EDMS 03-400-2

TECHNICAL SPECIFICATIONS

FOR

SUPPLY OF UNDER GROUND THREE CORE MEDIUM VOLTAGE ARMOURED CABLES 12/20 KV & 18/30 KV

Issue: March. 2023 / Rev- 2

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توجد بنود اختيارية (Option items) يجب تحديدها بواسطة شركة التوزيع قبل الطرح.

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1. SCOPE

This specification covers the minimum technical requirements for design, engineering, manufacture, testing, inspection, and construction and medium voltage, 50 Hz, three-core with stranded compact aluminum or copper conductors, extruded XLPE insulation, extruded semi-conductor screening, copper screen, steel double-tape armour and PVC oversheath cables. The cables shall be used in system with neutral earthed through resistance networks. The cables shall be for underground direct buried.

2. APPLICABLE STANDERDS

The cables should be complying with the latest edition of IEC publications unless otherwise specified in this specification .The equipment/material covered in this specification shall comply with the latest edition/amendment of the following codes and standards. Where any provision of this specification differs from those of the standards listed below at table (1) , the provisions of this specification shall apply.

Table (1)

S. No.	Standard No.	Description
1.	IEC 60028	International standard of resistance for copper
2.	IEC 60060	High-voltage test techniques
3.	IEC 60228	Conductors of insulated cables.
4.	IEC 60229	Electric cables – Tests on extruded over sheaths with a special protective function
5.	IEC 60230	impulse on cable and their accessories.
6.	IEC 60270	High-Voltage test techniques – Partial discharge measurements
7.	IEC 60287	Electric cables - Calculation of the current rating.
8.	IEC 60502-2	power cables for extruded insulation and their accessories from 6 KV (Um = 7.2 KV) up to 30 KV(Um = 36 KV).
9.	IEC 60811	Electric and optical fiber cables - Test methods for non-metallic materials.
10. i	IEC 60949	Calculation of thermally permissible short-circuits currents, taking into account non-adiabatic heating effects.

3. ENVIRONMENTAL CONDITIONS

The performance of the cables should be guaranteed for following the environmental conditions, any differences in the guaranteed performance should be clearly set out in the offer.

Minimum ambient temperature	: -5°c.
Maximum ambient temperature	: 45°c (50 °c option).
Maximum relative humidity	: 95%
Maximum altitude	: 1000 m.

4. SERVICE CONDITIONS

- The sunlight is very intense and the temperature of exposed 70°C.
- The maximum solar radiation intensity on a horizontal surface is 1000 w/m².
- Severe surface contamination from salt, dust, heavy industrial pollution, sandstorms, fine dust often carried in suspension in the atmosphere even on calm days, can be expected.
- Ground temperature can reach 35°C.
- cables shall be suitable for direct burial on the following conditions.

5. SYSTEM DETAILS :

Frequency	50 HZ
Nominal voltage	11 / 22 KV
Highest voltage	12 /24 KV

6. DESIGN CRITERIA:

1- The cables shall be designed for the following environmental conditions:

a. Occasional sand storms.
b. Salty air.
c. Soil conditions vary from dry sandy to wet silt or clay.
d. In some areas the soil is alkaline in others it is acidic or salty (optional according to ..EDC requirements).

2- The design and construction of cables shall secure the followings:

a. Maximum electric strength.
b. Maximum mechanical strength.
c. Maximum insulation resistance.
d. Maximum flexibility i.e. minimum bending radius.
e. Maximum thermal conductivity i.e. maximum heat dissipation.
f. Minimum thermal expansion and contraction due to overloads and short-circuits i.e. maximum resistance to voids formation i.e. minimum partial discharges.
g. Minimum capacitance and charging current.
h. Minimum dielectric losses.
i. High protection against water penetration and high resistance against sun rays, alkalines, acids and salts.

3- The maximum cables conductor temp. shall be rated for 90ºC continuous temperature and 130ºC maximum emergency temperature and 250 ºC short-circuit temperature.

7. CONSTRUCTION:

a. CONDUCTORS:-

The cables shall have stranded compacted circular plain aluminum/uncoated annealed copper conductors of class 2, The resistance of each conductor at 20 ºC shall not exceed the value specified in the latest- relevant applicable IEC 60228 standards.

The number of wires in the stranded conductors shall be as follow:

No.	Cable conductor C.S.A mm^2	Number of wires in the conductor	Max. DC resistance at 20°C (Ω/Km) AL	Max. DC resistance at 20°C (Ω/Km) CU
1	70	19	0.443	0.268
2	95	19	0.320	0.193
3	120	37	0.253	0.153
4	150	37	0.206	0.124
5	185	37	0.164	0.0991
6	240	61	0.125	0.0754
7	300	61	0.1	0.0601
8	400	61	0.0778	0.047
9	500	61	0.0605	0.0366

b. CONDUCTOR SCREENING:-

Each conductor shall be covered with an extruded non-metallic, semi-conducting compound layer. The screening layer shall be tightly to the conductor but shall be firmly bonded. The screening layer shall bond thoroughly to the insulation but shall be distinguished from it by its different color. The minimum thickness of the screening layer, for all size of cables 12/20 KV shall be not less than 0.6 mm and 0.8 mm for cables 18/30 KV.

c. INSULATION:-

Each conductor shall have an ozone-resistant insulation of cross-linked polyethylene (XLPE) extruded on the conductor screening. The nominal thickness of insulation shall be 5.5 mm and 8 mm for 12/20 KV and 18/30 KV cables respectively. The minimum thickness, at any point, of the insulation shall be not less than 4.85 mm and 7.1 mm for 12/20 KV and 18/30 KV cables respectively.
The minimum average insulation thickness measured during inspection shall be not less than the nominal value.
Requirements for the insulation
* 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.
$t_{min} \geq 0.9\ t_n - 0.1$
and 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.

d. INSULATION SCREENING:-

A non-metallic, semi-conducting compound layer, of different colour than that of the insulation, 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 conductor insulation or leaving traces over it during splicing or terminating the cables.
The minimum thickness of the semi-conducting layer shall be not less than 0.8 mm for all size of cables12/20 KV and 1 mm for cables 18/30 KV.

e. COPPER SCREEN:-

On each core insulation screening, flat copper tapes shall be applied helically and overlapped. The number of copper tapes and their percentage overlap, for each core, 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 be not less than the following:

No.	Number of cores x C.S.A of cable conductor mm^2	Effective C.S.A of copper screen/phase mm^2
1	3x70, 3x95 and 3x120	16/3
2	3x150, 3x185 , 3x240	25/3
3	3x300	30/3
4	3x400	35/3
5	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:

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

Where:

t : Thickness of tape (mm).

D_m: Diameter of semi-conducting insulation screening (mm) + 2t (mm).

L% : Overlap of copper tape, percent.

f. FILLERS AND SEPARATION SHEATH:

The interstices between the cores of the 3-cores cables shall be filled with non-conducting, impervious and extruded or non-extruded material so that the complete cable assembly shall be of substantial circular shape.

The 3-cores cables shall be also inner covered with impervious and non-conducting extruded material. 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:
(Ts = 0.02 Du + 0.6 mm). Where Du 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^2	Nominal (Average) thickness of separation sheath mm	
	12/20 KV	18/30 KV
3x70	1.6	1.9
3x95	1.7	1.9
3x120	1.8	2.0
3x150	1.8	2.0
3x185	1.9	2.1
3x240	2.0	2.2
3x300	2.1	2.3
3x400	2.2	2.4
3X500	2.3	---

***Note:** 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.

g. METALLIC ARMOUR:-

The 3-core cables shall be armoured by steel double-tape. The armour shall be applied helically in two layers so that the outer tape is approximately central over the gap of the inner tape. The gap between adjacent turns of each tape shall not exceed 50% of the tape width. The armour tape nominal thickness shall be as follow:

Number of cores x C.S.A of conductor (mm^2)	Nominal (Average) thickness of armour tapes (mm)	
	12/20 KV	18/30 KV
3x70	0.5	0.5
3x95	0.5	0.5
3x120	0.5	0.8
3x150	0.5	0.8
3x185	0.5	0.8
3x240	0.8	0.8
3x300	0.8	0.8
3x400	0.8	0.8
3X500	0.8	---

The thickness of the armour shall not fall below the specified nominal value by more than 10% during inspection of the cable.

h. OVERSHEATH:

The cables shall have impervious extruded PVC oversheath. The oversheath shall be suitable for exposure to sun rays and soil condition in Egypt (see design criteria). The nominal thickness of the oversheath shall be calculated by the following formula:

ts = 0.035 D + 1.0 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^2	Nominal (Average) thickness of oversheath (mm)	
	12/20 KV	18/30 KV
3x70	3	3.4
3x95	3.2	3.6
3x120	3.3	3.7
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	4.3	---

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

8. INSPECTION AND TESTING :-

1- …. Electricity Distribution Company (…EDC) reserves its right to carry out inspection during fabrication stages and witness the testing of the cables.
2- Unless otherwise specified or approved in writing by (…EDC), the cables shall be subjected to type, routine and special tests in accordance with all relevant applicable IEC standards.
3- Testing procedures and rejection of cables shall be in accordance with all relevant applicable IEC standards.
4- All tests shall be carried out by the manufacturer and at his expense and under control and supervision of (…EDC) inspection engineers.
5- The type, routine and special tests certificates shall be delivered to (…EDC).
6- 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.

8.1. TYPE TEST:

Medium voltage single core cable shall be tested in accordance to the latest relevant standards IEC 60502-2 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 as the following:

a) Electrical tests on completed cable:

1- Bending test, followed by partial discharge test.
2- Tan δ measurements
3- Heating cycle test followed by partial discharge test.
4- Impulse test followed by a voltage test.
5- Voltage test for 4 hours
6- Resistivity of semi-conducting screen.

b) Non-Electrical tests on cable components:

1. Measurement of thickness of insulation.
2. Measurement of thickness of non-metal sheaths.
3. Test for determining mechanical properties of insulation before and after ageing.
4. Test for determining mechanical properties of non-metal sheaths before and after ageing.
5. Additional ageing test on pieces of completed cables
6. Loss of mass test on PVC sheath.
7. Hot set test for XLPE insulation.
8. Shrinkage test for XLPE insulation.
9. Test for resistance of PVC insulation and sheath to cracking (heat shock test).

8.2. ROUTINE TESTS:

a) Measurement of the electrical dc resistance of conductors.

The dc resistance of conductor at 20°C shall not exceed the appropriate maximum value specified in IEC 60228.

b) Partial discharge test

The partial discharge test shall be caried out in accordance with IEC60885-3 except that the sensitivity as defined in IEC 60885-3 shall be 10 pC or better. The voltage being applied between conductor and the screen.

The test voltage shall be raised gradually to and held $2\mathbf{U_0}$ for ten seconds and then slowly reduced to 1.73 $\mathbf{U_0}$

There shall be no detectable discharge exceeding the declared sensitivity from the test object at 1.73 $\mathbf{U_0}$

c) Voltage test

The voltage shall applied for 5 minuets between the conductor and the metal screen. The power frequency test voltage shall be **3.5 $\mathbf{U_0}$** as shown in below table:

Rated voltage $\mathbf{U_0}$ **(** kV**)**	12	18
Test voltage (kV)	42	63

No breakdown of the insulation shall occur

9. IDENTIFICATION OF CABLE PHASES AND MARKING

Identification for cable phases shall be carried using coloured plastic ribbon between the insulation semi-conducting screening and copper screen (RED, YELLOW and BLUE).
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^2).
3- Material of conductors.
4- Manufacturer's name.
5- Year of manufacture.
6- Customer name (..EDC).
7- Cable length.

Distances between marking shall not exceed one meter and each mark shall serially indicate the remaining length of the cable.

10. PACKING:

1- The cable length on each reel shall be as long as possible to minimize the number of joints and shall be as follows:

Cable size mm^2	Cable length on reel (m) ±5%			
	12/20 KV		18/30 KV	
	AL	CU	AL	CU
3x70	600		500	
3x95	600		500	
3x120	500		450	
3x150	500		450	
3x185	450		400	
3x240	450		400	
3x300	400		350	
3x400	350		300	
3X500	300		---	---

2- All cable ends shall be firmly secured to the reel and shall be covered by heat-shrinkable end caps.
3- The cable reels shall be covered with wooden slabs of suitable thickness or with (الواح البولي إثيلين - الواح البولي بروبلين).
4- All cables shall be supplied on reels whose size not to exceed 2.7 m diameter and 1.7 m width including protrusion bolts length. The reels may be returnable as per agreement between the tender and …EDC.
5- The distribution company has the right to change the cable length and

consequently the red diameter will be changed to max size 3m.(optional according to .. EDC requirements.)

6- On each reel, the following data shall be printed on both sides:

* For (….EDC): ARAB REPUBLIC OF EGYPT.
* MEDIUM VOLTAGE POWER CABLES.
* MANUFACTURED BY :
* VOLTAGE CLASS : KV
* NUMBER OF CORES x CROSS-SECTION : mm^2
* MATERIAL OF CONDUCTORS : AL/CU
* TYPE OF INSULATION : XLPE
* LENGTH OF CABLE : M
* GROSS WEIGHT : KGS
* NET WEIGHT : KGS
* REEL NO / Date of manufacture :

11. 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 form date of installation .

12. SUBMITALLS :

The tenderer shall submit with his offer single copies of detail drawings of cable construction, instructions illustrating and explaining the design criteria and design bases, reference standards applied to the cables and instructions for erection, operation, quality control procedure and maintenance. The tenderer shall fill in thoroughly in type-writing the attached guarantee data for the offered cables.

13. GUARANTEE TABLE

A - TECHNICAL PARTICULARS:		
- Manufacturer's name		
- Standards applied to cable		
- Nominal voltage	KV	
- Number of cores		
- Shape of conductors		
- Diameter of strands	mm	
- Number of conductor strands		
- Overall diameter of conductor	mm	
- Cross-sectional area of conductor	mm^2	
- Material of conductors		
- Material of conductor screening		
- Thickness of conductor screening * Nominal value * Minimum value	 mm mm	
- Conductor insulation	XLPE	
- Thickness of conductor insulation * Nominal value * Minimum value	 mm mm	
- Material of insulation screening		

- Thickness of insulation screening * Nominal value * Minimum value	 mm mm	
- Material of screen tape	Copper	
- Thickness of tape	mm	
- Width of tape	mm	
- Percentage overlap of tape	%	
- Number of tapes		
- Effective cross-sectional area of screen per phase	mm^2	
- Material of filling		
- Material of separation sheath		
- Minimum thickness of separation sheath	mm	
- Material of armour tapes		
- Nominal thickness of armour tape	mm	
- Minimum thickness of armour tape	mm	
- Number of armour tapes	Double tape	
- Material of oversheath		
- Thickness of oversheath * Nominal value * Minimum value	 mm mm	
- Overall cable diameter	mm	

- Minimum bending radius of cable	mm	
- Cable weight per meter * Aluminum / copper * Copper sheath * Finished cable	 g g g	
- Length of cable per drum	m	
- Diameter of drum	m	
- Width of drum	m	
- Gross weight of charged drum	kg	
B- PERFORMANCE:		
- 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 μs impulse-withstand test voltage	kV	
- Insulation resistance measured by 5000V M.ohmmeter for 10 meters of cable at 20˚C	M.ohm	
- Thermal conductivity of finished cable	w/cm˚C	
- Partial discharge of cable at 1.73 $U_{\circ}$	Pc	
- Maximum equivalent star capacitance / km	μf	
- Maximum loss angle (tanδ) at $U_{\circ}$ and 20˚C		
- Maximum D.C. resistance of conductor per km of cable at 20˚C	Ohm/km	

- Maximum A.C. resistance of conductor per km of cable at 90˚C	Ohm/km	
- Inductance per core per km of cable	mH	
- Equivalent star reactance per km of cable 50 c/s	Ohm/km	
- Impedance per km of cable at 90˚C and 50 c/s	Ohm/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 for one phase * Screen for 3 phase	 KA KA KA	
- Maximum cable temperature * Continuous * Emergency * Short circuit	 ˚C ˚C ˚C	

I / we certify that the above-mentioned data are guaranteed for the offered cable

Signature