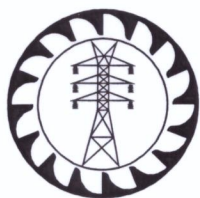


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CEB

SPECIFICATION

LOW VOLTAGE UNDERGROUND CABLES



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LOW VOLTAGE UNDERGROUND CABLES

1.0 SCOPE

This specification covers design, manufacture and testing of the following Low Voltage 0.6/1(1.2) kV Underground Cables;

- (a) Two Core 16 mm² Aluminium Conductor, XLPE Insulated, Galvanized Steel Wire Armoured, PVC sheathed Underground Cable.
- (b) Four Core 16/35/70/95/150/240/300/400 mm² Aluminium Conductor, XLPE Insulated, Galvanized Steel Wire Armoured, PVC sheathed Underground Cable.

2.0 SYSTEM PARAMETERS

(a)	Nominal voltage (U)	400V ph to ph /230V ph to Neutral
(b)	System highest voltage (U _m)	440 V ph to ph /250V ph to Neutral
(c)	System frequency	50 Hz
(d)	Method of earthing	Solidly earthed neutral at substations
(e)	Maximum system fault current/ duration	25 kA / 1 second

3.0 SERVICE CONDITIONS

(a)	Annual average ambient temperature	30 °C
(b)	Maximum ambient temperature	40 °C
(c)	Maximum relative humidity	90%
(d)	Environmental conditions	Humid tropical climate with heavily polluted atmosphere
(e)	Operational altitude	From M.S.L. to 1900 m above M.S.L.
(f)	Isokeraunic (Thunder days) level	100 days
(g)	Depth of laying	1.0 m
(h)	Conditions associated with laying	Mostly direct burying occasionally laid in ducts. High water table & sustained wet conditions are generally encountered with polluted water.

4.0 APPLICABLE STANDARDS

The equipment and components supplied shall be in accordance with the latest editions of the standards specified below and amendments thereof.

(a)	IEC 60228:2004	Conductors of Insulated Cables
(b)	IEC 60502-1: 2009	Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV) – Part 1: Cables for rated voltages of 1 kV ($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV)
(c)	IEC 60949:1988	Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects
(d)	BS EN/IEC 60811.1: 1995	Insulating and sheathing materials of electric cables. Common test methods. General application. Measurement of thickness and overall dimensions. Test for determining the mechanical properties
(e)	BS EN 50356:2002	Method of Spark Testing of Cables
(f)	BS 5467:2008	Electric cables. Thermosetting insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V

Material conforming to other International Standards which are not less stringent than the Standards stipulated above may be offered. When such alternative Standards are used, reference to such Standards shall be quoted and English language copies of such Standards shall be provided with the offer.

However, in the event of discrepancy, details given in this CEB specification supersede above standards.

5.0 BASIC FEATURES

5.1. Conductor

The conductor shall be Sector Shaped (except for 16 mm² two core and four core cables) plain annealed Aluminium Class 2 as per IEC 60228. In case of 16 mm² cables Circular or Sector Shaped conductors may be offered.

Minimum designed withstand fault current and duration for each conductor shall be as follows:

Conductor Size	Minimum fault current/duration
2C 16mm ² , 4C 16mm ²	1.5 kA / 1 second
4C 35mm ²	3.3 kA / 1 second



4C 70 mm ²	6.6 kA / 1 second
4C 95 mm ²	9 kA / 1 second
4C 150 mm ²	14.1 kA / 1 second
4C 240 mm ²	22.7 kA / 1 second
4C 300 mm ² and above	25 kA / 1 second

5.2. Insulation

The insulation of each core (Phase and Neutral Conductors) shall be XLPE and shall be applied by extrusion and cross-linked to form a compact and homogeneous layer in accordance with the IEC 60502-1 standard.

Colour of the insulation of the three phases shall be Brown, Black and Grey and that of the neutral shall be Blue.

5.3. Laying Up

The Cores shall be layed-up with a right hand direction of lay.

5.4. Inner Covering and Fillers

Inner covering shall be extruded from materials suitable for the operating temperature of the cable and compatible with the insulating materials as per IEC 60502-1. Fillers if applicable shall be non-hygroscopic.

5.5. Armour

Armour shall be closed single layer galvanized steel wire complying with IEC 60502-1. However minimum diameter of a steel wire shall be 1.6 mm.

The armour shall be applied helically with a left-hand lay. The minimum mass of zinc coating on the steel wire shall not be less than the value stipulated in BS 5467. Armour shall be able to withstand at least 1/3rd of the specified fault current and duration as per clause 5.1.

Manufacturer shall prove the fault current withstand capability using adiabatic equation specified in IEC 60949. Introduction of similar sized copper or aluminium alloy strands in between steel wires in order to increase fault current carrying capacity is acceptable. However maximum number of such strands shall not exceed 10% of the total strands.

5.6. Oversheath

The oversheath shall be of extruded black P.V.C. type. The oversheath shall confirm to IEC 60502-1 "Type ST2" or "Type 9" conforming to BS 7655-4.2.



5.7. Technical Parameters of Conductors, Insulation and Sheath

Conductor Cross Section (mm ²)	Minimum no of wires in the conductor	DC Resistance (Ω/km)	Tensile Strength of Conductor material(N/mm ²)	Nominal Insulation Thickness (mm)	Sheath Thickness (mm)
16	7	1.91	125-205	0.7	Not less than 2
35	6	0.868		0.9	
70	12	0.443		1.1	Not less than 3
95	15	0.320		1.1	
150	15	0.206		1.4	
240	30	0.125		1.7	
300	30	0.100		1.8	
400	53	0.0778		2.0	

* Maximum design stress shall not be more than 5 kV/ mm.

6.0 REQUIREMENTS FOR SELECTION

6.1. Quality Assurance

The manufacturer shall possess ISO 9001:2015 or latest Quality Assurance Certification valid throughout the delivery period of this bid, for the manufacture of Low Voltage Underground Cables for the plant where manufacturing is being done. The Bidder shall furnish a copy of the ISO certificate certified as true copy of the original by the manufacturer, along with the offer.

6.2. Manufacturing Experience

The manufacturer shall have minimum of ten (10) years experience in manufacturing Low Voltage Underground Cables. Out of this period offered Low Voltage Underground Cable type should have been supplied successfully outside the country of the manufacturer for minimum of five (5) years for usage in utilities.

If the manufacturer has supplied similar items to CEB for the last five (5) years with proven sales records; without any adverse performance records, such manufacturers will be exempted from above requirements.



6.3. Type Tests

Type Test Certificates conforming to the above referred standards or any other international standard which is not less stringent, issued by:

Either

- (a) an accredited independent testing laboratory acceptable to the CEB or
- (b) an accredited or independent testing laboratory acceptable to the CEB where the type tests have been witnessed by CEB or a reputed independent body acceptable to CEB

shall be furnished with the offer. Type Test Certificates shall clearly indicate the relevant standard, items concerned, showing the manufacturers identity, type No. /catalogue No. and basic technical parameters. In case if the submitted type tests are according to any other international standard which is not less stringent than the specified, then the copy of the used standard in English shall be submitted with offer.

Proof of accreditation and accredited scope by a national/ international authority shall be forwarded with the offer. Test certificates shall be complete including all the pages as issued by the testing authority. Type test certificates shall be in English language. Parts of test certificates shall not be acceptable.

Following type tests as per IEC 60502-1 shall be furnished with the offer;

A. Electrical Type Tests

- (a) Insulation resistance measurement at ambient temperature
- (b) Insulation resistance measurement at maximum conductor temperature in normal operation
- (c) Voltage test for 4 h

B. Non- Electrical Type Tests

- (a) Measurement of thickness of insulation (testing done for IEC defined sizes acceptable)
- (b) Measurement of thickness of non-metallic sheaths (testing done for IEC defined sizes acceptable)
- (c) Tests for determining the mechanical properties of insulation before and after Ageing
- (d) Tests for determining the mechanical properties of non-metallic sheaths before and after ageing
- (e) Additional ageing test on pieces of completed cables
- (f) Loss of mass test on PVC sheaths of type ST2
- (g) Pressure test at high temperature on insulations and non-metallic sheaths
- (h) Test for resistance of PVC insulation and sheaths to cracking (heat shock test)
- (i) Hot set test for EPR, HEPR and XLPE insulations and elastomeric sheaths
- (j) Water absorption test on insulation
- (k) Flame spread test on single cables
- (l) Shrinkage test for XLPE insulation



Following type test as per BS 5467 for armour wires shall be provided with the offer

(m) Mass of zinc coating

7.0 INFORMATION TO BE FURNISHED WITH THE OFFER

The following shall be furnished with the offer.

- (a) Following technical details in English clearly identifying the offered items, but not limited to:
 - (i) Comprehensive catalogues
 - (ii) Dimensional drawings
 - (iii) Schematic diagrams
 - (iv) Calculations, graphs and tables
 - (v) Operational literature
 - (vi) Current rating – laid direct /ducts/air with correction tables of rating factors and group rating factors
 - (vii) Maximum symmetrical short circuit current rating curve for 0.2 to 3.0 sec. duration
 - (viii) Calculations to prove armour can withstand specified earth fault current
- (b) Documentary evidence on following:
 - (i) Maximum design electrical stress (taking purity of raw materials, manufacturing conditions and ageing of cables in to account).
 - (ii) Purity of raw materials.
 - (iii) Control of extrusion process to achieve smooth extruded surfaces, homogenous extrudates and prevention of void formations.
- (c) ISO 9001:2015 or latest Quality Assurance Certificate in accordance with clause 6.1.
- (d) Manufacturer shall furnish a list of supplies with supplied item, purchaser (specifying address contact persons and contact details, country), year & quantity to prove his manufacturing experience and outside the country sales in accordance with Clause 6.2.
- (e) Type Test Certificates in accordance with the clause 6.3.
- (f) Duly filled and signed 'Annex - B: Schedule of Technical Requirements and Guaranteed Technical Particulars'.

Not furnishing above documents and details may result in offer being rejected.



8.0 PERFORMANCE GUARANTEES AND WARRANTY

Manufacturer should provide CEB a warranty ensuring that cables supplied meet the specification and any defected cable shall be replaced without extra cost during the first year after the final delivery to CEB stores.

9.0 SAMPLES

Two specimens samples of length 0.5 meter from each category offered shall be supplied with the offer.

10.0 SPARES

Not Applicable.

11.0 PACKING AND LABELING/MARKING

11.1. Packing

The cables shall be supplied in non - returnable drums and the drums shall be made of timber, pressure impregnated against fungal and insect attack, or made of steel suitably protected against corrosion suitable to mount on standard drum jacks.

A polythene lining shall be provided to prevent any damage to cable from the chemical used for preservation of timber. The drum shall be lagged with closely fitted battens to protect cable from damage. The ends of all cables shall be sealed with heat shrinkable caps to prevent the ingress of moisture during transportation and storage.

The length of cable per drum for the sizes of cable up to and including 70 mm² shall be 500 meters and for cables of sizes higher than 70 mm². shall be 250 meters. The cable length per drum shall not vary more than $\pm 2\%$.

11.2. Identification and Marking of the Cable and Drums

The word "CEB", voltage rating as U_0/U (U_m), size of the cable, standard adopted, conductor size, year of manufacture, manufacturer's name or trade mark, warranty period and travel length shall be embossed at intervals as stipulated in BS 6622:2007 as applicable, on the outside of the oversheath. The embossing shall be weatherproof and abrasion proof.

Each drum shall be labeled (with clear stencil) with the following;

- (a) "PROPERTY OF CEYLON ELECTRICITY BOARD"
- (b) Bid No. Serial No.....
- (c) Manufacturer's identification.



- (d) Cable Type, Voltage Rating, Conductor Size and Number of Cores.
- (e) Number and year of standard adopted.
- (f) Net Weight & Gross Weight in kg.
- (g) Length of cable in meter.
- (h) Direction of rolling
- (i) Year of Manufacture.

12.0 INSPECTION AND TESTING

12.1. Routine Tests

The Routine Test Certificates conforming to the relevant standards shall be furnished for the observation of the Engineer appointed by CEB at the time of inspection. In addition, the routine test certificates shall be sent with the shipment of cables.

Following Routine Tests as per IEC 60502-1 shall be carried out

- (a) Measurement of the electrical resistance of conductors
- (b) Voltage test

12.2. Inspection

The Successful bidder shall make necessary arrangements for inspection by an Engineer appointed by the CEB and also to carry out in his presence necessary Acceptance tests on procured item and material without any additional cost. Acceptance test reports shall be a part of the shipping document. CEB may waive off the inspection either with the condition of witnessing the acceptance tests by an independent body acceptable to CEB or completely. In such a situation a notice of waive off will be issued in advance to the supplier.

12.3. Acceptance Tests

Unless specified below, visual inspection, dimensional checks, sample tests specified in the relevant standards, selected type tests and the routine tests conducted for the selected sample in addition to the complete routine test reports shall form the acceptance test report.

- (a) Conductor examination
- (b) Check of dimensions
- (c) Hot set test for EPR, HEPR and XLPE insulations and elastomeric sheaths
- (d) Verification of resistivity of armour strands as against calculations provided in clause 7.0
- (a)(viii)



13.0 ANNEXES

- Annex – A : Price Variation
- Annex –B : Schedule of Technical Requirements and Guaranteed Technical Particulars
- Annex –C : Non-Compliance Schedule



ANNEX- A

PRICE VARIATION

The Bidders shall forward their offers on the basis of the Price Variation stipulated below.

1.0 BASIS OF THE OFFER

- (a) Suppliers of Low Voltage Insulated Wires are required to make their offers on the basis of a Base Price plus a Fixed Price Margin.
- (b) The Base Price shall be the LME Official Settlement Price (Cash Official Offer Price) of Aluminium High Grade 99.7% and Steel, at London Metal Exchange (LME) in US Dollars on the 14th day before the closing of Bids (exclusive of the bid closing date) or the previous working day if that day is a non-working day at the LME.
- (c) The Fixed Price Margin shall be quoted in the currency of choice of the Bidder.

Accordingly, FOB Price of foreign Bidders offering cables from outside the country and the ex-factory price of Local Bidders shall be computed **for the evaluation as;**

$$\{A_0 \times MT1 \times US_0 + B_0 \times MT2 \times US_0 + FP \times CC_0\} \times TL$$

Where;

- A₀** - Base Price which is the LME Official Settlement Price (Cash Official Offer Price) of Aluminium High Grade 99.7%, in US Dollars per Metric ton at the LME on the fixed date [Clause(1 b)]
- B₀** - Base Price which is the 1 month closing price of Steel Rebar in USD per Metric Ton at the LME on the fixed date [Clause(1 b)]
- FP** - Fixed Price Margin per kilometre of offered Low Voltage Underground Cable in the currency allowed under Clause 1(c) above.
- MT1** - Quantity of High Grade Aluminium 99.7% in Metric Ton for the manufacture of one kilometre of offered Low Voltage Underground Cable considered for bid price.
- MT2** - Quantity of Steel in Metric Ton for the manufacture of one kilometre of offered Low Voltage Underground Cable considered for bid price.



- TL** - Total Length in kilometres of Low Voltage Underground Cable offered.
- CC₀** - Currency Conversion rate from the currency of choice of the Bidder to LKR prevailing on the 14th day before Bid opening.
- US₀** - Currency Conversion rate from the US Dollars to LKR prevailing on the 14th day before Bid opening.

2.0 AWARD PRICE

- (a) The FOB Award Price of foreign Bidders offering Low Voltage Underground Cable shall be computed as;

$\{A_1 \times MT1 \times TL + B_1 \times MT2 \times TL\}$ in US Dollars + $[FP \times TL]$ in the currency of choice quoted.

- (b) The Ex-factory Award Price of Local Bidders offering Low Voltage Underground Cable shall be computed as;

$\{A_1 \times MT1 \times US_1 + B_1 \times MT2 \times US_1 + FP \times CC_1\} \times TL$ in LKR

Where;

- A₁** - Base Price which is the LME Official Settlement Price (Cash Official Offer Price) of Aluminium High Grade 99.7% in US Dollars per Metric ton at the LME at the 3rd working day immediately after the day of award.
- B₁** - Base Price which is the 1 month closing price of Steel Rebar in US Dollars per Metric ton at the LME at the 3rd working day immediately after the day of award.
- FP** - Fixed Price Margin per kilometre of Low Voltage Underground Cable in the currency of choice.
- TL** - Total Length in kilometres Low Voltage Underground Cable awarded.
- CC₁** - Conversion rate from the currency of choice to Sri Lankan Rupees prevailing on the 3rd working day immediately after the day of award.
- US₁** - Currency Conversion rate from the US Dollars to LKR prevailing on the 3rd working day immediately after the day of award.

Intimation of the award will be faxed/ e-mailed to the successful Bidder and or to his agent in Sri Lanka on the same day of the award.



3.0 CONVERSION OF CURRENCY

- (a) For the purpose of the evaluation the Prices A_0 , B_0 in US Dollars and the Fixed Price Margin (FP) in the currency of choice of the Bidder will be converted to LKR at the official Selling Exchange Rate of the Central Bank of Sri Lanka prevailing on the 14th day before closing of Bids.
- (b) The payment for the foreign Bidders for supply of Low Voltage Underground Cable will be made at the contract price in the currency quoted for the Fixed Price Margin (FP). The metal base prices in US Dollars will be converted to the currency of the FP at the official Selling Exchange rate at the Central Bank of Sri Lanka prevailing at the 3rd working day immediately after the day of award.
- (c) The payment for local suppliers for the supply of Low Voltage Underground Cable will be made in LKR. The Prices of Aluminium and Steel in US Dollars will be converted to LKR at the official Selling Exchange rate at the Central Bank of Sri Lanka prevailing on the 3rd working day immediately after the day of award.

4.0 VARIATION FIGURES

The Bidders shall furnish;

- (i) Fixed Price Margin (FP) for manufacture of one kilometre of Low Voltage Underground Cable in the currency allowed in Clause 1(c)
- (ii) Weight in metric tons of High Grade 99.7% Aluminium (MT1) required for the manufacture of one kilometre of Low Voltage Underground Cable
- (iv) Weight in metric tons of Steel (MT2) required for the manufacture of one kilometre of Low Voltage Underground Cable

in the price schedule.

.....
Signature and seal of the Manufacturer

.....
Date

I/We certify that the above data are true and correct

.....
Signature and seal of the Bidder

.....
Date



ANNEX B

SCHEDULE OF TECHNICAL REQUIREMENTS AND GUARANTEED TECHNICAL PARTICULARS

(CEB Requirements shall be filled by the procurement entity and information of the offer shall be filled by the manufacturer for each size/type of cable offered)

		CEB Requirement	Offered
1.	Name of the Manufacturer		
2.	Country of Origin		
3.	Nominal cross-sectional area mm ²		
4.	No. of cores		
5.	Rated Voltage category	0.6 /1 (1.2) kV	
6.	System Highest Voltage	440V ph to ph /250V ph to Neutral	
7.	Designed Fault Current and duration for conductor kA/s	As per clause 5.1	
8.	Maximum Nominal Operating Temperature	90 °C	
9.	Maximum Design Stress	5 kV/mm	
10.	Applicable Standards	IEC 60502-1 as applicable	
11.	Conductor Particulars		
	(a) Diameter mm		
	(b) Number of strands. Nos.		
	(c) Diameter of strands. mm		
	(d) Material	Aluminium	
	(e) Shape	Sector	
	(f) Type		
	I. Solid / Stranded	Stranded	
	II. Compact / Non compact		
12.	Insulation Particulars		
	(a) Material	XLPE	
	(b) Thickness		
	I. Minimum average mm	As specified	
	II. Minimum at a point mm	As per applicable	

		standard	
13.	Extrusion Process		
14.	Laying up		
15.	Metallic armour		
	(a) Material	Galvanized Steel	
	(b) Diameter of a wire mm	As per applicable standard	
	(c) Mass of zinc coating	As per applicable standard	
	(d) Fault current withstand capability and duration kA/s		
16.	Oversheath		
	(a) Type/Material	PVC-ST2 Type 9 or	
	(b) Thickness		
	I. Nominal mm	As per applicable standard	
	II. Min. at a point mm	As per applicable standard	
	(c) Whether Graphite layer provided	Yes	
	(d) Whether DC test on oversheath carried out		
17.	Overall diameter of cable mm		
18.	Approximate weight of cable kg/ km		
19.	Minimum bending radius mm	As per applicable standard	
20.	Whether the cable ends are sealed before shipping	As per clause 11.0	
21.	Indicate the details of marking provided on the over sheath.		
	(a) Cable Designation	As per applicable standard	
	(b) Identification of manufacturer		
22.	Current Rating		
	(a) Laid direct		
	(b) Laid in ducts		
	(c) Laid in air		
	(d) Whether the maximum symmetrical short circuit current rating curves for 0.2 to 3 Sec. duration Furnished	Yes	
23.	Conditions of laying where the above rating are valid.		
	(a) Standard depth of laying	1.0 m	
	(b) Ambient air temperature	30 °C	

24.	(a) Maximum conductor DC resistance at 20°C	Ω/km	As per applicable standard	
	(b) Maximum conductor reactance at 50 Hz	Ω/km		
	(c) Maximum conductor capacitance at 50Hz	μ F/km		
	(d) Coefficient of Thermal variations of the Electrical parameters			
25.	Maximum allowable conductor temperature at and duration			
	(a) Full Load conditions/ Duration	°C/Duration		
	(b) Short Circuit conditions/ Duration	°C/Duration		
	(c) Overload conditions/ Duration	°C/Duration		
	(d) Allowable maximum overloading in determining the above	%/A		
26.	Drum Particulars			
	(a) Material of the drum		Steel/Wood	
	(b) Dimensions.	mm x mm		
	(c) Weight	kg		
	(d) Standard cable length			
	(e) Weight of standard length with drum	kg		
27.	Whether a certified copy of ISO 9001:2015 or latest furnished with the offer?		As per clause 6.1	
28.	Whether the entire Type Test Certificates in accordance with clause 6.3 furnished with the offer?	Yes/No	Yes	
29.	Whether all information in accordance with clause 7.0 furnished with the offer?	Yes/No	Yes	

.....
Signature of the Manufacturer and seal

.....
Date

I/We certify that the above data are true and correct

.....
Signature of the Bidder and seal

.....
Date



Annex – C**Non-Compliance Schedule**

On this schedule the bidder shall provide a list of non-compliances with this specification, documenting the effects that such non-compliance is likely to have on the equipment life and operating characteristics. Each non-compliance shall be referred to the relevant specification clause.

Clause No.	Non-Compliance

.....
Signature of the Manufacturer

.....
Date

I/We certify that the above data are true and correct

.....
Signature of the Bidder and seal

.....
Date

