wires, no cracks, breaks or failures.	Signs of light fretting with no significant material loss on the ACS wires, no cracks, breaks or failures.
	2nd Layer of OPGW: Stainless Steel Optical Unit	Signs of light fretting with no significant material loss, no cracks, breaks or failures.	Signs of light fretting with no significant material loss, no cracks, breaks or failures.
	Center Wire: ACS Wires	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
Dead-end	Outer Armor Rods	Signs of light fretting with no significant material loss, no cracks, breaks or failures.	Signs of light fretting with no significant material loss, no cracks, breaks or failures.
	Inner Reinforcing Rods	Signs of light fretting with no significant material loss, no cracks, breaks or failures.	Signs of light fretting with no significant material loss, no cracks, breaks or failures.
OPGW Cable Under Dead-end Hardware	1st (Outer) Layer of OPGW: AA Wires	Signs of light fretting with no significant material loss, no cracks, breaks or failures.	Signs of light fretting with no significant material loss, no cracks, breaks or failures.
	2nd Layer of OPGW: AA Wire	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
	2nd Layer of OPGW: ACS Wires	Signs of light fretting with no significant material loss, no cracks, breaks or failures.	Signs of light fretting with no significant material loss, no cracks, breaks or failures.
	2nd Layer of OPGW: Stainless Steel Optical Unit	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.
	Center Wire: ACS Wires	There were no visible signs of breaks, cracks, or failure.	There were no visible signs of breaks, cracks, or failure.

7.5 Acceptance Criteria

As specified in IEC 60794-1-21:2015 Paragraph 31.5, there shall be no visible cracks or openings on the elements of cable. The maximum measured optical attenuation increase should not exceed the value specified in the detail specification.

As specified in IEC 60794-4-10:2014 Paragraph 8.3.8.3, on completion of the test the following criteria shall be considered:

- The change in attenuation of monitored optical fibers shall comply with the general optical requirements stated in 8.3.1.
    - As specified in 8.3.1: a permanent or temporary increase in optical attenuation greater than 0.2 dB/km of test fiber, at 1550 nm nominal wavelength for single-mode fibers, shall constitute failure.
- The elements of OPGW shall have no cracks or splits.

7.6 Conclusion

The cable, as tested, met the requirements for the Galloping Test as specified in IEC 60794-1-21:2015 Paragraph 31.5 and IEC 60794-4-10:2014 Paragraph 8.3.8.3.

[The remainder of this page intentionally left blank.]

8 Temperature Cycle Test on Complete OPGW

Test Date:	April 24 – 28, 2017
Test Laboratory:	Kinectrics International Inc.
Cable Manufacturer:	El Sewedy Cables
End-User:	Filiales Groupe SONELGAZ
Accessories:	Not Applicable
Kinectrics Staff:	Mr. Michael Colbert Mr. Aaron Duncan Ms. Corrine Dimnik
Witnesses:	Mr. Nabil Abdennour – GRTE Mr. Said Hamoudi – CEEG Mr. Riadh Fellouh – El Sewedy Cables Algeria Mr. Miloud Aggoun – El Sewedy Cables Algeria

8.1 Test Objective and Standard

The objective of the Temperature Cycle Test is to verify the good performance of the fiber when the cable is subjected to extreme thermal cycles.

The test was performed in accordance with IEC 60794-1-22:2012 *"Optical fibre cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental test methods"* Method F1, IEC 60794-4-10:2014 Paragraph 8.3.9 and Kinectrics Method.

8.2 Test Set-up

8.2.1 Test Assembly and Apparatus

A photo of the actual set-up for the Temperature Cycle Test is shown in Figure 8-1.

The reel with approximately 519.5 m of OPGW cable was placed in a 5 m x 6 m x 4 m environmental chamber.

Figure 8-1: Set-up for Temperature Cycle Test

8.2.2 Optical Network

For the attenuation measurement, twenty-four (24) of the forty-eight (48) fibers were spliced together to form one continuous loop of 12.467 km (24 fibers x 519.5 m). The total length of fiber under test was approximately 12.467 km. The cable and fiber terminations and the method to measure optical attenuation are described in Appendix C.

8.2.3 Instrumentation and Data Acquisition

Four (4) thermocouples were placed in the environmental chamber to measure the temperature. Two (2) thermocouples were installed on separate 25 cm cable samples and located on either side of the cable reel. The third thermocouple was located under the first layer on the cable reel, and recorded for information purposes. The fourth thermocouple measured the air temperature inside the chamber, and recorded for information purposes.

The measuring instruments used in this test are listed in Appendix D.

8.3 Test Procedure

The cable was subjected to two (2) thermal cycles. A thermal cycle was based on the chamber temperature starting at +22ºC ± 3 ºC, lowering to -40ºC and holding for a minimum of 16 hours. The chamber temperature was then increased to +75ºC and held for a minimum of 16 hours. To complete the cycle, the chamber temperature was returned to +22ºC ± 3 ºC. All temperature transitions were conducted at a rate of between 20ºC/hour and 40ºC/hour. The chamber temperature was based on the average of the two (2) thermocouples installed on the 25 cm cable samples, located on either side of the cable reel.

The cable reel temperature and optical data were recorded every five (5) minutes throughout the test.

8.4 Test Results

Optical attenuation and chamber temperature vs. time are shown in Figure 8-2. There was no permanent increase in optical attenuation measured after the test.

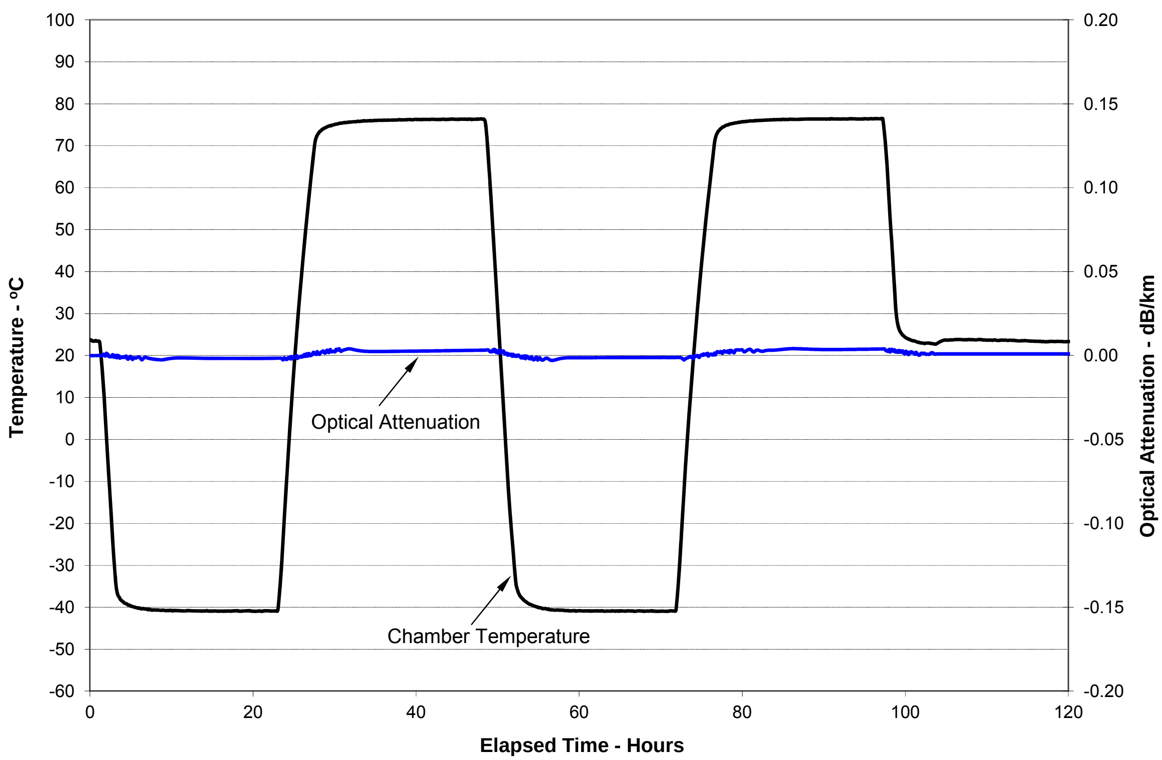


Figure 8-2: Temperature Cycle Test – Temperature and Optical Attenuation vs. Time

8.5 Acceptance Criteria

As specified in IEC 60794-1-22:2012 Paragraph 3.5, the acceptance criteria for the test shall be as stated in the detail specification. Typical failure modes include loss of optical continuity, degradation of optical transmittance or physical damage to the cable.

As specified in IEC 60794-4-10:2014 Paragraph 8.3.9, any permanent increase in attenuation in optical fibers after the test shall not exceed 0.10 dB/km when measured at 1 550 nm.

8.6 Conclusion

The cable, as tested, met the requirements for the Temperature Cycle Test as specified in IEC 60794-1-22:2012 Paragraph 3.5 and IEC 60794-4-10:2014 Paragraph 8.3.9.

[The remainder of this page intentionally left blank.]

9 Water Penetration Test

Test Date:	April 24, 2017
Test Laboratory:	Kinectrics International Inc.
Cable Manufacturer:	El Sewedy Cables
End-User:	Filiales Groupe SONELGAZ
Accessories:	Not Applicable
Kinectrics Staff:	Mr. Aaron Duncan Ms. Corrine Dimnik
Witnesses:	Mr. Nabil Abdennour – GRTE Mr. Said Hamoudi – CEEG Mr. Riadh Fellouh – El Sewedy Cables Algeria Mr. Miloud Aggoun – El Sewedy Cables Algeria

9.1 Test Objective and Standard

The objective of the Water Penetration Test is to expose a length of fluid blocked optical unit to a head of water to verify that water does not pass through the unit

The test was performed in accordance with IEC 60794-1-22:2012 Method F5B, IEC 60794-4-10:2014 Paragraph 8.3.10 and Kinectrics Method.

9.2 Test Set-up

9.2.1 Test Assembly and Apparatus

A schematic of the set-up for the Water Penetration Test is illustrated in Figure 9-1. A photo of the actual test set-up is shown in Figure 9-2.

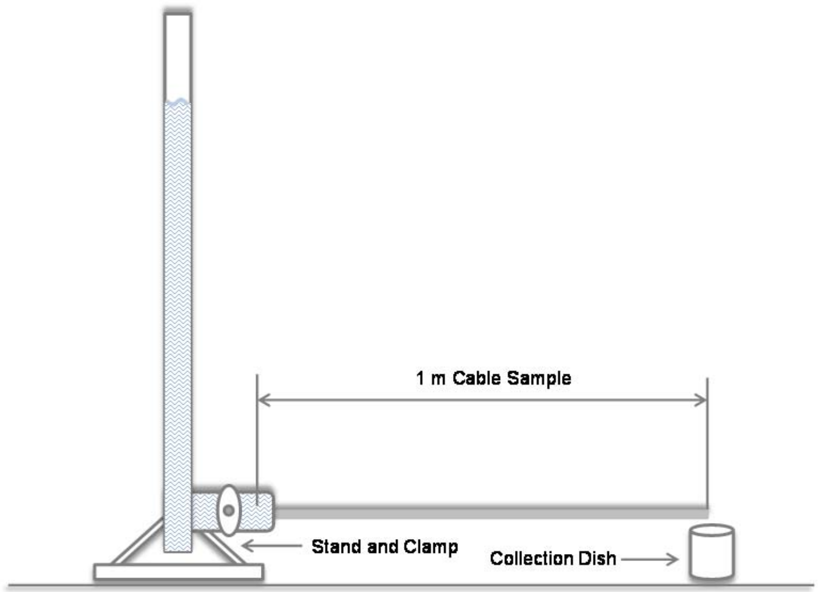


Figure 9-1: Set-up for Water Penetration Test (Schematic)

Figure 9-2: Set-up for Water Penetration Test (Actual Sample)

A one (1) m section of OPGW cable was prepared for this test. All components of the cable were removed from the fluid-blocked stainless steel tube.

The stainless steel tube containing the optical fibers was positioned horizontally with one end attached to a vertically-aligned, clear plastic tube using a water-tight fitting. The fitting did not restrict the water from entering the stainless steel tube. A collection dish was placed under the open end of the optical unit to collect any water that may pass through it.

The test was carried out in a temperature-controlled laboratory at 22ºC ± 3ºC.

9.2.2 Optical Network

Optical measurements are not required for the Water Penetration Test.

9.2.3 Instrumentation and Data Acquisition

The optical unit and collection dish were visually checked for water. The start and completion times, and ambient air temperature were manually recorded. No digital data logging system was required for this test.

The measuring instruments and equipment used in this test are listed in Appendix D.

9.3 Test Procedure

The fluid blocked optical unit was installed in the Water Penetration test fixture. The clear plastic tube was filled with 1.0 meter ± 0.1 meter of water. The water was maintained at this level for at least one (1) hour. During and at the conclusion of one (1) hour, the open end of the optical unit was visually checked for water.

9.4 Test Results

The results of the Water Penetration Test are summarized in Table 9-1.

Table 9-1: Water Penetration Test Results

Sample Under Test	Start Date & Time	Completion Date & Time	Observation
Stainless Steel Tube	April 24, 2017 at 14:03	April 24, 2017 at 15:06	No water was observed at end of the tube or in the collection dish.

9.5 Acceptance Criteria

As specified in IEC 60794-4-10 paragraph 8.3.10, no water leak should be detected at the unsealed end of the sample after 1 hour of 1 m height of water pressure is applied on one end of the sample.

9.6 Conclusion

The cable, as tested, met the requirements for the Water Penetration Test as specified in IEC 60794-4-10:2014 Paragraph 8.3.10.

[The remainder of this page intentionally left blank.]

10 Short Circuit Test

Test Date:	April 28, 2017
Test Laboratory:	Kinectrics International Inc.
Cable Manufacturer:	El Sewedy Cables
End-User:	Filiales Groupe SONELGAZ
Accessories:	Dead-end wraps supplied by RIBE Part No. AW306192/RW214330LIS
Kinectrics Staff:	Mr. Michael Kastelein Ms. Corrine Dimnik Mr. Shon Paglia
Witnesses:	Mr. Nabil Abdennour – GRTE Mr. Said Hamoudi – CEEG Mr. Riadh Fellouh – El Sewedy Cables Algeria Mr. Miloud Aggoun – El Sewedy Cables Algeria

10.1 Test Objective and Standard

The objective of the Short Circuit Test is to verify that the OPGW can withstand repeated short circuit applications without exceeding optical, physical or thermal requirements.

The test was performed in accordance with IEC 60794-1-24:2014 *"Optical fibre cables – Part 1-24: Generic specification – Basic optical cable test procedures – Electrical test methods"* Method H1 and IEC 60794-4-10:2014 Paragraph 8.3.11.

10.2 Test Set-up

10.2.1 Test Assembly and Apparatus

A schematic of the electrical circuit for the Short Circuit Test is illustrated in Figure 10-1. Photos of the actual set-up for the test are shown in Figure 10-2, Figure 10-3, and Figure 10-4. The test was carried out at Kinectrics' Indoor High Current Test Facility.

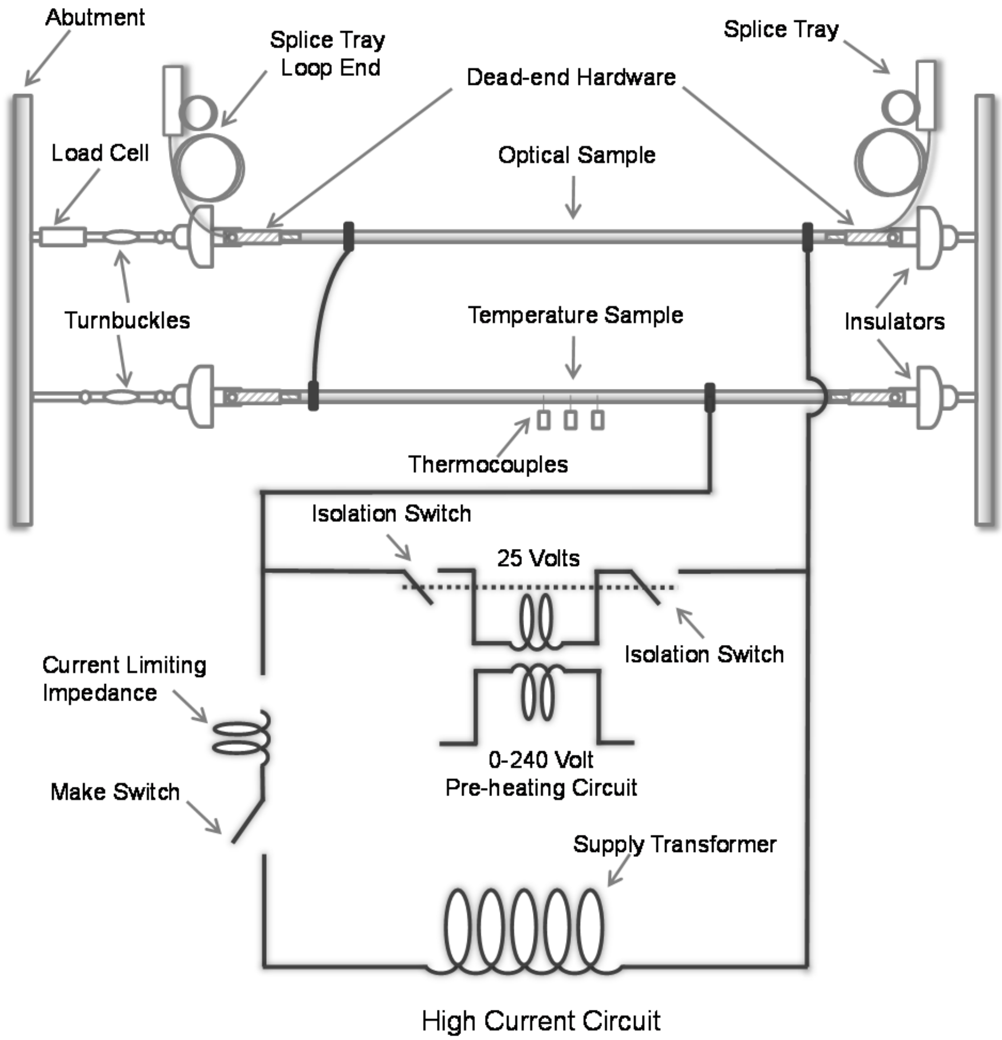


Figure 10-1: Set-up for Short Circuit Test (Schematic)

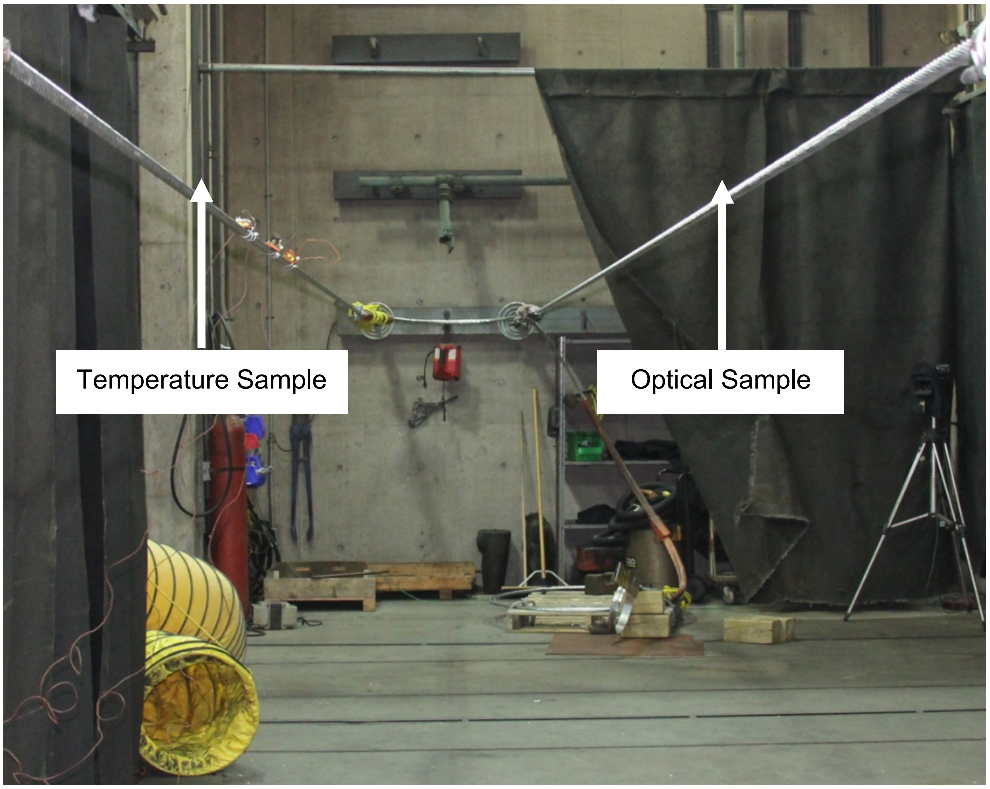


Figure 10-2: Set-up for Short Circuit Test (Actual Sample)

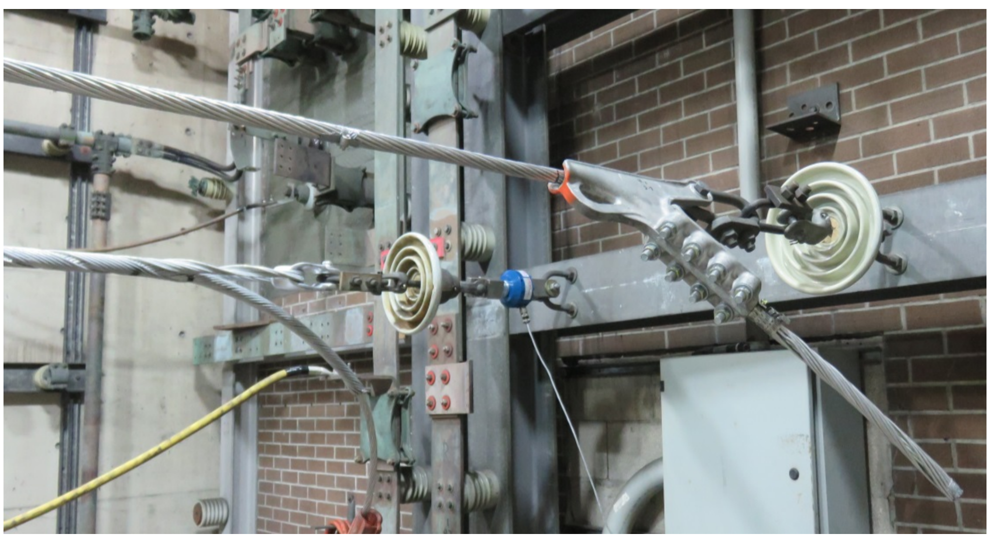


Figure 10-3: Set-up for Short Circuit Test (Actual Sample)

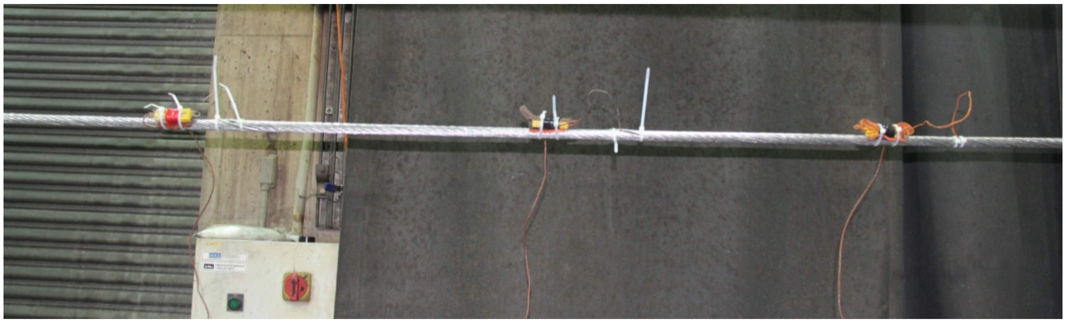


Figure 10-4: Set-up for Short Circuit Test – Thermocouple Installation (Actual Sample)

Two (2) OPGW samples were used for this test. One sample, “Optical Sample”, was used to monitor the performance of the optical fibers and to observe any physical damage that might occur during the test. The other sample, “Temperature Sample”, was used only to measure the temperature at several points in the cross-section of the cable. The cables were positioned approximately 1 m apart and about 2 m above the ground.

The cables were electrically connected in series so that they would be subjected to the same short circuit current. The short circuit current was provided by a high level current transformer. An air conditioning unit was used to maintain the ambient temperature of the High Current Test Facility and the cable temperature to 20ºC between short circuit applications.

10.2.2 Optical Sample

The Optical Sample was terminated beyond both dead-end assemblies such that the optical fibers could not move relative to the OPGW. The cable and fiber terminations and the method to measure optical attenuation are described in Appendix C.

The length of cable between the current injection points was approximately 10 m. A turnbuckle was used to tension the cable to the required value. A load cell was used to measure the tension. The optical sample was tensioned to about 17.1 kN at 20ºC. This is about 15 % of the cable’s RTS.

For the attenuation measurement, twenty-four (24) of the forty-eight (48) fibers were spliced together to form one continuous loop of 236.4 m (24 fibers x 9.85 m). The gauge length for attenuation measurements was taken to be the length between current injection points.

10.2.3 Temperature Sample

Optical signals were not measured in the Temperature Sample.

The length of cable between the current injection points was also approximately 10 m. A turnbuckle was used to tension the cable to nominally the same value as the Optical Sample. A dynamometer was used to measure the tension.

The temperature in this sample was measured at three (3) locations using three (3) fast responding thermocouples. They were spaced approximately one (1) m apart, installed as per Table 10-1. The thermocouples were electrically isolated from other instrumentation to prevent electrical interference. The thermocouple installation is shown in Figure 10-4.

Table 10-1: Short Circuit Test – Location of Thermocouples in Temperature Sample

Thermocouple No.	Position
1	Between two aluminum alloy (AA) wires in outer layer
2	Between AA wire and stainless steel tube
3	Inside stainless steel tube

10.2.4 Instrumentation and Data Acquisition

The signal from all three (3) thermocouples and the variation in the optical attenuation were plotted in real-time, typically once every second, to provide a "digital strip chart" to observe the trend of the signals over the entire test period. Before each short circuit application, the acquisition system was triggered for high-speed acquisition. For each short circuit application, or "shot", the high-speed waveform recorded the short circuit current at a minimum of 5,000 samples/second; while the signal from the optical power meters and thermocouples were recorded at reduced rate, a minimum of 200 samples/second.

The measuring instruments and equipment used in this test are listed in Appendix D.

10.3 Test Procedure

The OPGW samples were tensioned to 17.1 kN or 15% of the cable RTS and maintained at a temperature of no more than 20°C, and the initial optical measurement was recorded. To ensure the optical signals were stable, the power meters were powered on and operating for at least fifteen (15) minutes before the first shot.

The optical measurement was normalized to zero before the first official shot.

The cable was first subjected to one (1) low-level calibration shot and then three (3) "official" shots. The purpose of the calibration shot was to ensure that the current level was correct. For the "official" shots, the target values for the electrical parameters are outlined in Table 10-2.

Table 10-2: Short Circuit Test – Target Electrical Parameters

Parameter	Target Value
Energy	400 kA^2-second
Fault Current	40 kA
Duration	0.25 seconds
Asymmetry	Maximum possible

For each shot, the fault current and duration may vary slightly from the target values. The objective was to achieve the energy (I^2t) level for each shot. To recognize the practical issues of performing this test, IEEE Std. 1138-2009 *"Standard for Testing and Performance for Optical Ground Wire (OPGW) for Use on Electric Utility Power Lines"* makes the following allowances: the average of the pulses shall exceed the minimum I^2t level specified by the supplier. However, no single pulse shall be less than 95% of the minimum I^2t level.

The optical and temperature data were acquired for at least fifteen (15) minutes after the last shot. The cable was maintained at 20°C during this hold period.

The cables were visually inspected for birdcaging or other damage during the test. Birdcaging is defined as one or more cable strands that permanent protrude greater than one strand diameter from the normal cable geometry. A strand will be considered to have birdcaged if light can be seen between the protruding strand and the cable. This observation is made after the cable has cooled to the reference temperature after the last pulse. Temporary birdcaging during the pulses shall not constitute failure.

Upon completion of the test, the OPGW was dissected and inspected for signs of cracking or breaking.

10.4 Test Results

The cable temperature, optical attenuation and short circuit electrical data for the calibration shot and the five (5) "official" shots are summarized in Table 10-3. The data for each shot is shown in Figure 10-5, Figure 10-6 and Figure 10-7.

Table 10-3: Summary of Short Circuit Test Results

Test No.		Irms (kA)	Duration (s)	I^2t (kA^2s)	Initial Cable Temperature (°C)	Maximum Temperature Rise (°C)		
						Therm. #1	Therm. #2	Therm. #3
#1	17-2391	39.48	0.253	394.7	19	159	118	126
#2	17-2392	40.51	0.254	416.4	19	177	126	133
#3	17-2393	40.52	0.254	416.3	19	181	127	134

Thermocouple #1: Between two AA wires in outer layer

Thermocouple #2: Between AA wire and stainless steel tube

Thermocouple #3: Inside stainless steel tube

The maximum permanent increase in optical attenuation measured after the short circuit applications was 0.010 dB, or 0.042 dB/test fiber km.

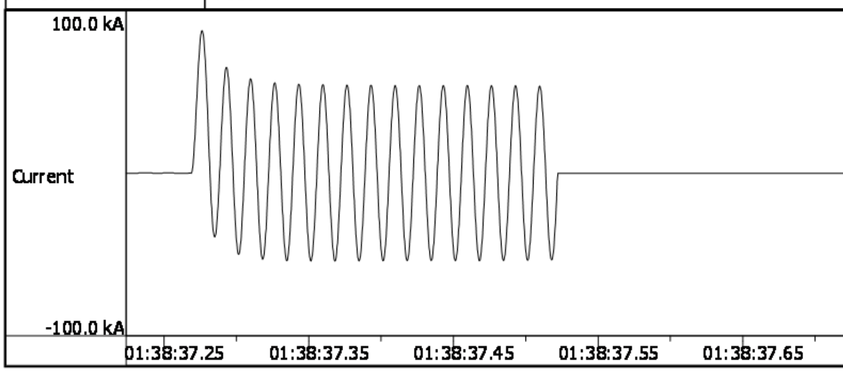
The maximum absolute temperature reached was 200ºC (19ºC + 181ºC), and was measured during Shot #3 on Thermocouple #1 (between two aluminum alloy wires). The maximum absolute temperature reached in the optical unit was 153ºC (19ºC + 134ºC), and was measured during Shot #3 on Thermocouple #3 (inside optical unit).

[The remainder of this page intentionally left blank.]

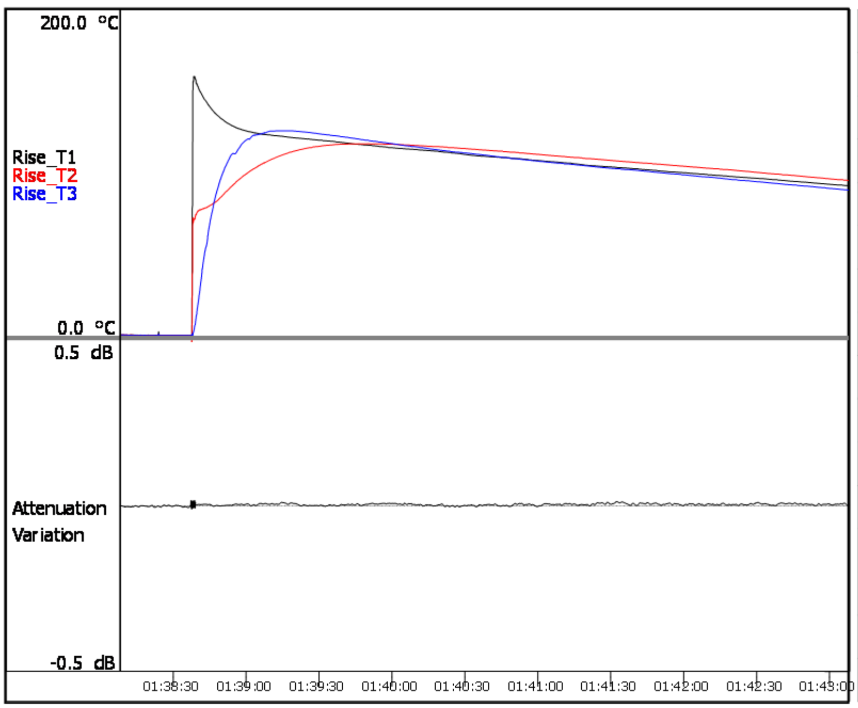
High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario

Project #	K-419874
Client:	El Sewedy
Test Description:	IEEE 1138-2009 Fault Current Test on OPGW
Item Description:	Algeria using El Sewedy 19.5mm, 48 fibre
Item Description	Fault current: 40.0 I²t: 400k A²s
Shot Information:	Test #1



I RMS	39.48 kA
I Peak	87.87 kA
Dur.	253.3 ms
I²t	3.947E+08 A²sec



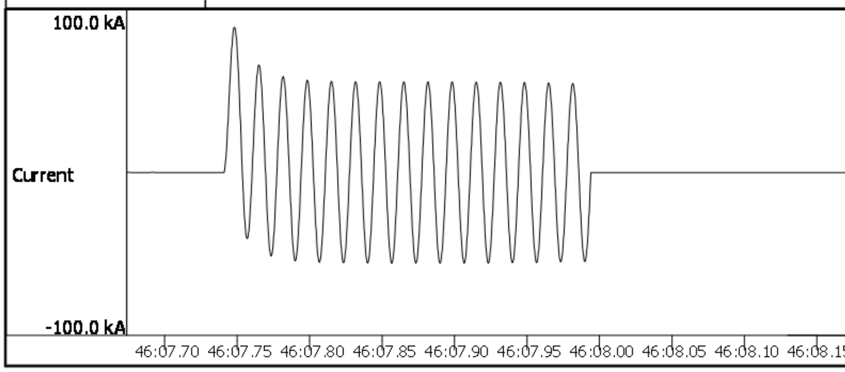
Initial T.	19 °C
Max Rise	
T1	159 °C
T2	118 °C
T3	126 °C
Optical	
Length	9.85 m
# Fibres	24
TFL	236.4 m
Attn (initial)	-0.006 dB
Attn (after)	0.005 dB
Attn (temp)	0.015 dB
Attn (perm)	0.010 dB
Initial Ten.	4020 lbf

Figure 10-5: Short Circuit Test – Shot #1

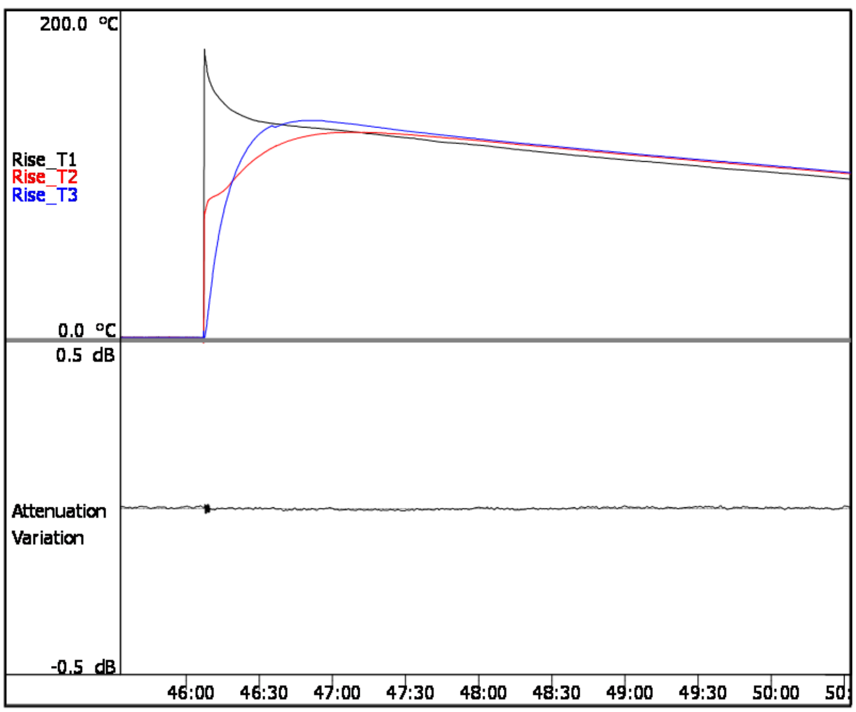
High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario

Project #	K-419874
Client:	El Sewedy
Test Description:	IEEE 1138-2009 Fault Current Test on OPGW
Item Description:	Algeria using El Sewedy 19.5mm, 48 fibre
Item Description	Fault current: 40.0 I^2t: 400k A^2s
Shot Information:	Test #2



I RMS	40.51 kA
I Peak	89.37 kA
Dur.	253.7 ms
I^2t	4.164E+08 A^2sec



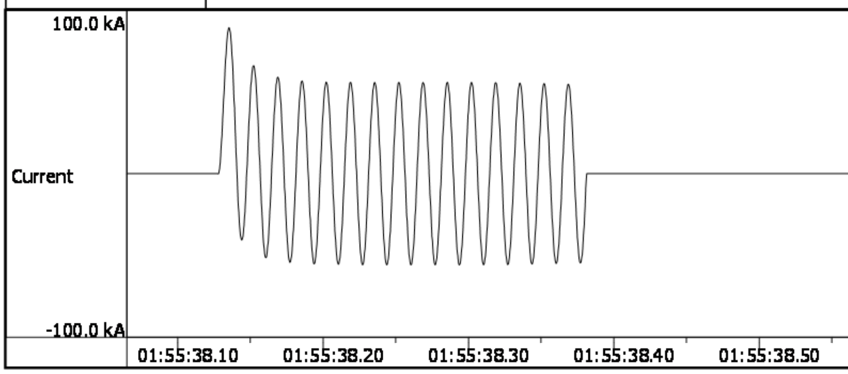
Initial T.	19 °C
Max Rise	
T1	177 °C
T2	126 °C
T3	133 °C
Optical	
Length	9.85 m
# Fibres	24
TFL	236.4 m
Attn (initial)	0.007 dB
Attn (after)	0.003 dB
Attn (temp)	0.013 dB
Attn (perm)	-0.004 dB
Initial Ten.	3381 lbf

Figure 10-6: Short Circuit Test – Shot #2

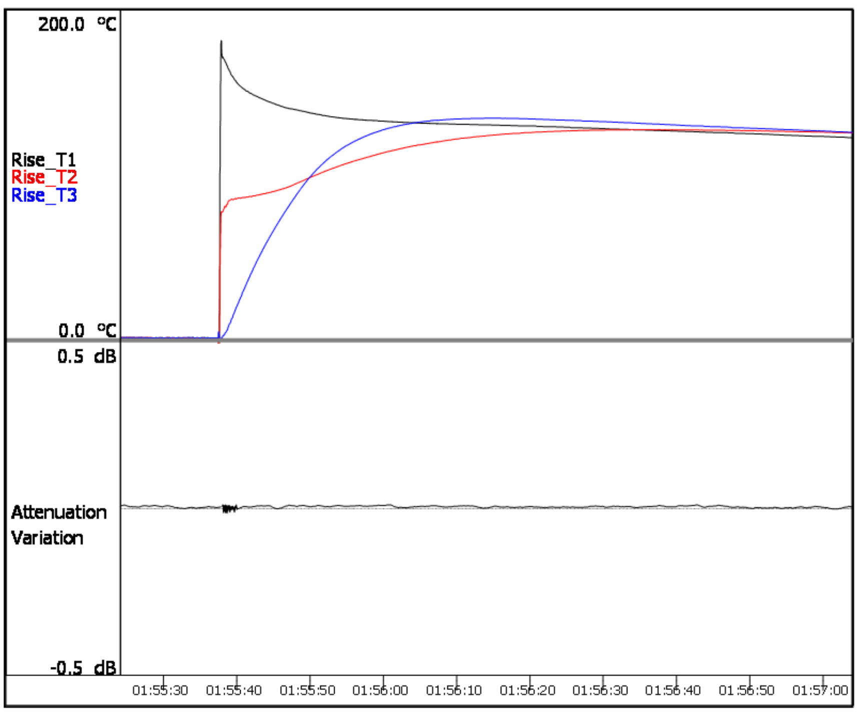
High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario

Project #	K-419874
Client:	El Sewedy
Test Description:	IEEE 1138-2009 Fault Current Test on OPGW
Item Description:	Algeria using El Sewedy 19.5mm, 48 fibre
Item Description	Fault current: 40.0 I²t: 400k A²s
Shot Information:	Test #3



I RMS	40.52 kA
I Peak	89.37 kA
Dur.	253.6 ms
I²t	4.163E+08 A²sec



Initial T.	19 °C
Max Rise	
T1	181 °C
T2	127 °C
T3	134 °C
Optical	
Length	9.85 m
# Fibres	24
TFL	236.4 m
Attn (initial)	0.003 dB
Attn (after)	0.002 dB
Attn (temp)	0.012 dB
Attn (perm)	-0.001 dB
Initial Ten.	3010 lbf

Figure 10-7: Short Circuit Test – Shot #3

After completion of test, sections of the Optical Sample cut from the mid-span, and near both dead-ends were dissected and visually examined for damage. The components were compared to an untested section. Refer to Table 10-4 for dissection results. Photos of the dissected west span are shown in Figure 10-8 to Figure 10-11.

Table 10-4: Short Circuit Test – Dissection Results

Cable Component	East Dead-end	Midpoint	West Dead-end
Aluminum Alloy Wires	No signs of excessive wear, discoloration, deformation or breakdown.	No signs of excessive wear, discoloration, deformation or breakdown.	No signs of excessive wear, discoloration, deformation or breakdown.
Aluminum-Clad Steel Wires	No signs of excessive wear, discoloration, deformation or breakdown.	No signs of excessive wear, discoloration, deformation or breakdown.	No signs of excessive wear, discoloration, deformation or breakdown.
Grease	Grease present, with no signs of excessive discoloration or breakdown.	Grease present, with no signs of excessive discoloration or breakdown.	Grease present, with no signs of excessive discoloration or breakdown.
Stainless Steel Loose Tube	No signs of excessive wear, discoloration, deformation or breakdown.	No signs of excessive wear, discoloration, deformation or breakdown.	No signs of excessive wear, discoloration, deformation or breakdown.
Fibers	No signs of excessive discoloration or breakdown. White fiber shows some light discoloration, but all fibers can be identified.	No signs of excessive discoloration or breakdown. White fiber shows some light discoloration, but all fibers can be identified.	No signs of excessive discoloration or breakdown. White fiber shows some light discoloration, but all fibers can be identified.
Binders	No signs of excessive wear, discoloration, deformation or breakdown.	No signs of excessive wear, discoloration, deformation or breakdown.	No signs of excessive wear, discoloration, deformation or breakdown.
Compound	No signs of excessive wear, discoloration, deformation or breakdown.	No signs of excessive wear, discoloration, deformation or breakdown.	No signs of excessive wear, discoloration, deformation or breakdown.

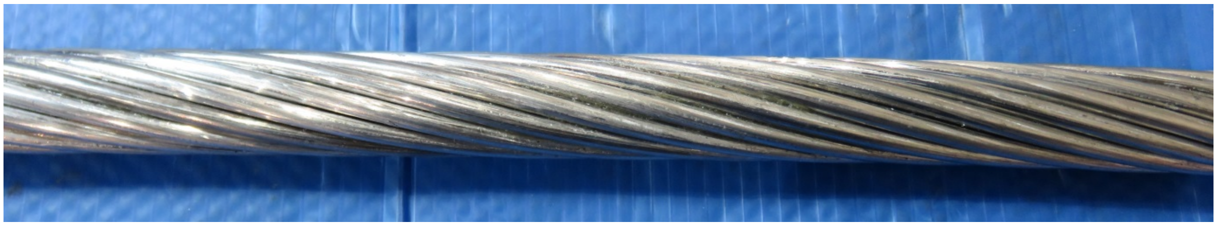


Figure 10-8: Short Circuit Test Dissection: West Section – 1st (Outer) Layer

Figure 10-9: Short Circuit Test Dissection: West Section – 2nd (Inner) Layer with Grease

Figure 10-10: Short Circuit Test Dissection of West Section – Stainless Steel Tube

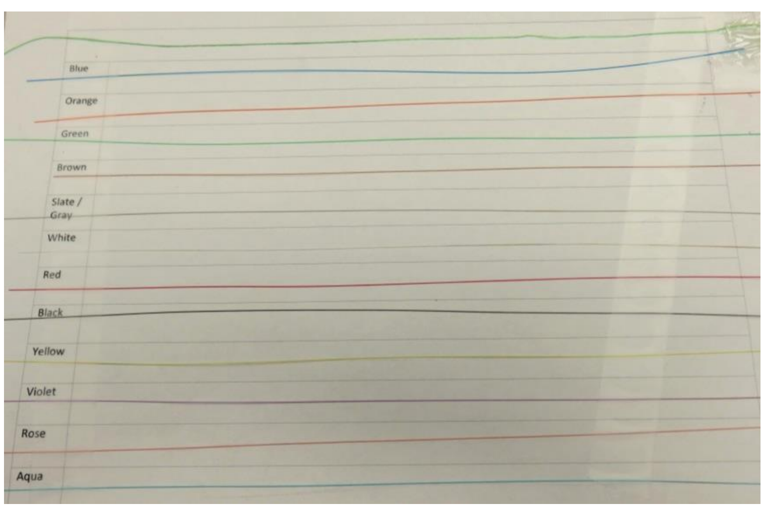


Figure 10-11: Short Circuit Test Dissection of West Section – Fibers

10.5 Acceptance Criteria

As specified IEC 60794-1-24:2014 Paragraph 3.5, the acceptance criteria for the test shall be as stated in the detail specification. On completion, the maximum temperature reached by any component in the OPGW shall be within the allowed temperature range specified by the supplier for this component.

Excessive wear, discoloration, deformation or breakdown shall not be observed by the inspection after the exposure to the current pulse.

As specified in IEC 60794-4-10:2014 Paragraph 8.3.11, on completion of the test the following criteria shall be considered:

- The maximum temperature measured inside the optical unit of OPGW on each pulse shall not exceed 200 °C.
    - This applies to Thermocouple T3 only.
- Any permanent increase in attenuation in the monitored optical fibers 30 min after the test shall comply with the general optical requirements stated in 8.3.1.
    - As specified in 8.3.1: a permanent or temporary increase in optical attenuation greater than 0.2 dB/km of test fiber, at 1550 nm nominal wavelength for single-mode fibers, shall constitute failure.
- Any visible rupture or degradation on the OPGW elements, such as bird-caging effect on armour wires, during the test or after releasing the OPGW load, is considered a failure.
    - Birdcaging as defined in IEEE 1138-2009 Paragraph 6.4.3.3: one or more cable strands that permanently protrude greater than one strand diameter from the normal cable geometry. A strand will be considered to have birdcaged if light can be seen between the protruding strand and the cable. This observation will be made after the able has cooled to the reference temperature after the last pulse. Temporary birdcaging during the pulses shall not constitute failure.
- The optical unit(s) of the tested sample shall be dissected and inspected visually for excessive wear, discoloration, deformation or breakdown.

10.6 Conclusion

The cable, as tested, met the requirements for the Short Circuit Test as specified in IEC 60794-1-24:2014 Paragraph 3.5 and IEC 60794-4-10:2014 Paragraph 8.3.11.

11 Lightning Arc Test

Test Date: April 25 and 27, 2017

Test Laboratory: Kinectrics International Inc.

Cable Manufacturer: El Sewedy Cables

End-User: Filiales Groupe SONELGAZ

Accessories: Klein grips supplied by Kinectrics

Kinectrics Staff: Mr. Michael Colbert
Mr. Aaron Duncan
Ms. Corrine Dimnik

Witnesses: Mr. Nabil Abdennour – GRTE
Mr. Said Hamoudi – CEEG
Mr. Riadh Fellouh – El Sewedy Cables Algeria
Mr. Miloud Aggoun – El Sewedy Cables Algeria

11.1 Test Objective and Standard

The objective of the Lightning Arc Test is to verify the mechanical and optical performance of the OPGW cable when subjected to simulated lightning arc conditions.

The test was performed in accordance with IEC 60794-1-24:2014 Method H2, IEC 60794-4-10:2014 Paragraph 8.3.12 and Kinectrics Method.

11.2 Test Set-up

11.2.1 Test Assembly and Apparatus

A schematic of the set-up for the Lightning Arc Test is illustrated in Figure 11-1.

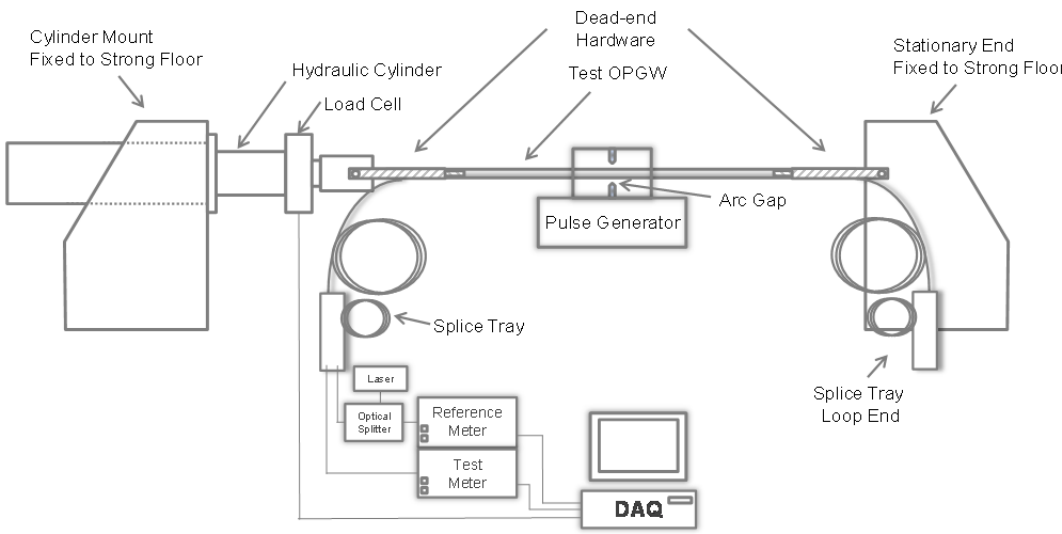


Figure 11-1: Set-up for Lightning Arc Test (Schematic)

An OPGW sample was installed between two (2) fixed abutments in a hydraulically activated horizontal test machine. The length of the cable between the load points of the dead-end assembly was approximately 10 m. A load cell was installed at one end to measure the tension in the cable.

The test was carried out in a temperature-controlled laboratory at 22ºC ± 3ºC.

11.2.2 Optical Network

One (1) OPGW sample was terminated beyond both dead-end assemblies such that the optical fibers could not move relative to the OPGW. The cable and fiber terminations and the method to measure optical attenuation are described in Appendix C.

For the attenuation measurement, twenty-four (24) of the forty-eight (48) fibers were spliced together to form one continuous loop of 240 m (24 fibers x 10 m). The gauge length for attenuation measurements was taken to be the length under tension, from dead-end to dead-end.

11.2.3 Instrumentation and Data Acquisition

A load cell was used to measure the cable tension. A thermocouple was used to measure the air temperature. A current shunt was used to measure the applied arc current.

Once the arc was triggered, the GPIB (General Purpose Interface Bus) output of the optical power meters, cable tension and air temperature were recorded every second by a digital data logging system.

The measuring instruments and equipment used in this test are listed in Appendix D.

11.3 Test Procedure

Five (5) hits, simulating lightning arc strikes, were performed on five (5) separate sections of the cable sample as follows.

One at a time, a section was installed in the hydraulically activated horizontal test machine and tensioned to 17.1 kN or 15% of the cable RTS. The test conditions were based on IEC 60794-1-24:2014 Table 1, Class 0 parameters. A nominal arc current of 100 A with negative polarity was applied to the cable through a 6 cm long thin filament. The thin filament was blown and the current increased and created an arc to the cable, constituting a “hit”. The duration of the arc was nominally 0.5 seconds. This produced a nominal charge transference of 50 Coulombs. The tolerance on the charge transfer was ±10%.

After each hit, the OPGW was visually inspected for signs of deterioration, cracking or breaking of the optical unit. The number of broken or damaged wires was recorded for each hit.

Upon completion of the five (5) simulated lightning arc strikes, the remaining strength of each section of OPGW was calculated based on the remaining, unbroken wires.

11.4 Test Results

A summary of the test results is listed in Table 11-1 and Table 11-2. There was no temporary or permanent increase in optical attenuation measured during or after the simulated lightning arc strikes. The current waveforms for the arcs are shown in Figure 11-2 to Figure 11-6.

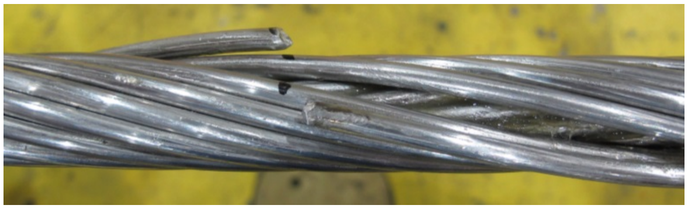
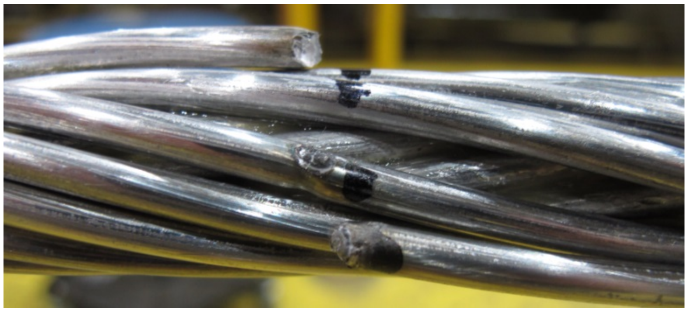
There were no signs of deterioration, cracking or breaking of the optical unit after each hit.

The calculated remaining breaking strength for each of the five (5) sections of cable was greater than 75% of the cable RTS, or greater than 85.56 kN.

Table 11-1: Lightning Arc Test – Summary of Measured Values

Test (Figure)	Total Charge (Coulombs)	Maximum Change in Optical Attenuation (dB)	Cable Tension Before / After Hit (kN)	Calculated Remaining Breaking Strength (% RTS)
Hit 1	52.8	-0.01	17.1 / 15.3	99%
Hit 2	52.7	0.00	17.1 / 16.7	100%
Hit 3	51.9	0.00	17.1 / 16.8	99%
Hit 4	45.4	0.00	17.1 / 16.8	100%
Hit 5	53.8	0.00	17.1 / 15.9	100%

Table 11-2: Lightning Arc Test – Summary of Results

Test (Coulomb)	Number of Wires Broken or Damaged	Photograph After Lightning Arc
Hit 1 (52.8 C)	3 Wires affected in outer layer: - 2 AA broken - 1 AA with small burn - No damage to inner layer	
Hit 2 (52.7 C)	3 Wires affected in outer layer: - 1 AA broken - 2 AA with small burns - No damage to inner layer	
Hit 3 (51.9 C)	3 Wires affected in outer layer: - 2 AA broken - 1 AA with small burn - No damage to inner layer	
Hit 4 (45.4 C)	3 Wires affected in outer layer: - 1 AA broken - 2 AA with small burn - No damage to inner layer	
Hit 5 (53.8 C)	2 Wires affected in outer layer: - 1 AA broken - 1 AA with large burn - No damage to inner layer	

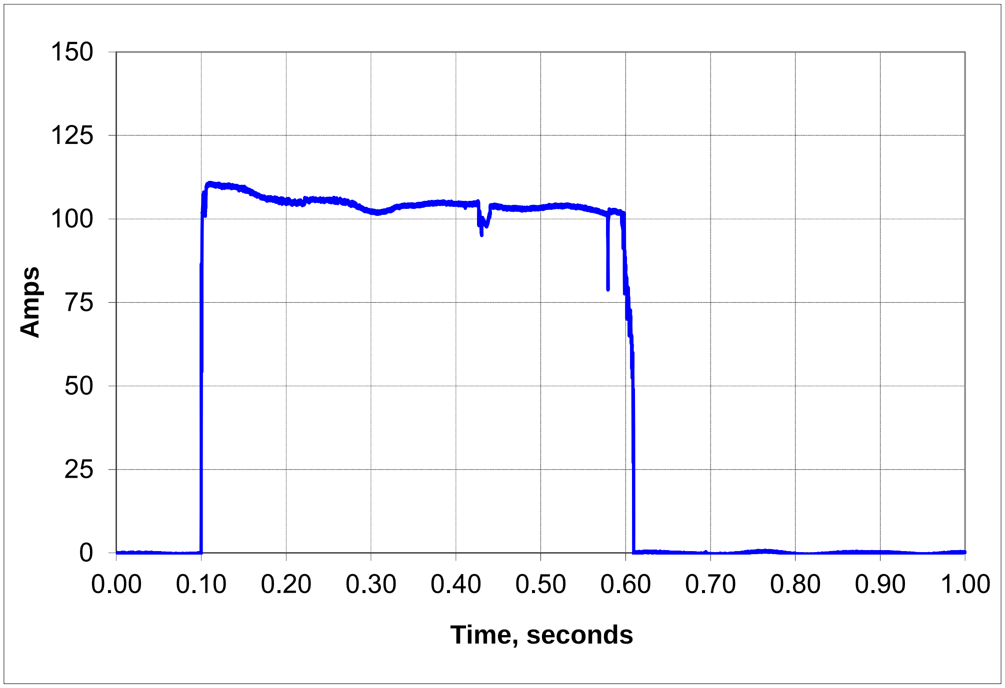


Figure 11-2: Lightning Arc Test – Hit #1 Current Waveform 52.8 C

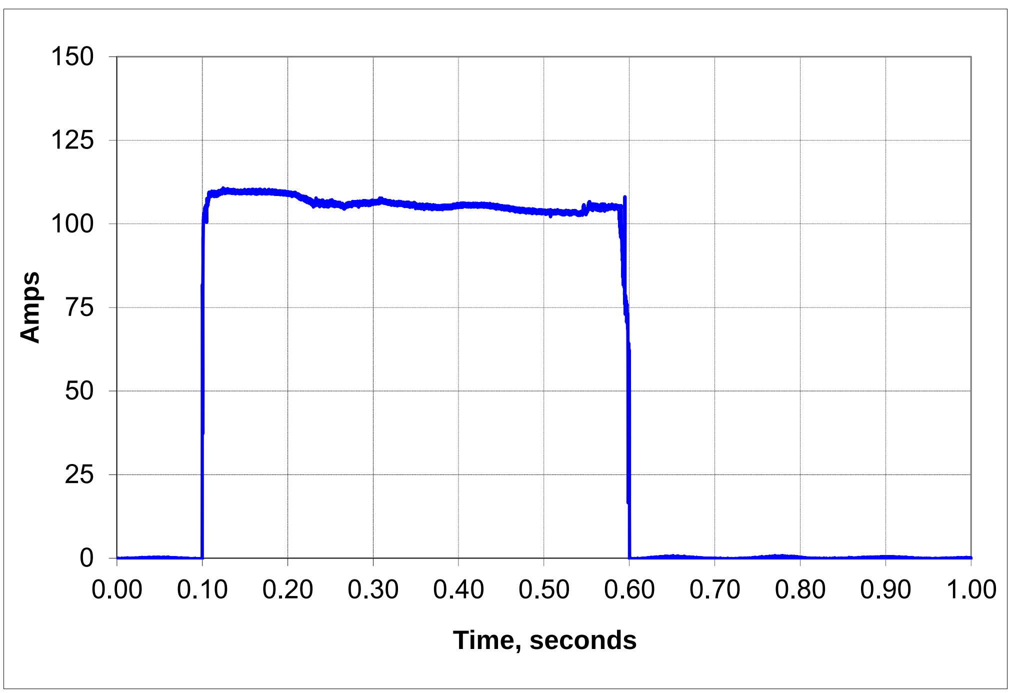


Figure 11-3: Lightning Arc Test – Hit #2 Current Waveform 52.7 C

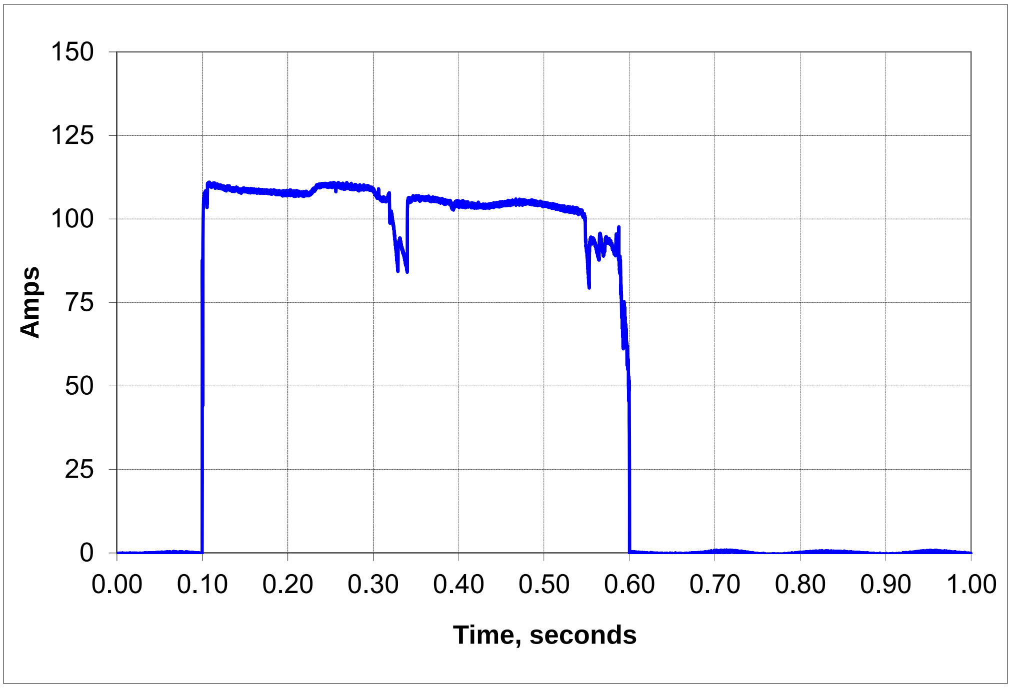


Figure 11-4: Lightning Arc Test – Hit #3 Current Waveform 51.9 C

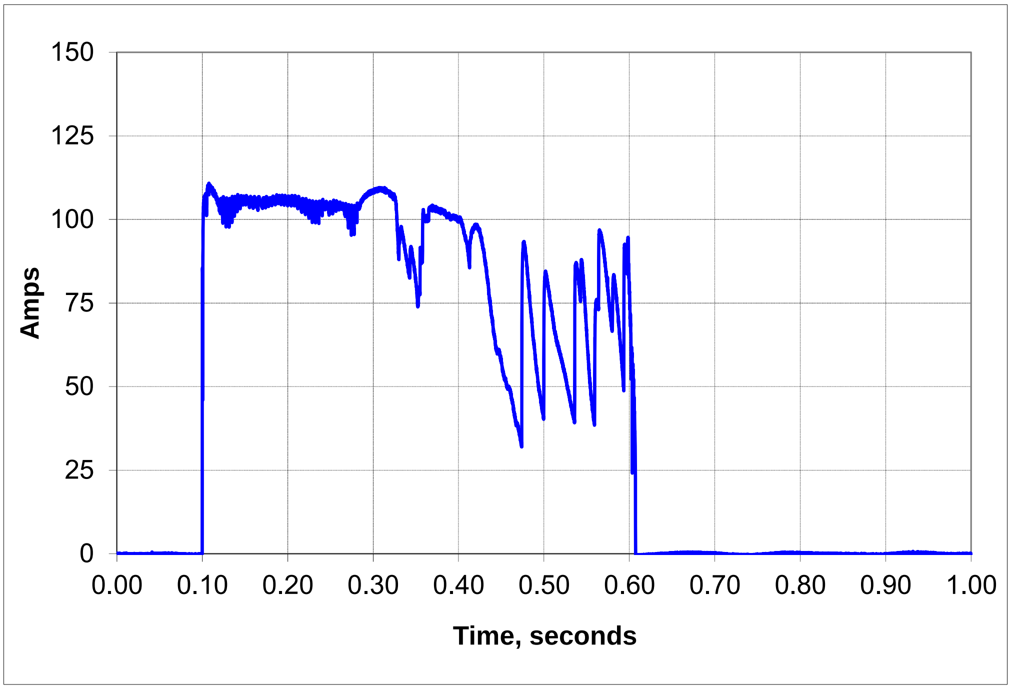


Figure 11-5: Lightning Arc Test – Hit #4 Current Waveform 45.4 C

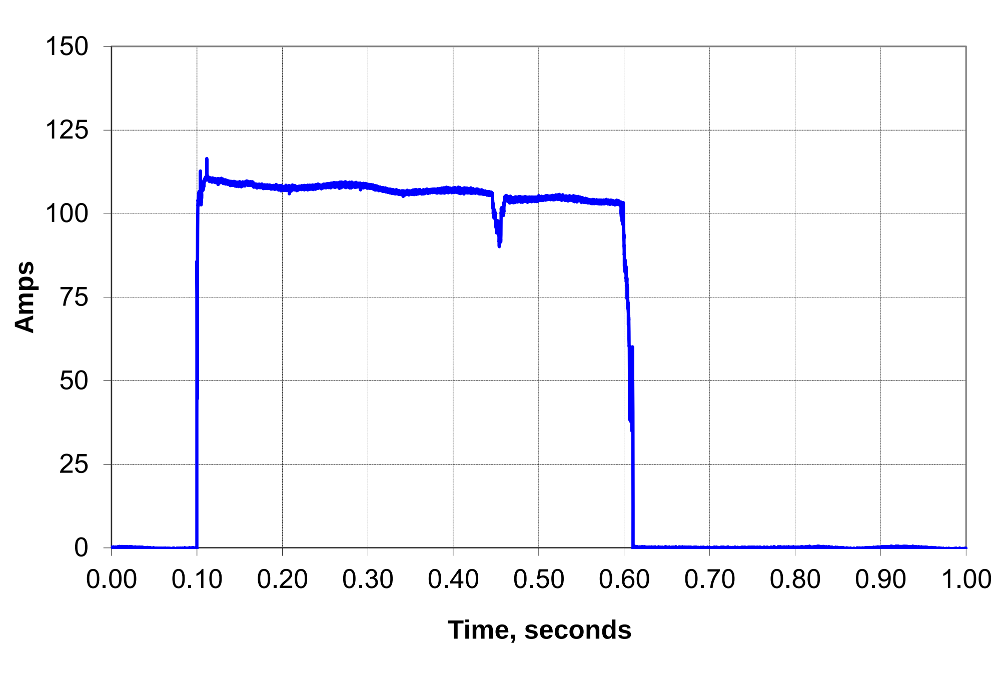


Figure 11-6: Lightning Arc Test – Hit #5 Current Waveform 53.8 C

11.5 Acceptance Criteria

As specified IEC 60794-1-24:2014 Paragraph 4.6, on completion of the test, the following criteria shall be considered:

- Any permanent or temporary increase in optical attenuation greater than the specified value shall constitute a failure.
- If any wires are found to be broken, then the residual strength of the OPGW shall be calculated for the remaining unbroken wires. If the calculated residual strength is less than 75 % of the original declared RTS, then this shall constitute a failure.

As specified in IEC 60794-4-10:2014 Paragraph 8.3.12, on completion of the test the following criteria shall be considered:

- The change in attenuation of monitored optical fibers shall comply with the general optical requirements stated in 8.3.1.
    - As specified in 8.3.1: a permanent or temporary increase in optical attenuation greater than 0.2 dB/km of test fiber, at 1550 nm nominal wavelength for single-mode fibers, shall constitute failure.

- If after the lightning impact, on any of the impact zones any wires are found to be broken, then the residual strength of the sample with broken wires shall be evaluated. If the residual strength in the sample is less than 75 % of the OPGW RTS, then this shall constitute a failure.
- Any visible bird-caging effect on armour wires, during the test or after releasing the OPGW load, is considered a failure in this test.

11.6 Conclusion

The cable, as tested, met the requirements for the Lightning Arc Test as specified in IEC 60794-1-24:2014 Paragraph 4.6, IEC 60794-4-10:2014 Paragraph 8.3.12 and Kinectrics Method.

[The remainder of this page intentionally left blank.]

Appendix A Acronyms and Abbreviations

DAQ – Data Acquisition

DC – Direct Current

GPIB – General Purpose Interface Bus

IEEE – Institute of Electrical and Electronics Engineers

IEC – International Electrotechnical Commission

ISO – International Organization for Standardization

LVDT – Linear Variable Differential Transducer

OPGW – Optical Ground Wire

OTDR – Optical Time Domain Reflectometer

RTS – Rated Tensile Strength

MAOC – Maximum Allowable Ovality of the Cable

Appendix B OPGW Specification (Provided by El Sewedy)

EL SEWEDY CABLES

Câble de Garde à Fibres Optiques (OPGW)

Fiche Technique: AA/ACS 155/59 - 40.0kA/0.25s

SM-MFOA

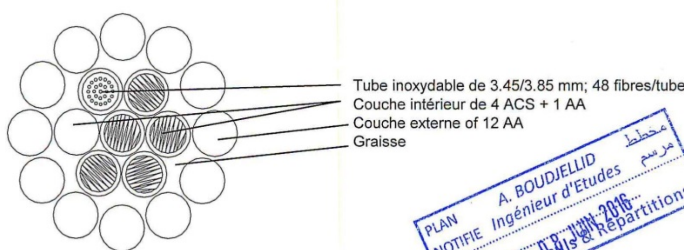
APPLICATION

- Ces câbles conviennent à l'installation comme fil de garde optique dans les lignes de puissances.
- Le câble agit comme fils de garde normal protégeant la phase des fils contre les éclaires et porte des courants de défaut de la terre.
- Le câble fournit également un chemin optique dans les installations des lignes de puissances pour les besoins de télécommunication.

Dispositifs

- Installation comme fil de garde normal avec les machines conventionnelles.
- Le plus fiable pour les utilités des fibres optiques.
- La meilleure solution pour remplacer les vieux fils de garde et pour la construction des nouvelles lignes.
- À prix réduit

Diagramme en coupe



PLAN NOTIFIE A. BOUDJELLID Ingénieur d'Etudes Date: 08 JUN 2016 Division Calculs & Répartitions

CONSTRUCTION

Fibre Optique	: Pour les spécifications du fibre voir les caractéristiques optiques.	
Second Enduit	: L'enduit secondaire se compose d'un tube en acier inoxydable soudé par laser. Chaque fibre est uniquement identifiée par une couleur de fibre et pour le compte du fibre au dessus de 12 avec un filé coloré de faisceau de fibres. Le tube est rempli de composé hydrofuge.	
Element Central	: Fil d'ACS (20SA)	: 3.9 mm
Première couche	: Tube inoxydable	: 3.45 / 3.85 mm
	: 4 fils d'ACS (20SA)	: 3.9 mm
	: 1 fil d'alliage d'aluminium (AA)	: 3.9 mm
	: Direction de la couche	: " Gauche "
Deuxième couche	: 12 fils d'alliage d'aluminium (AA)	: 3.9 mm
	: Direction de la couche	: " Droite "
Graisse	: Les interstices du noyau du câble sont remplis de graisse selon EN 50326 classe A et le point de goutte > 150 ° C ANNEXE C figure C.3 selon IEC 1089	

EL SEWEDY CABLES	400 Kv - 48 Fiber	Page 1 / 3 Issue 10-06-04 EE

DRC. Spa EL SEWEDY CABLES ALGERIA R.C N 0972689 B 06 Nis 006 1628 07401 M. Fiscal 000516097265914

Fiche Technique: AA/ACS AA/ACS 155/59-40.0kA/0.25s

Toutes les valeurs en cette fiche sont nominales si rien d'autre n'a été mentionné.

PLAN NOTIFIE A. BOUDJELLID Ingénieur d'Etudes Date: 08 JUIN 2016 Division Calculs & Répartitions

CARACTÉRISTIQUES TECHNIQUES

Nombres des tubes	1	
Nombres des fibres / tube	48	
Cable Ø	19.5	mm
Poids du Cable approx.	878	kg/km
Support de la coupe	215.03	mm²
AA en coupe	155.30	mm²
ACS en coupe	59.73	mm²
Charge de rupture calculée (UTS)	114.08	kN
Module d'élasticité	86.33	kN/mm²
Coefficient de dilatation thermique.10^{-6}	17.79	1/K
Effort de tension permis		
Effort journalier	84.90	N/mm²
Effort de tension maximum	222.80	N/mm²
Effort de tension de Résistance	382.00	N/mm²
Courant nominal à court terme IEC 724 à		
Température Initiale/finale 20 / 200 °C	40	kA, 0.25 s.
Résistance de courant direct à 20 °C	0.190	Ω/km
Transport, stockage, operation	- 40 à + 80	°C
Installation	- 10 à + 50	°C

* La tolérance est ±5%

Caractéristiques optiques

Type de fibre	Monomode		
selon les spécifications	ITU-T G.652		
Diamètre de champ de mode	9.2 ± 0.5		µm
Diamètre de revêtement	125 ± 1		µm
Diamètre enduisant	245 ± 10		µm
Longueur d'onde	1310	1550	nm
Coefficient d'atténuation (moyen maxi)	≤0.36	≤0.22	dB/km
Dispersion	3.5	18.0	ps/nm.km
PMD	0.5		ps.km$^{-½}$

Coloration du Fibre

Fibre No.	1	2	3	4	5	6
Couleur du Fibre	Bleu	Orange	Vert	Marron	Grise	Blanc

Fibre No.	7	8	9	10	11	12
Couleur du Fibre	Rouge	Noire	Jaune	Violet	Rose	Turquoise

Coloration adaptée aux besoins du client sur demande

Coloration de filé de reliure ou marquage de bague

Faisceau de fibres	1	2
Couleur de filé	Bleu	Orange

EL SEWEDY CABLES	Page 2 / 3	Issue 10-06-04 EE

Spa EL SEWEDY CABLES ALGERIA
R.C. N 0972689 B 06
Nis 006 1628 07401 56
M. Fiscal 000616097265391

Fiche Technique: AA/ACS AA/ACS 155/59-40.0kA/0.25s

Essai et inspection

L'essai comportera le suivant:	
- Caractéristiques optiques (longueur de chaque câble) - Caractéristiques mécaniques - Caractéristiques électriques - Inspection visuelle du cable	Atténuation (Monomode à 1310 / 1550nm) Diamètre du cable Résistance de courant direct Coloration / inscriptions des fibres / tubes
Les caractéristiques mécaniques et l'inspection visuelle seront effectuées avec une fréquence de 1 sur 10 tambours, commençant par le premier tambour. Le premier tambour sera toujours vérifié quand la quantité est moins de 10 tambours. Les résultats d'essai certifiés sont fournis sur demande. Si l'essai et l'inspection à effectuer par les tiers parties seront exigés, il incombe à l'acheteur de nommer cette partie et d'en assumer les charges	

Emballage

Longueur standard Tolérance de longueur	3000 – 5000 +/-100, Nous réservons le droit de livrer jusqu'à un maximum de 10 % de la quantité commandée dans des longueurs plus courtes avec un minimum 2000 m/tambour.	m m
Cachetage des extrémités des câble	Pour empêcher l'entrée de l'humidité les extrémités de câble sont scellées avec les montures d'embout thermo-rétrécissables.	
Protection/emballage	La bobine sera traînée avec les lattes en bois fortes afin d'empêcher l'OPGW des dommages dans l'ordinaire manipulant et embarquant.	

la longueur des Tourets selon la commande

PLAN NOTIFIE
A. BOUDJELLID
Ingénieur d'Etudes
Date: 08 JUIN 2016
Division Calculs & Répartitions
مخطط مرسم

EL SEWEDY CABLES		Page 3 / 3	Issue 10-06-04 EE

R.C N 0972689 B 06
Nis 006 1628 0740 56
M. Fiscal 000616097268914

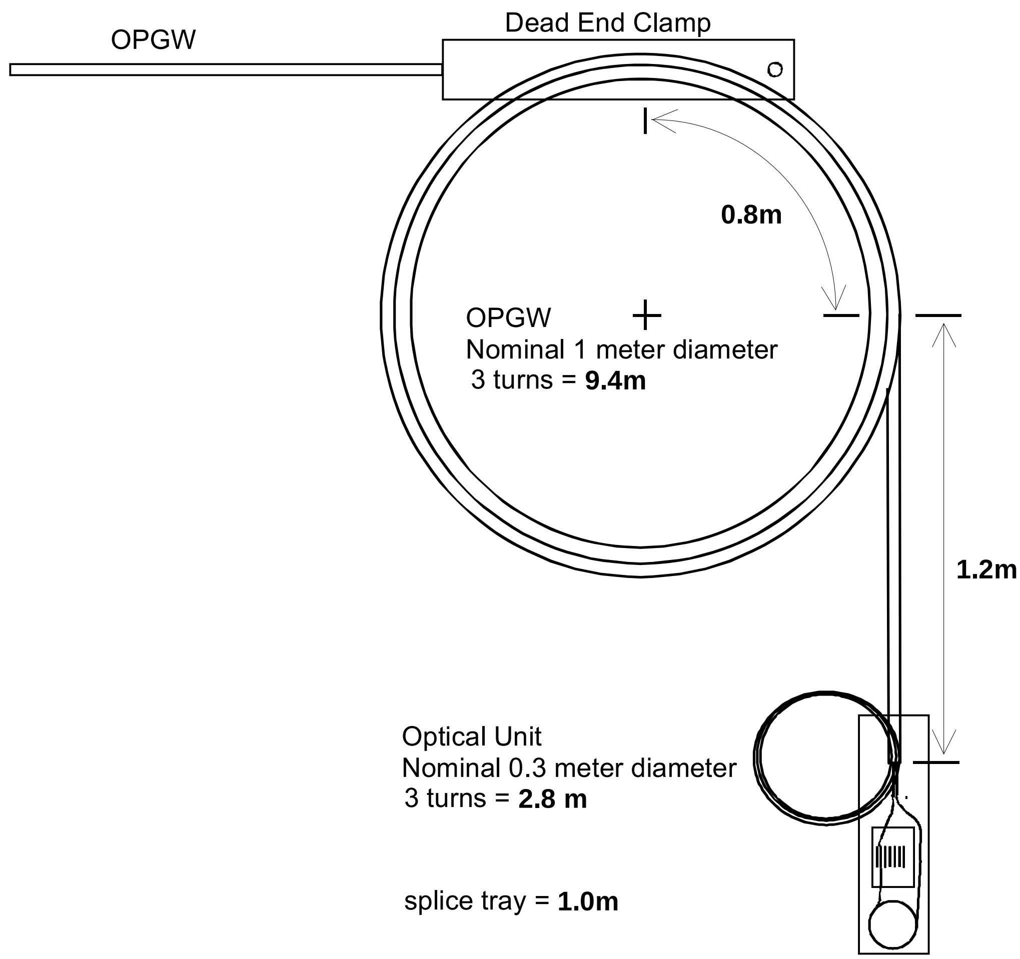
Appendix C Optical Measurements

C.1 General Set-up and Procedures

The set-up to monitor the optical attenuation for the mechanical and electrical tests is recommended by IEEE Std. 1138-2009, "IEEE Standard for Testing and Performance for Optical Ground Wire (OPGW) for Use on Electric Utility Power Lines". To increase the sensitivity to changes in attenuation, a number of fibers in each test sample are spliced together, or concatenated, to form one continuous length. The minimum number of fibers spliced for each test is in accordance with IEEE 1138-2009 Paragraph 6.2, Table 2. A laser source with a nominal wavelength of 1550 nm ± 20 nm is injected to an optical splitter. The splitter divides the source signal into two signals each with nominally one-half the power as the original source signal. One of the split signals is sent directly to an optical power meter and serves as the reference signal. The other split signal is spliced into one of the free ends of the concatenated test fibers. A second power meter is connected to the returning end of the test fibers. This measurement is the test signal. During the tests the readings from both optical power meters are monitored continuously. The data are stored periodically in a computer for future analysis. Manual readings are taken periodically to confirm the logged data. Any changes in the difference between the reference and test signals indicate a change in the attenuation in the test fiber. A net increase in attenuation means a loss in the optical signal. A net decrease in attenuation indicates a gain in the signal.

C.2 Test Sample Termination Arrangement

The test samples are terminated in a manner such that the optical fibers at both ends of the sample cannot move relative to the OPGW. The general arrangement of preparing loops between the test sample and the fiber splice tray is shown in Figure C-1.



Total length: 9.4 + 0.8 + 1.2 + 2.8 + 1.0 = 15.2m

Figure C-1: Test Sample Termination Arrangement

Appendix D Instrument Sheet

TEST DESCRIPTION	EQUIPMENT DESCRIPTION	MAKE	MODEL	ASSET # or SERIAL #	ACCURACY CLAIMED	CALIBRATION DUE DATE	TEST USE
Tensile Performance Test	Optical Power Sensor Module	HP	81531A	KIN-01480 #7	±0.15dB, ±1pW	July 7, 2017	Power Meter
	Optical Power Sensor Module	HP	81531A	KIN-02810 #3	±0.15dB, ±1pW	September 12, 2017	Power Meter
	A/D Datalogger	National Instruments	PCI-6221	KIN-01836	±1% of Reading	January 30, 2018	Data Acquisition
	Load Cell (MTS) 100 KIP Conditioner	Lebow MTS	3156 (100,000 lbs) 494.26 DC Channel: S2-J2A	KIN-03727 KIN-01724	±1% of Reading	August 30, 2018	Tension
	Displacement Transducer (ENCODER PWP)	ASM	WS10-1250-25-IE41LI-SBO-M12-HG	KIN-04890	±1% of Reading	February 21, 2018	Displacement
	Optical Fibre Monitor	Opto-Electronics	OFM 10	KIN-91820	0.02% + 2.5 cm	June 8, 2017	Fibre Strain
	Thermocouple Temperature Transmitter	Omega Omega	Type T TX13	KIN-00919 KIN-00918	±1C	November 1, 2018	Temperature
	Measuring Tape	Lufkin	L1730CME 30 m / 100 ft	KIN-04726	±0.0508 m	December 7, 2018	Cable Length

TEST DESCRIPTION	EQUIPMENT DESCRIPTION	MAKE	MODEL	ASSET # or SERIAL #	ACCURACY CLAIMED	CALIBRATION DUE DATE	TEST USE
Stress-Strain and Breaking Test	A/D Datalogger	National Instruments	PCI-6221	KIN-01836	± 1% of Reading	January 30, 2018	Data Acquisition
	Load Cell (MTS) 100 KIP Conditioner	Lebow MTS	3156 (100,000 lbs) 494.26 DC Channel: S2-J2A	KIN-03727 KIN-01724	±1% of Reading	August 30, 2018	Tension
	Displacement Transducer (ENCODER)	ASM	WS10-1250-25-IE41LI-SBO-M12-HG	KIN-03772 UNIT #3	< 1.0% of reading	November 29, 2017	Cable Strain
	Thermocouple Temperature Transmitter	Omega Omega	Type T TX13	KIN-00919 KIN-00918	± 1C	November 1, 2018	Temperature
	Measuring Tape	Lufkin	L1730CME 30 m / 100 ft	KIN-04726	±0.0508 m	December 7, 2018	Cable Length

TEST DESCRIPTION	EQUIPMENT DESCRIPTION	MAKE	MODEL	ASSET # or SERIAL #	ACCURACY CLAIMED	CALIBRATION DUE DATE	TEST USE
Sheave Test	Optical Power Sensor Module	HP	81531A	KIN-01480 #7	±0.15dB, ±1pW	July 7, 2017	Power Meter
	Optical Power Sensor Module	HP	81531A	KIN-02810 #3	±0.15dB, ±1pW	September 12, 2017	Power Meter
	Load Cell Conditioner w/READOUT	Lebow Daytronic	3124-20K (20,000 lbs) 3270	KIN-01504 KIN-01532	±1% of Reading	November 29, 2017	Tension
	A/D Datalogger	National Instruments	PCI-6221	KIN-01837	±1% of Reading	November 11, 2017	Data Acquisition
	Digital Protractor	Mitutoyo	Pro 3600 950-318	KIN-03538	±0.1 deg	February 8, 2018	Cable Angle
	Thermocouple Temperature Transmitter	Omega Omega	Type T TX13	KIN-00919 KIN-00918	± 1C	November 1, 2018	Temperature
	Digital Caliper	Mitutoyo	500-196-20	KIN-02911	±0.001 in	October 17, 2017	Cable Diameters
	Gauge Block	Starrett	RD0310	KIN-03537	±0.08 µm	August 21, 2019	Creep LVDT Verification
	Measuring Tape	Lufkin	L1730CME 30 m / 100 ft	KIN-04726	±0.0508 m	December 7, 2018	Cable Length

TEST DESCRIPTION	EQUIPMENT DESCRIPTION	MAKE	MODEL	ASSET # or SERIAL #	ACCURACY CLAIMED	CALIBRATION DUE DATE	TEST USE
Aeolian Vibration Test (Fence Span)	Optical Power Sensor Module	HP	81531A	KIN-02811 #2	±0.15dB, ±1pW	September 12, 2017	Power Meter
	Optical Power Sensor Module	HP	81531A	KIN-01481 #8	±0.15dB, ±1pW	September 12, 2017	Power Meter
	Load Cell Conditioner	Interface Burster	1020AF-50KN-B (5000 kg) 9163-V01000	KIN-04193 #15 KIN-04194	±1% of Reading	July 12, 2017	Tension
	Input Module	National Instruments	cDAQ-9239	KIN-04848 8	±0.1% of Reading	February 17, 2017	Data Acquisition
	Input Module	National Instruments	cDAQ-9211	KIN-03705 UNIT 2	±0.01% of Reading	November 2, 2017	Data Acquisition
	Digital Protractor	Mitutoyo	Pro 3600 950-316	KIN-03375	±0.1 deg	September 14, 2017	Cable Angle
	V-Scope	PLP	V-Scope	KIN-02544 #3	<1% of reading for 0.3 to 0.8 inches p-p	June 9, 2017	Cable Amplitude inch p-p
	Measuring Tape	Master Craft	(57-7190-0) 100 ft / 30 m	KIN-00314	±0.0508 m	May 11, 2017	Cable Length

TEST DESCRIPTION	EQUIPMENT DESCRIPTION	MAKE	MODEL	ASSET # or SERIAL #	ACCURACY CLAIMED	CALIBRATION DUE DATE	TEST USE
Creep Test (KB019 – Span 4)	Load Cell Conditioner	Strainsert Burster	TLNS 20 (SS)X (20,000 lbs) 9163-V01000	KIN-00827 KIN-03879 KIN-04194"	±1% of Reading	January 31, 2018	Tension
	LVDT AMP	RDP Group Gantner Instrum.	ACT1000A A6- 2CF	KIN-04754 KIN-04755	±0.033 mm	February 3, 2018	Cable Displacement
	LVDT AMP	RDP Group Gantner Instrum.	ACT1000A A6- 2CF	KIN-04756 KIN-04757	±0.033 mm	February 3, 2018	Cable Displacement
	Data Logger	Agilent	34970A	KIN-01527	±1% of Reading	February 9, 2018	Data Acquisition
	Thermocouple	Omega	Type T	KIN - 01074	± 1C	February 9, 2019	Temperature
	Thermocouple	Omega	Type T	KIN - 01261	± 1C	February 9, 2019	Temperature
	Thermocouple	Omega	Type T	KIN - 01262	± 1C	February 9, 2019	Temperature
	Measuring Tape	Lufkin	L1730CME 30 m / 100 ft	KIN-04726	±0.0508 m	December 7, 2018	Cable Length
	Gauge Block	Mitutoyo	RD0317	KIN-04804	±0.08 µm	February 3, 2022	LVDT Verification

TEST DESCRIPTION	EQUIPMENT DESCRIPTION	MAKE	MODEL	ASSET # or SERIAL #	ACCURACY CLAIMED	CALIBRATION DUE DATE	TEST USE
Galloping Test	Optical Power Sensor Module	HP	81536A	KIN-01478 #13	±0.15dB, ±1pW	July 6, 2017	Power Meter
	Optical Power Sensor Module	HP	81536A	KIN-03766 #14	±0.15dB, ±1pW	November 4, 2017	Power Meter
	Input Module	National Instruments	cDAQ-9239	KIN-04849 9	±0.1% of Reading	February 17, 2018	Data Acquisition
	Input Module	National Instruments	cDAQ-9211	KIN-03706 UNIT 3	±0.01% of Reading	November 2, 2017	Data Acquisition
	Load Cell Conditioner w/READOUT	Strainsert Daytronics	TLNS-10(AA) (10,000 lbs) 3270	KIN-04736 #1	±1% of Reading	November 1, 2017	Cable Tension
	Digital Protractor	Mitutoyo	PRO 3600	KIN-03375	±0.1 deg	September 14, 2017	Cable Angle
	Measuring Tape	Master Craft	(57-7190-0) 100 ft / 30 m	KIN-00314	±0.0508m	May 11, 2017	Cable Length
Water Penetration Test	Digital Temperature Meter	Fluke	52 K/J	KIN-00033	± 0.7°C + 0.1% of Reading	June 14, 2017	Laboratory Temperature
	Measuring Tape	Lufkin	L1730CME 30 m / 100 ft	KIN-04726	±0.0508 m	December 7, 2018	Cable Length

TEST DESCRIPTION	EQUIPMENT DESCRIPTION	MAKE	MODEL	ASSET # or SERIAL #	ACCURACY CLAIMED	CALIBRATION DUE DATE	TEST USE
Temperature Cycling	Data Logger	Agilent	34970A	KIN-01697	DC V/A, RMS V/A, Freq, 4-wire	October 27, 2017	Data Acquisition
	20-Channel Multiplexer	Agilent	34901A	KIN-02952	Chan 1 to 20 DC Volts, Type T & J	November 1, 2017	Data Acquisition
	Optical Power Sensor Module	HP	81637B	KIN-00147 #10	±0.15dB, ±1pW	July 6, 2017	Power Meter
	Optical Power Sensor Module	HP	81633B	KIN-00148 #11	±0.15dB, ±1pW	July 6, 2017	Power Meter
	Thermocouple	Omega	Type T	KIN - 01068	± 1 degree C	May 24, 2017	Chamber Temperature
	Thermocouple	Omega	Type T	KIN - 01455	± 1 degree C	May 24, 2017	Chamber Temperature
Lightning Arc Test	Optical Power Sensor Module	HP	81531A	KIN-02810 #3	±0.15dB, ±1pW	September 12, 2017	Power Meter
	Optical Power Sensor Module	HP	81531A	KIN-01480 #7	±0.15dB, ±1pW	July 7, 2017	Power Meter
	AC Current Shunt	IPC Resistors Inc	SSR 260	KIN-03010	±0.5 %	March 21, 2018	Current Shunt
	A/D Datalogger	National Instruments	PCI-6034E	KIN-01315	±0.1% of Reading	June 30, 2017	Data Acquisition
	A/D Datalogger	National Instruments	PCI-6221	KIN-01837	±0.1% of Reading	November 11, 2017	Data Acquisition
	Thermocouple / Transmitter	Omega	Type T / TX13	KIN – 00919 / KIN-00918	± 1 degree C	November 1, 2018	Laboratory Temperature
	Load Cell (MTS)200 KIP Conditioner	Lebow MTS	3129-200K(200,000 lbs) 494.26 DCChannel: S2-J2B	KIN-01725 KIN-01724	±1% of Reading	August 31, 2018	Cable Tension
	Measuring Tape	Lufkin	L1730CME 30 m / 100 ft	KIN-04726	±0.0508 m	December 7, 2018	Cable Length

TEST DESCRIPTION	EQUIPMENT DESCRIPTION	MAKE	MODEL	ASSET # or SERIAL #	ACCURACY CLAIMED	CALIBRATION DUE DATE	TEST USE
Short Circuit Test	Optical Power Sensor Module	HP	81633B	KIN-03765 #16	±0.15dB, ±1pW	November 7, 2017	Power Meter
	Optical Power Sensor Module	HP	81637B	KIN-03764 #17	±0.15dB, ±1pW	November 4, 2017	Power Meter
	Load Cell & Indicator	Interface	1210ACK-10K-B / 9820	KIN-01866 / KIN-01867	± 1% of Reading	April 16, 2017	Tension of Optical Sample
	Dynamometer	Dillion	4000 KG	KIN-01876	±1% of Reading	December 21, 2017	Tension of Temperature Sample
	Resistive Instrumentation Shunt	0.5 ohm	HCL	KIN-03430	±0.1%	August 29, 2018	Non inductive Shunt
	Current Instrumentation Transformer	Raccal-Decca	CT2463-2	KIN-91748	-	December 4, 2017	Resistive Shunt for current measurements
	Waveform Recorder	Genesis	-	IDH496	-	September 20, 2017	Recording Fault Current and Optics
	Waveform Recorder	Genesis	-	KIN-04038	-	June 28, 2017	Recording Temperature
	Thermal Isolation Unit	Kinectrics	KTHL-2	KIN-03166	-	March 25, 2018	Cable Components Temperatures
	Isolation Amplifier	FYLDE	BE560	KIN-01706	-	December 12, 2017	Electrical Isolation

Appendix E Kinectrics ISO 17025 Certificate of Accreditation

CERTIFICATE OF ACCREDITATION

Standards Council of Canada
Conseil canadien des normes

CERTIFICAT D'ACCRÉDITATION

KINECTRICS INC.

800 Kipling Avenue, Unit 2, KL 206, Toronto, Ontario, Canada, M8Z 5G5

having been assessed by the Standards Council of Canada (SCC) and found to conform with the requirements of ISO/IEC 17025:2005 (CAN-P-4E) and the conditions for accreditation established by SCC is hereby recognized as an

ACCREDITED TESTING LABORATORY

for the specific tests or types of tests listed in the scope of accreditation approved by SCC and found on the SCC website at www.scc.ca.

ayant fait l'objet d'une évaluation réalisée par le Conseil canadien des normes (CCN) et été jugé conforme aux exigences énoncées dans ISO/CEI 17025:2005 (CAN-P-4E) et aux conditions liées à l'accréditation établies par le CCN, est de fait reconnu comme étant un

LABORATOIRE D'ESSAIS ACCRÉDITÉ

pour les essais ou types d'essais énumérés dans la portée d'accréditation approuvée par le CCN et figurant dans le site web du CCN au www.ccn.ca.

Accredited laboratory number: / Numéro de laboratoire accredité : 610

Accreditation date: / Date d'accréditation : 2006-11-16

Issued on: / Délivré le : 2014-11-27

Expiry date: / Date d'expiration : 2018-11-16

This certificate is valid until the date of expiration unless suspended, withdrawn or superseded by the SCC. / Le présent certificat est valide jusqu'à la date d'expiration, à moins qu'il ne soit suspendu, retiré ou remplacé par le CCN.

Vice-President - Accreditation Services / Vice-présidente - Services d'accréditation

This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF Communiqué dated January 2009)".

Ce laboratoire est accrédité conformément à la Norme internationale reconnue ISO/CEI 17025:2005. Cette accréditation démontre la compétence technique d'un organisme pour une portée définie et l'exploitation d'un système de management de la qualité de laboratoire (cf. communiqué conjoint ISO-ILAC-IAF daté de janvier 2009).

Canada

Appendix F Distribution

Mrs. Naima Hamadouche (6)
ELSEWEDY CABLES ALGERIA
153 Rue Ali Khoudja Elbiar
16000
ALGER – ALGERIE

Email: n.hamadouche@elsewedy.com
Mobile: +213 (0) 7 70 27 14 31

Ms. Corrine Dimnik (1)
Kinectrics International Inc.
800 Kipling Ave, Unit #2
Toronto, ON, M8Z 5G5

Email: corrine.dimnik@kinectrics.com

[The remainder of this page is intentionally left blank.]

TIC 1036-12

TYPE TEST CERTIFICATE OF COMPLETE TYPE TEST

OBJECT single-core power cable

TYPE CU/XLPE/CW/HDPE

Rated voltage, U_o/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.

KEMA Nederland B.V.

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

Arnhem, 23 August 2012

Order No: 72120727

Version: 1

TABLE OF CONTENTS

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

<u>Conductor</u>

- 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

<u>Conductor screen</u>

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

<u>Insulation</u>

- 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 mm^2
- 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, ST_7
- 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 KEMA	begin: 0 m 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	$D_r \leq 2706$	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	partial discharge level
	xU_0	(kV)	(s)	(pC)
1	1,75	63	10	
	1,5	54	-	not detectable

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.

3.4 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]	tan δ
	xU_0	(kV)	(μF/km)	
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	
	(°C)	(A)	total duration (hours)	duration of conductor at steady temperature (hours)	total duration (hours)	total duration (hours)	applied voltage $2U_0$ (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	partial discharge level
	xU_0	(kV)	(s)	(pC)
1	1,75	63	10	
	1,5	54	-	not detectable

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.

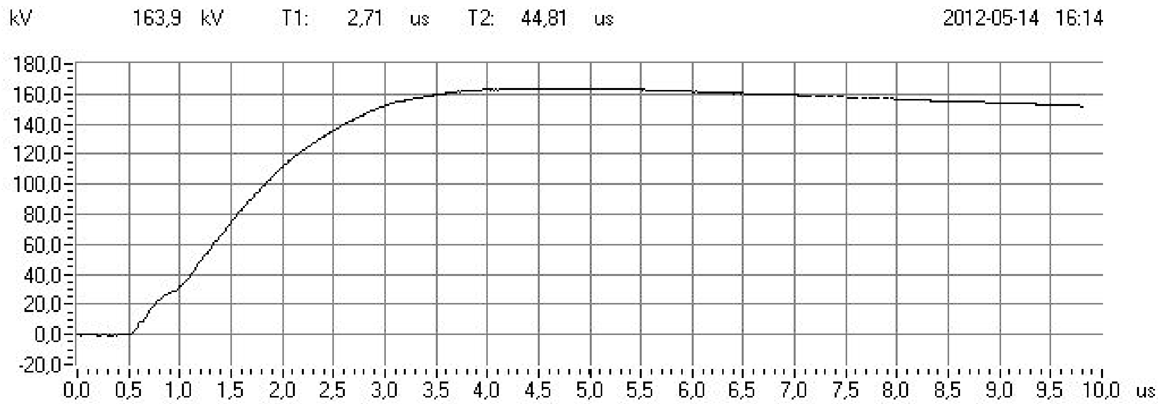


Fig. 1: Waveshape 72120727, +50%

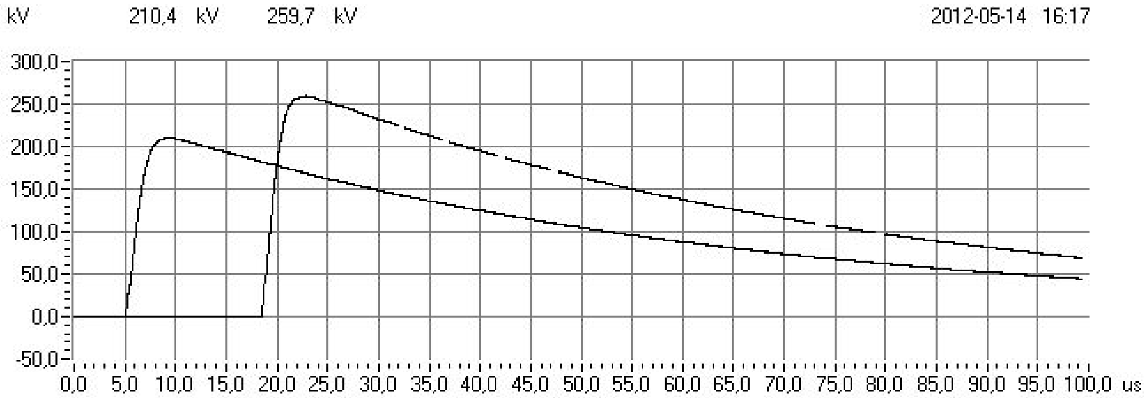


Fig. 2: 72120727, +65% and +80%

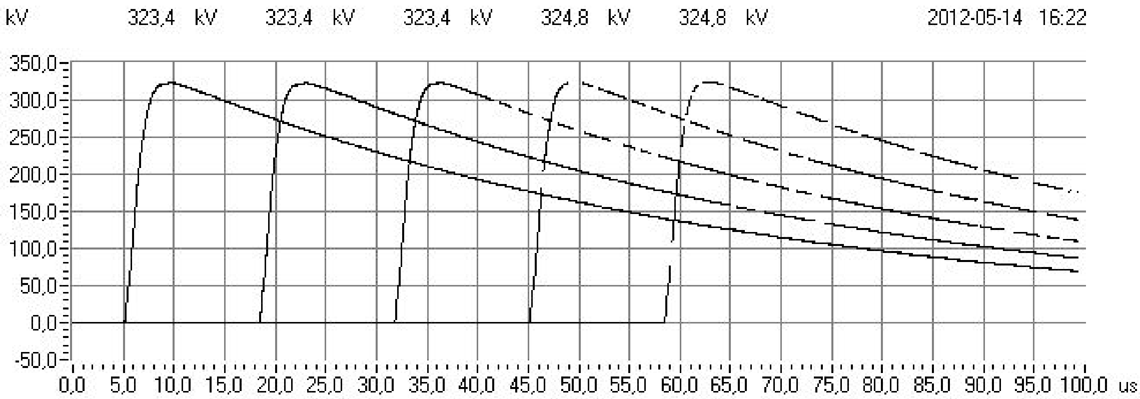


Fig. 3: 72120727, +100%

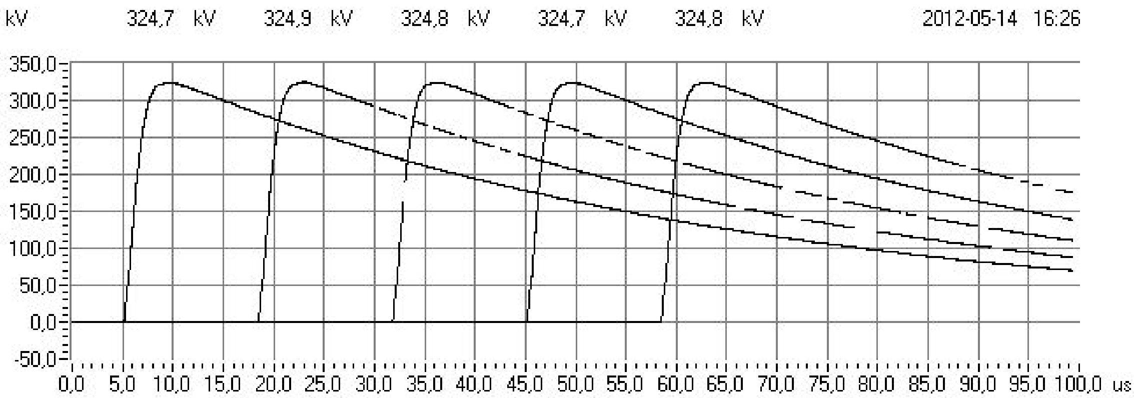


Fig. 4: 72120727, +100%

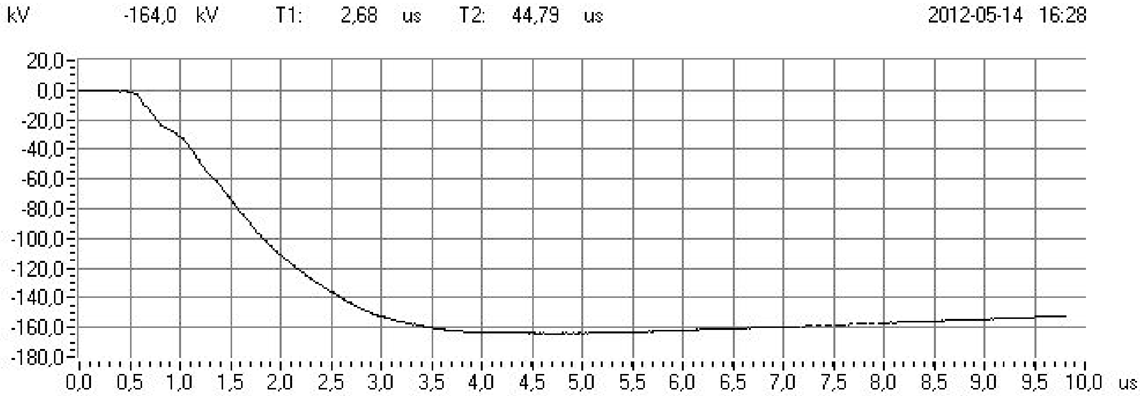


Fig. 5: Waveshape 72120727, -50%

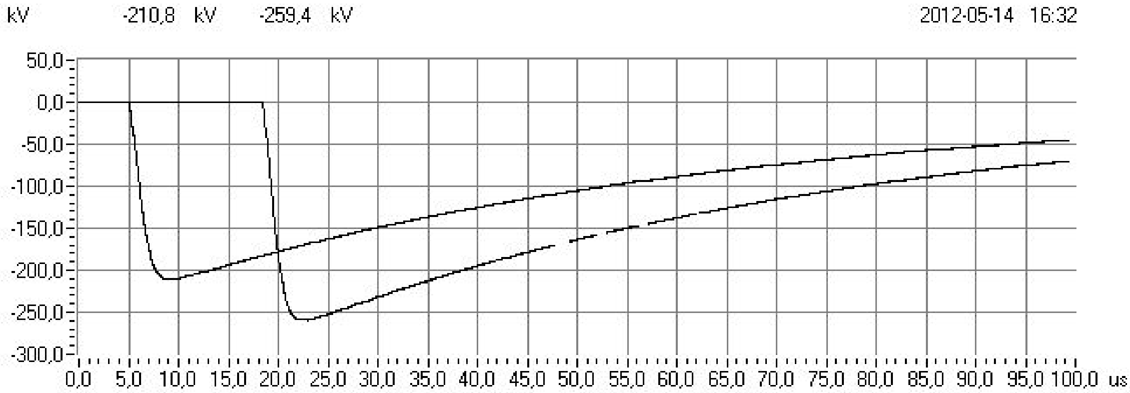


Fig. 6: 72120727, -65% and -80%

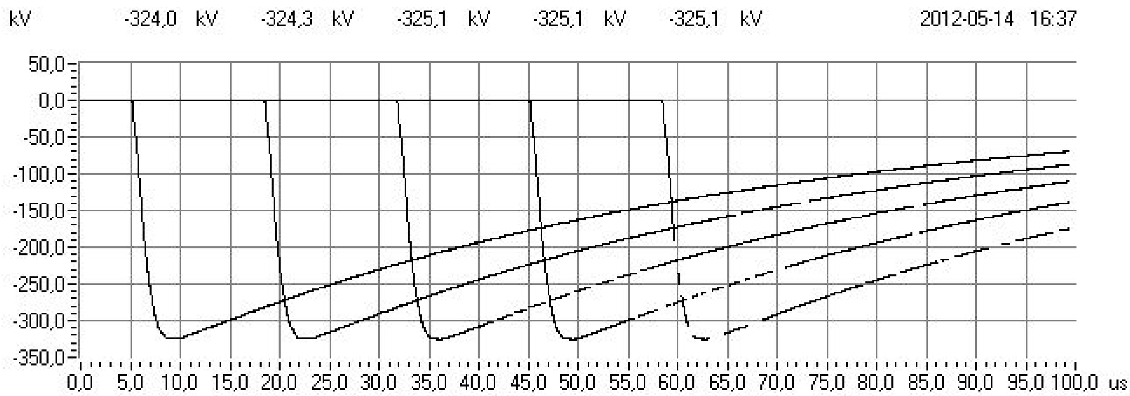


Fig. 7: 72120727, -100%

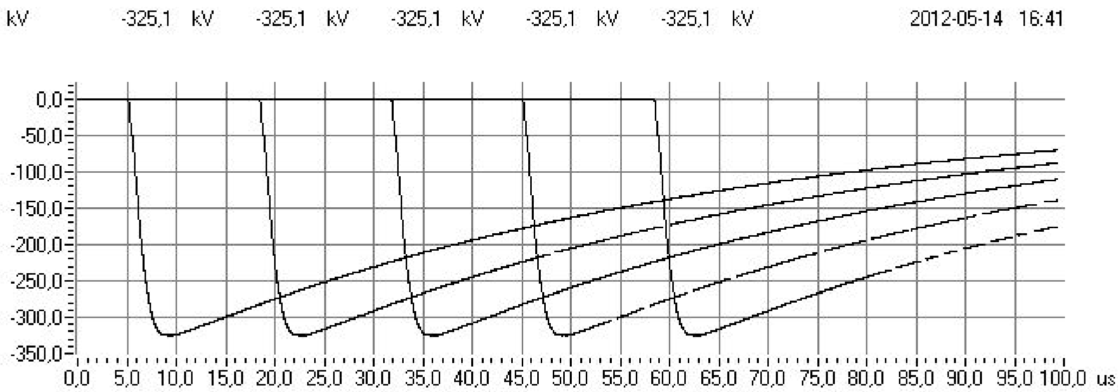


Fig. 8: 72120727, -100%

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	≤ 0,283		0,283
thickness of insulation				
- nominal	mm	-	10,4	
- average	mm	-		10,4
- minimum, t_{min}	mm	≥ 9,4		9,8
- maximum, t_{max}	mm	-		10,8
- $(t_{max} - t_{min}) / t_{max}$	-	≤ 0,15		0,09
thickness of oversheath				
- nominal	mm	-	3,3	
- average	mm	-		5,3
- minimum, t_{min}	mm	≥ 2,7		4,1

Result
The cable construction complied with the requirements.

4.1 Check of cable construction (continued)

	observed/determined
construction	outer sheath, thick 5,3 mm aluminium laminated sheath, thick 0,30 mm swell tape (white) width 60 mm, thick 0,25 mm, overlap 27% copper wire screen, 55 wires copper tape, open helix width 20 mm, thick 0,10 mm swell tape (black) width 48 mm, thick 0,22 mm, overlap 21% isolation screen outer diameter 56,9 mm, thick 1,27 mm isolation outer diameter 54,3 mm, thick 10,38 mm conductor screen outer diameter 33,3mm, thick 1,30 mm conductor outer diameter 30,4 mm, composition 1-6-12-18-23
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/mm²	≥ 12,5	24,7
- elongation	%	≥ 200	538
after ageing			
- tensile strength	N/mm²	-	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/mm²	≥ 12,5	63,5
- elongation	%	≥ 300	1029
after ageing			
- tensile strength	N/mm²	-	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/mm²	-	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/mm²	-	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 oversheath

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/cm^2

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	%	≤ 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
	(°C)	(A)	total duration (hours)	duration of conductor at steady temperature (hours)	total duration (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

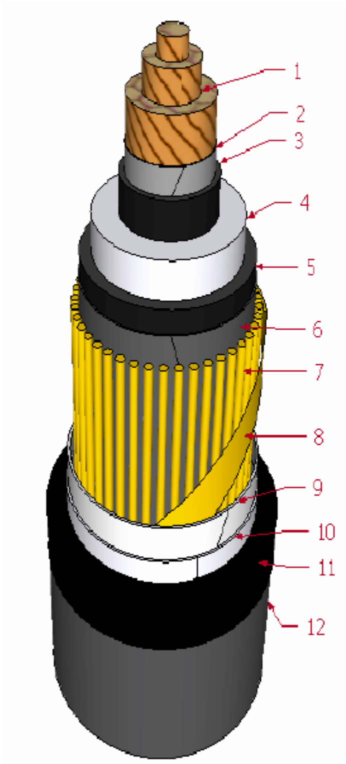
The measurement uncertainties in the results presented are as specified below unless otherwise indicated.

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 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%

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: 630mm^2 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.	*Copper Conductor with Swelling Material*		**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.	*Copper wires screen*	**55 x 1.43**	
8.	*Open Helix Copper Tape*	**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***

الشركة الجزائرية لتوزيع الكهرباء و الغاز

Société Algérienne de Distribution de l'Electricité et du Gaz

AUTORISATION D'EMPLOI N°0220/E/2020

Identification du fabricant	
Nom ou raison sociale	**El Sewedy Câble Algérie**
Adresse: N° tél / N° fax :	**Zone Industrielle de Ain Defla – Algérie** **027 51 20 68 / 027 59 15 85**

- Vu l'autorisation d'emploi N° **0228/2017** délivrée en date du **18/07/2017** par la CARAMEG (PV de réunion N°**04/2017** du 18/**07/2017**)
- Vu le comportement satisfaisant en exploitation durant les (03) trois années de mise en exploitation du matériel ci-dessous désigné

La Commission (PV de la CAEMEG N°**03/2020** du **27/07/2020**) reconduit l'autorisation d'emploi pour une durée de quatre (04) années pour l'utilisation, sur les réseaux de Distribution d'électricité/gaz, du matériel suivant :

Identification du matériel	
Désignation	Câble unipolaire avec âme en Aluminium isolé au PRC de tensions : - 10 kV de sections 185 mm² et 240 mm² - 30 kV de section 120 mm²
Normes ou spécifications	CEI 60502-2 et Spécification Technique
Fabricant	El Sewedy Câble Algérie
Type ou référence	-
Unité de production	Zone Industrielle de Ain Defla – Algérie

- *Le fabricant demeure seul responsable du maintien des caractéristiques et performances de ce matériel pour sa fabrication en série industrielle.*
- *Cette autorisation ne soustrait pas le fabricant des essais contractuels qui pourraient être demandés par l'utilisateur, lors de la réception ou à la livraison du matériel fourni à ce dernier.*
- *La présente autorisation ne donne aucun droit, à son titulaire, au bénéfice d'une quelconque part de marché, pour ce type de matériel, auprès des filiales du groupe Sonelgaz. Pour ce faire, le fabricant doit participer aux appels d'offres lancés par ces dernières ou toutes autres dispositions conformes à la réglementation des marchés en vigueur.*
- *En outre, la récurrence de l'absence de participation du fabricant aux appels d'offres, lorsqu'il est sollicité par les filiales du groupe Sonelgaz, entraineront le retrait automatique de cette autorisation, et ce sans préjudice de tous dommages et intérêts qui pourraient être réclamés par le fabricant.*

Date d'effet : 27/07/2020 **Date d'expiration : 26/07/2024**

Direction Centrale Qualification Développement et Expertise — SADEG — Société Algérienne de Distribution de l'Electricité et du Gaz

Le Directeur Central Qualification Développement et Expertise

W.SALHI
Directrice Centrale
Qualification Développement et Expertise

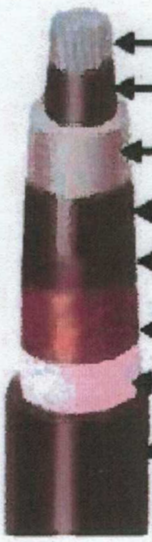
SADEG/ DCQDE : Route de Ouled Fayet RN 36, Colline des Grands Vents el Achour Alger
Tel N° : 023.31.40.83 à 89 - Fax N° : 023.31.40.97/023.31.40.85
Société du Groupe Sonelgaz

Fiche technique jointe à l'autorisation d'emploi N° 0220/E/2020 du 27 juillet 2020
Câble HTA unipolaire avec âme en Aluminium isolé au PRC
de fabrication El Sewedy Câble Algérie

Description	Caractéristiques techniques – Tension		
	10 kV		30 kV
Section de câble (mm²)	1x185	1x240	1x120
Tension assignée (kV)	6/10/12		18/30/36
Nature de l'âme conductrice	Aluminium	Aluminium	Aluminium
Diamètre approximatif de l'âme (mm)	15.8	18.3	12.7
Ecran semi conducteur extrudé (mm)	0.7	0.7	0.7
Nature de l'isolant	PRC extrudé	PRC extrudé	PRC extrudé
Epaisseur de l'isolant (mm)	3.4	3.4	8
Diamètre sur isolant (mm)	24.9	26.7	31.5
Ecran semi conducteur extrudé (mm)	0.8	0.8	0.8
Ruban d'étanchéité gonflant semi conducteur	Oui	Oui	Oui
Nature de l'écran de mise à la terre	Ruban en cuivre	Ruban en cuivre	Ruban en cuivre
Ruban d'étanchéité gonflant	Oui	Oui	Oui
Gaine extérieure PVC	Noir (2.5 mm)	Noir (2.6 mm)	Noir (2.8 mm)
Diamètre extérieur approximatif (mm)	33.4	35	40.01
Poids total approximatif (kg/km)	1250	1485	1550
Résistance max. en courant continu à 20°C (Ohm/km)	0.164	0,125	0.253
Courant de court circuit admissible :			
- Dans le conducteur à 250°C pd 1s (kA)	17.5	22.7	11.3
- Dans l'écran métallique à 200°C pd 1s (kA)	0.93	0.93	1.16
Capacité de transit : sous conditions			
Câble enterré (A)	362	418	281
Câble à l'air libre (A)	473	551	360

SADEG/ DCODE : Route de Ouled Fayet RN°36, Colline des Grands Vents el Achour Alger
Tel N° : 023.31.40.83 à 89 - Fax N° : 023.31.40.97/023.31.40.85
Société du Groupe Sonelgaz

Photo jointe à l'autorisation d'emploi N° 0220/E/2020 du 27 juillet 2020
Câble HTA unipolaire avec âme en Aluminium isolé au PRC
de fabrication El Sewedy Câble Algérie



Câble HTA unipolaire avec âme en Aluminium isolé au PRC

Marquage :

Le marquage des câbles Moyenne Tension comporte sur la gaine extérieure par impression à l'ancre indélébile ou en relief, les informations suivantes :

- **Nom du fabricant : El Sewedy Câble Algérie**
- **Année de fabrication**
- **Nature de l'isolant**
- **Section et tension du câble**
- **Norme de fabrication**
- **Métrage**

SADEG/ DCODE : Route de Ouled Fayet RN°36, Colline des Grands Vents el Achour Alger
Tel N° : 023.31.40.83 à 89 - Fax N° : 023.31.40.97/023.31.40.85
Société du Groupe Sonelgaz