



**EEHC DISTRIBUTION MATERIALS SPECIFICATION**

**EDMS 03-402-1**  
**18-04-2023**

**EDMS 03-402-1**

**SPECIFICATION**

**FOR**

**SUBMARINE THREE-CORE CABLES**

**FOR MEDIUM VOLTAGE NETWORKS**

**12/20 (24 kV) AND 18/30 (36 kV)**

Issue: April-2023/ Rev- 1

- This revision contains option items that must be selected by EDC before bidding.



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**GLOSSARY**

EEHC	Egyptian Electricity Holding Company
EDMS	Egyptian Distribution Material Specifications
EDC	Electricity Distribution Company
IEC	International Electrotechnical Commission
SC	Short Circuit
XLPE	Cross-linked polyethylene
PVC	Polyvinyl chloride
LLDPE	Linear low density polyethylene
$U_o$	the rated power frequency voltage between conductor and earth or metal screen for which the cable is designed
$U$	the rated power frequency voltage between conductors for which the cable is designed
$U_m$	the maximum value of the "highest system voltage" for which the equipment may be used



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### 1. SCOPE

This document specifies the minimum technical requirements for design, manufacturing, testing, inspection, supply and delivery of submarine power cables suitable for submarine installations of the medium voltage networks of Egyptian Electricity Distribution Companies (EDCs). This specification covers both Aluminum and copper armored **three**-core cables with extruded XLPE insulation for 12/20 (24 kV) and 18/30 (36 kV), 50 Hz distribution networks.

### 2. APPLICABLE STANDARDS

The equipment/material covered in this specification shall comply with the latest edition/amendment of the standards given in Table (1). Where any provision of this specification differs from those of the standards listed below, the provisions of this specification shall apply. Any deviations from the listed standards or the provisions of this specification shall be clearly set out in the offer.

**Table (1)**

Standard No.	Description
IEC 63026	Submarine power cables with extruded insulation and their accessories for rated voltages from 6 kV up to 60 kV - Test methods and requirements.
IEC 60502-2	Power cables with extruded insulation and their accessories for rated voltages from 6 kV up to 30 kV
IEC 60228	Conductors of insulated cables
IEC 60811	Electric and optical fibre cables - Test methods for non-metallic materials
IEC 60229	Electric cables - Tests on extruded oversheaths with a special protective function
IEC 60230	Impulse tests on cables and their accessories
IEC 60270	High-voltage test techniques - Partial discharge measurements
IEC 60885-3	Electrical Test method for electric cables – Test methods for partial discharge measurements on length of extruded power cables



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**3. ENVIRONMENTAL CONDITIONS**

The electrical and mechanical properties of the required submarine cables shall be guaranteed under the environmental conditions given in Table (2).

**Table (2)**

Ambient temperature	-5°C to +45°C (50°C is an option according to _ _ EDC requirements)
Maximum relative humidity	95 %
Altitude	Up to 1000 m above mean sea-level

**4. SERVICE CONDITIONS**

- Cables Installed with permanently submerged conditions with water depth up to 250 m.
- Cables shall withstand Severe water conditions such as extreme wind, wave or current loads -Seabed subsidence, mudslide – earthquake loads ( direct , indirect) – dropped objects – dragged anchor or trawling gear – installation vessel positioning failure during installation or recovery.
- Cables should be suitable for installed on the following conditions:
  - Ambient temperature : ( 20 ± 15) °C.
  - Thermal resistivity of Sea bed: 1 km/W.
  - Burial depth of sea bed: 1 m.
- The cable shall be rated for 90°C continuous temperature, 130°C maximum emergency temperature and 250°C short circuit temperature.

**5. DESIGN CRITERIA**

**5.1 Conductors**

- The cables shall have compacted circular plain aluminum / plain annealed copper conductors of class 2, stranded according to the latest IEC 60228 edition and filled



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with swelling powder between wires.

- The number of wires in the stranded conductors shall be as given in Table (3) The DC resistance of each conductor at 20°C shall not exceed the value specified in Table (3).

Table (3)

Cable conductor C.S.A mm <sup>2</sup>	Number of wires in the conductor	AL Conductor Max. DC resistance at 20°C (Ω/km)	CU Conductor Max. DC resistance at 20°C (Ω/km)
150	37	0.206	0.124
185	37	0.164	0.0991
240	37	0.125	0.0754
300	61	0.1	0.0601
400	61	0.0778	0.047
500	61	0.0605	0.0366

### 5.2 Conductor Screening

- The conductor of each core shall be covered with an extruded non-metallic, semi-conducting compound layer. The screening layer shall be tightly filled to the conductor but shall be easily cold strippable. The screening layer shall bond thoroughly to the insulation but shall be distinguished from the insulation by different color.
- For all 12/20 kV cable sizes, the minimum thickness of conductor screening layer shall not be less than 0.6 mm.
- For all 18/30 kV cable sizes, the minimum thickness of conductor screening layer shall not be less than 0.8 mm.

### 5.3 Insulation

- The conductor of each core shall have an ozone-resistant insulation of cross-linked



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polyethylene (XLPE) extruded on the conductor screen.

- For all 12/20 kV cable sizes, the nominal thickness of insulation layer is 5.5 mm. The minimum thickness of insulation at any point shall not be less than 4.85 mm.
- For all 18/30 kV cable sizes, the nominal thickness of insulation layer is 8 mm. The minimum thickness of insulation at any point shall not be less than 7.1 mm.
- The average insulation thickness measured during inspection shall not be less than the nominal value. For each piece of core, the smallest value measured shall not fall below 90 % of the nominal value by more than 0.1 mm, i.e.  $t_{\min} \geq 0.9 t_n - 0.1$

Additionally:  $(t_{\max} - t_{\min}) / t_{\max} \leq 0.15$

Where:

$t_{\max}$ : is the maximum thickness, in millimeters,

$t_{\min}$ : is the minimum thickness, in millimeters,

$t_n$ : is the nominal thickness, in millimeters

Note:  $t_{\max}$  and  $t_{\min}$  are measured at the same cross-section.

### 5.4 Insulation Screening

- A non-metallic, semi-conducting compound layer, of distinguished color shall be extruded on the insulation **of each core**. The insulation screening layer shall be firmly bonded to the insulation and removable without damaging or scratching the insulation or leaving traces over it during splicing or terminating the cables.
- For all 12/20 kV cable sizes, the minimum thickness of insulation screening layer shall not be less than 0.8 mm.
- For all 18/30 kV cable sizes, the minimum thickness of insulation screening layer shall not be less than 1 mm.

### 5.5 Semi-conductive Swelling Tape

- A water barrier, semi-conductive swelling tape of thickness **not less than 0.5 mm**



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shall be lapped helically to be applied over the insulation screening of each core with overlap  $\geq 10\%$ .

### 5.6 Copper Sheath

- On each core, flat copper tapes and/or wires shall be applied helically and overlapped. For each core, the number of copper tapes and/or wires and the overlap percentage shall be selected in such a way to obtain the specified effective cross-sectional area of copper screen per phase. The effective cross-sectional area of copper screen per phase shall not be less than the following:

Number of cores x C.S.A of cable conductor (mm <sup>2</sup> )	Effective C.S.A of copper screen/phase (mm <sup>2</sup> )
3x150, 3x185 , 3x240	25/3
3x300	30/3
3x400	35/3
3x500	35/3

- The effective cross- sectional area of copper screen per phase (A) shall be calculated by the following formula:

For flat copper tapes, helically applied and overlapped:

$$A_{tapes} = \pi D_m t \sqrt{\frac{100}{2(100 - L\%)}}$$

Where:

t: Thickness of tape, mm.

D<sub>m</sub>: Diameter of semi-conducting swelling tape, mm + 2t mm.

L%: Overlap of copper tape, percent.





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For wires:

$$A_{wires} = \pi d^2 N / 4$$

Where:

d: diameter of wire

N: number of wires

### 5.7 Non-Conductive Swelling Tape

- On each core, a water barrier, non-conductive swelling tape of thickness not less than 0.5 mm shall be lapped helically open helix to be applied over the copper sheath.

### 5.8 Fillers and Separation Sheath

- The interstices between the three cores of the cable shall be filled with non-conducting, impervious and extruded or non-extruded material but the distance between cores and non-conductive swelling tape shall be filled with extruded PVC so that the complete cable assembly shall be of substantial circular shape.
- The materials used for fillers and separation sheath shall be compatible with the XLPE insulation and suitable for the operating temperature of the cable.
- The nominal thickness of the separation sheath shall be calculated by the following formula:

$$(T_s = 0.02 D_u + 0.6 \text{ mm})$$

Where  $D_u$  is the fictitious diameter under this oversheath in mm.

- The thickness of the separation sheath shall be as follow:

Number of cores x C.S.A of conductor mm <sup>2</sup>	Nominal (Average) thickness of separation sheath mm	
	12/20 kV	18/30 kV
3x150	1.8	2.0



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3x185	1.9	2.1
3x240	2.0	2.2
3x300	2.1	2.3
3x400	2.2	2.4
3x500	2.3	----

- The measured smallest thickness of the PVC separation sheath, at any point, shall not fall below 80% of the specified nominal value by more than 0.2 mm.

### 5.9 Non-Conductive Swelling Tape

- A water barrier, non-conductive swelling tape of thickness **not less than 0.5 mm** shall be lapped helically to be applied over the separation sheath with overlap  $\geq 10\%$ .

### 5.10 Metallic Sheath (Lead)

- A sheath consist of lead shall be applied as a reasonably tight-fitting sameness tube.  
**The nominal thickness of the lead metallic sheath shall be 3.1 mm.**

### 5.11 Non-Conductive Swelling Tape

- A water barrier, non-conductive swelling tape of thickness **not less than 0.5 mm** shall be lapped helically to be applied over the metallic sheath with overlap  $\geq 10\%$ .

### 5.12 Metallic Armour

- The cables shall be armoured by a **single layer of galvanized steel wire armour**. Special consideration shall be given to the possibility of corrosion, not only for mechanical safety, but also electrical safety. The material and dimensions of the galvanized steel wire shall be in accordance with IEC 60502 standard.

### 5.13 Non Conductive Swelling Tape

- A water barrier, non-conductive swelling tape of thickness **not less than 0.5 mm** shall be lapped helically to be applied over the armouring with overlap  $\geq 10\%$ .

### 5.14 Outer Jacket

- The cable shall have an oversheath of linear low density polyethylene (LLDPE) water resist. **(in iec 63026 materials of cable outer serving are usually of textile**



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origin (e.g. polypropylene yarns) of suitable thickness)

- The nominal thickness of the oversheath shall be calculated by the following formula:

$$t_s = 0.035 D + 1.0 \text{ mm}$$

where D: is the fictitious diameter under the oversheath. The thickness of the oversheath shall be not less than the following values:

Number of cores x C.S.A of conductor mm <sup>2</sup>	Nominal (Average) thickness of oversheath mm	
	12/20 KV	18/30 KV
3x150	3.4	3.8
3x185	3.5	3.9
3x240	3.7	4.1
3x300	3.9	4.3
3x400	4.1	4.5
3x500		

- The measured smallest thickness of the oversheath, at any point, shall not fall below 80 % of the specified nominal value by more than 0.2 mm.

### ~~4.14 Fiber-optic data cable (Optional)~~

~~(specs to be added with manufactures)~~

## 6. TESTING and INSPECTION

### 6.1 General

- Submarine cables shall be subjected to the following type, routine and special tests in accordance with the latest relevant IEC standards. Cable acceptance and rejection shall be in accordance with the latest relevant IEC standards.
- All tests shall be carried out by the manufacturer and at his expense.
- \_\_ EDC reserves its right to carry out inspection during fabrication stages and witness the routine tests of the cables.



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- According to \_ \_ EDC requirements, sample tests sample tests shall be carried out on a minimum of 10% of the drums offered. \_ \_ EDC reserves its right to carry out sample tests on up to 100% of the offered quantity.
- The type, routine and special tests certificates shall be delivered to \_ \_ EDC.
- Attendance of \_ \_ EDC representatives during fabrication stages and testing shall not relieve the manufacturer of his full responsibility for furnishing the cables in accordance with the requirements of this specification and shall not give him the right to invalidate any claim that \_ \_ EDC may make because of defective or unsatisfactory material or faulty workmanship.

### 6.2 Type Tests

- Submarine cables shall be tested in accordance to the latest relevant standards IEC 63026 and this specification. It shall be the responsibility of the manufacture to perform or to have performed all the tests specified. All type tests had to be performed by accredited laboratories. The type test reports to be submitted shall include the following:

#### (a) Mechanical tests:

- Coiling test
- Tensile bending test
- Tensile test

#### (b) Electrical type tests:

- Partial discharge tests.
- Tan  $\delta$  measurement
- Heating cycle voltage test.
- Lightning Impulse voltage test followed by a power frequency voltage test.
- Examination of the cable system with cable and accessories on completion with above tests.
- Resistivity of semi-conducting screen.

#### (c) Longitudinal/Radial water penetration (LWP, RWP) test



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(d) Non-Electrical type tests on cable components and on complete cable:

- Check of cable construction.
- Tests for determining the mechanical properties of insulation before and after ageing.
- Tests for determining the mechanical properties of oversheaths before and after ageing.
- Ageing tests on pieces of complete cable to check compatibility of materials.
- Pressure test at high temperature for **ST7 oversheaths**.
- Hot set test for XLPE insulation.
- Test on components of cables with longitudinally applied metal tape or foil, bonded to the oversheath.
- Water absorption test for insulation.
- Shrinkage test for XLPE insulation.

**6.3 Routine Tests**

- (a) Partial discharge test
- (b) AC voltage test

**6.4 Sample Tests**

- The following tests (a to i) shall be carried out on each core of the samples and test (j) on a completed cable:
  - (a) Conductor examination.
  - (b) Measurement of electrical resistance of conductor and of metal screen
  - (c) Measurement of thickness of insulation
  - (d) Measurement of thickness of oversheath
  - (e) Measurement of thickness of metal sheath
  - (f) Measurement of diameters
  - (g) Hot set test for XLPE insulation
  - (h) Measurement of capacitance
  - (i) Test on components of cables with longitudinally applied metal tape or foil,



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bonded to the oversheath.

(j) Examination of cable.

**7. MARKING and CABLE IDENTIFICATION**

- The cable over sheath shall be marked throughout its length with the following items:
  - 1- Rated Voltage.
  - 2- Size (number of cores x C.S.A. of conductor mm<sup>2</sup>)
  - 3- Material of conductors.
  - 4- Manufacturer's name
  - 5- Year of manufacture.
  - 6- Customer name ( \_ \_ EDC).
  - 7- Cable length.
- Distances between markings shall not exceed one meter and each mark shall serially indicate the remaining length of the cable.

**8. PACKING**

- All cables shall be supplied on reels with suitable sizes and weight. **To prevent or minimize cable joints, the cable length on each reel shall be specified by \_ \_ EDC in the tendering documents or by agreement between \_ \_ EDC and the supplier.**
- All cable ends shall be firmly secured to the reel and shall be covered by heat-shrinkable end caps.
- The cable reels shall be covered with wooden slabs of suitable thickness. Polypropylene and poly-ethaline slabs can be accepted
- On each reel, the following data shall be printed on both sides:
  - For ----- Electricity Distributing Co. ( \_ \_ EDC)
  - Medium voltage submarine power cables
  - Manufactured by: -----
  - Voltage class: ----- kV



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- Number of cores and cross-section: **3x**----- mm<sup>2</sup>
- Material of conductor: Al / Cu
- Type of insulation: XLPE
- Length of cable: ----- meters
- Net weight ----- kgs
- Gross weight: ----- kgs
- **P.O. No.** -----
- Reel No. / Date of manufacturing: ----- (**must be written also on the reel body**)

**9. GUARANTEE**

- The supplier shall guarantee the cables against all defects arising out of faulty design or manufacturing defects or defective material for a period of 18 months from the date of delivery or 12 months from date of installation.

**10. SUBMITALLS**

- The tenderer shall submit with his offer detail drawings of cable construction illustrating and explaining the design criteria and design bases.
- **Approval certificate issued by Egyptian Electricity Holding Company (EEHC) shall be submitted with the offer.**

**11. TECHNICAL DATA SCHEDULE**

- The tenderer must fill in thoroughly the attached technical data schedule.
- Any offer does not accompanied with clear and complete technical data schedule shall be rejected.

**TECHNICAL DATA SCHEDULE**  
**SUBMARINE POWER CABLES**

\_\_ EDC Inquiry No: \_\_\_\_\_ Item No: \_\_\_\_\_

DESCRIPTION	UNIT	Vendor
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	Proposed Values*
<b><u>A - Technical Particulars:</u></b>	
- Manufacture's name	
- Standards applied to cable	
- Type of cable	
- Operating voltage kV	
- Number of cores	
- Phase cross-sectional area of conductor mm <sup>2</sup>	
- Material of conductors	
- Shape of conductors (with/without swelling powder)	
- Number of conductor strands	
- Diameter of strand mm	
- Overall diameter of conductor mm	
- Material of conductor screening	
- Thickness of conductor screening	
* nominal value mm	
* minimum value mm	
* maximum value mm	
- Conductor insulation XLPE	
- Thickness of insulation	
* Nominal value mm	
* Minimum value mm	
* Maximum value mm	
- Material of insulation screening	
- Thickness of insulation screening	
* Nominal value mm	
* Minimum value mm	
* Maximum value mm	
- Semi-conductive swelling tape:	
* Thickness of swelling tape mm	
* Percentage overlap of tape %	





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- Material of metallic sheath		
- Thickness of metallic sheath	mm	
- Material of separation sheath		
- Thickness of separation sheath	mm	
- Material of armour tapes		
- Number of armour tapes		
- Nominal thickness of armour tape	mm	
- Width of armour tape	mm	
- Non conductive swelling tape:		
* Thickness of swelling tape	mm	
* Percentage overlap of tape	%	
- Material of oversheath		
- Thickness of oversheath		
* nominal value	mm	
* minimum value	mm	
* maximum value	mm	
- Overall cable diameter	mm	
- Minimum bending radius of cable	mm	
- Cable weight per meter		
* Aluminium (conductor)	kg	
* Lead (sheath)	kg	
* Finished cable	kg	
<b><u>B- Performance:</u></b>		
- Power frequency withstand test voltage	kV	
- Duration of power frequency withstand voltage	minutes	
- D.C withstand test voltage	kV	
- Duration of D.C withstand test voltage	minutes	
- 1.2/50 $\mu$ s impulse-withstand test voltage	kV	
- Tensile strength of finished cable	kg/mm <sup>2</sup>	
- Compression strength of finished cable	kg/mm <sup>2</sup>	



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- Insulation resistance measured by 5000V M.ohmmeter for 10 meters of cable at 20°C	MΩ	
- Minimum bending radius of cable	cm	
- Thermal conductivity of finished cable	w/cm°C	
- Partial discharge of cable at 1.73 U <sub>o</sub>	pc	
- Maximum loss angle (tanδ) at U <sub>o</sub> and 20°C		
- Maximum D.C. resistance of conductor per km of cable at 20°C	Ω/km	
- Maximum A.C. resistance of conductor per km of cable at 90°C	Ω/km	
- Maximum reactance per km of cable at 50 Hz.	Ω/km	
- Maximum capacitance per km of cable	μF/km	
- Impedance per km of cable at 90°C and 50 Hz.	Ω/km	
- Charging current per km of cable	Amp/km	
- Dielectric losses per km of cable	Watt/km	
- Maximum continuous current rating * In air 45°C * In ground 30°C	Amps Amps	
- Maximum one second short circuit current capacity of: * Conductor * Screen / one phase * Screen for 3 phase	kA kA kA	
- Maximum cable temperature * Continuous * Emergency * Short circuit	°C °C °C	
<b><u>C- Packing:</u></b>		
- Diameter of drum	m	
- Width of drum	m	
- Length of cable per drum	m	
- Gross weight of charged drum	kg	



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- The cable drum shall be covered with wooden  
slabs of suitable thickness

Yes/No

- (\*) - Values to be provided / proposed by the vendor.  
- Please, provide explanations for deviations if any. (Use separate sheet if necessary.)

I / We guarantee the technical data given above for the offered material/equipment.

Description	Manufacturer of Material/Equipment	Vendor/Supplier
Vendor/Supplier		
Location and Office Address		
Name and Signature of Authorized Representative with Date		
Official Seal / Stamp		