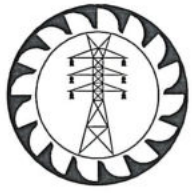
003:2019

CEB
SPECIFICATION

ALUMINIUM BARE CONDUCTORS



CEYLON ELECTRICITY BOARD
SRI LANKA

Telephone: +94 11 232 8051

Fax: +94 11 232 5387

CONTENTS

SPECIFICATION FOR ALUMINIUM BARE CONDUCTORS

1.0 SCOPE

This specification covers the general requirements of the design, manufacturing and testing of undermentioned Aluminium Bare Conductors for the use in overhead power transmission and distribution systems.

(a) All Aluminium Conductors (AAC) –Fly Conductor
(b) All Aluminium Alloy Stranded Conductors (AAAC) – Willow / Elm conductor

The procurement entity shall prescribe one of the above categories in price schedule indicating the conductor size and any other extra options. The sizes of Aluminium/Aluminium Alloy wires shall be as stipulated in the Annex - A (Conductor Particulars)

2.0 SYSTEM PARAMETERS

(a)	Nominal voltage (U)	400 V	11 kV	33 kV
(b)	System highest voltage (U_m)	440 V	12 kV	36 kV
(c)	System frequency	50 Hz	50 Hz	50 Hz
(d)	Method of earthing	Solid earthed	Resistively /Effectively earthed	Resistively /Effectively earthed
(e)	System fault level	25kA	25 kA	25 kA

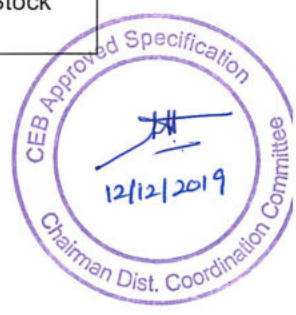
3.0 SERVICE CONDITIONS

(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

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)	BS 215 - Part 1:1970	All Aluminium Conductors.
(b)	BS EN 50183: 2000	Conductors for overhead lines – Aluminium– magnesium – silicon alloy wires.
(c)	BS EN 1715 -2:1998	Aluminium and aluminium alloy – Drawing stock.
(d)	BS 2627 :1970	Specification for wrought Aluminium for electrical purposes, Wire.
(e)	ANSI/ASTM B233-97	Standard specification for Aluminium 1350 Drawing Stock for electrical purposes.



(f)	BS EN 573-3: 2007	Aluminium and aluminium alloy- Chemical composition and form of wrought products.
(g)	BS EN 50189 :2000	Conductors for overhead lines. Zinc coated steel wires.
(h)	BS EN 50326: 2002	Conductors for overhead lines. Characteristics of greases.

Material conforming to other International Standards which are equal to or higher but 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. Design of Wire

Aluminium and Aluminium Alloy wires shall be uniform in quality, circular in cross section, clean, smooth and free from harmful defects, splinter irregularities and brittle places.

	AAC	AAAC	
1. General			
(a) Type of Conductor	**Fly**	**Willow**	**Elm**
(b) Material of wire used to manufacture the conductor	Aluminium (Type AL1)	Aluminium Alloy (Type AL3)	
2. Aluminium / Aluminium Alloy Wire			
(a) Applicable Standard	BS EN 60889/ BS EN 50182	BS EN 50183/ BS EN 50182	
(b) Standard wire diameter (mm)	3.40	4.04	3.76
(c) Cross-sectional area of standard diameter wire (mm^2)	9.079	12.819	11.104
(d) No. of wires per conductor	7	7	19
(e) Standard Resistance at 20^0C per km (Ω)	3.113	2.562	2.958
(f) Co-efficient of linear expansion ($/^0C$)	23×10^{-6}		
(g) Minimum Tensile Strength of individual wires (N/mm^2)	165	295	
(h) Minimum breaking load of standard diameter wire (N)	1490	4030	3490
(i) Minimum elongation after fracture on 250mm	-	3.0	
(j) Joints	Joints shall be in accordance with Clause 5.6 of BS EN 50182		

5.2. Construction/Stranding of Aluminium/Aluminium Alloy Conductors

The construction of the conductors shall be as follows. The completed conductor shall be smooth and free from imperfections, dirt, grit, excessive amounts of drawing oil and other foreign deposits.

The AAC/AAAC shall be manufactured in accordance with BS EN 50182.

The lay ratio of the different layers shall be within the limits given in Table 2 of BS EN 50182.In all constructions, the successive layers shall have opposite directions of lay, the outermost layer being right-handed. The wires in each layer shall be evenly and closely stranded.

In conductors having multiple layers of wires, the lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

Sufficient grease shall be applied to the inner Aluminium Alloy Strands to fill the inter-strand spaces. (viz: Inner Layer Protection).

5.3. Conductor Materials

5.3.1. Aluminium Alloy (For AL3)

The Aluminium - Magnesium - Silicon Alloy shall be processed from the drawing stock having alloy designation EN AW-6201 (EA1 Mg0, 7Si) as per BS EN 1715 -2. The chemical composition of the designated alloy shall conform to BS EN 573 -3:) are as follows

Element	Percentage Composition
Cu	0.10 (Max)
Fe	0.50 (Max)
Si	0.5 - 0.9
Mn	0.03 (Max)
Mg	0.6 - 0.9
Zn	0.10 (Max)
Cr	0.03 (Max)
B	0.06 (Max)
Other elements, each	0.03 (Max)
Other elements, total	0.10(Max)
Aluminium	Remainder

5.3.2. Aluminium Re-Draw Rods (For AL1)

Aluminium Re - Draw Rods used in the manufacturing of Aluminium wire for the fabrication of ACSR/AAC shall conform to ANSI / ASTM B 233-97.

The quality of Aluminium Re - Draw rods used for the manufacture of ACSR/AAC conductor shall conform to the CEB Specification 001:2018.

5.4. Grease

In case of AAAC, grease used for additional corrosion protection shall have a dropping point of not less than 100°C.

The type of grease used in the manufacture of AAAC and technical specifications shall be furnished with the offer.

5.5. Workmanship

(a) The conductors shall be cleaned and free of imperfections, such as pipes, laps, cracks, kinks, bends, twists, seems excessive grease and other injurious defects.

(b) Higher quality of work shall be maintained in drawing the wire and fabrication of the conductors.

(c) Due precaution shall be taken to prevent the Aluminium Re - Draw Rods, Aluminium wires Aluminium Alloy Wire or All Aluminium Alloy Conductor making contact with copper conductors, copper parts or copper residues during the process of redrawing stranding as well as storage.

(d) All machines and equipment used for this purpose of redrawing shall be properly cleaned, free from any copper residues.

6.0 REQUIREMENTS FOR SELECTION

6.1. Quality Assurance

The manufacturer/s shall possess ISO 9001:2015 or latest Quality Assurance Certification valid throughout the delivery period of this bid, for the manufacture of AAC/AAAC conductor. The Bidder shall furnish copies 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 five (5) years experience in manufacturing Aluminium Conductors. Out of this period offered Aluminium Conductor type should have been supplied successfully outside the country of the manufacturer for minimum of three (3) years for usage in utilities. The product offered has to be in same voltage range of offered item and shall have been used in service utilities over past 5 years.

If the manufacturer has supplied similar items to CEB for the last three (3) years with proven sales records; without any adverse performance records, such manufacturers will be exempted from above requirements.

6.3. Type Tests

The following Type Test Certificates conforming to relevant standard stipulated in clause 4.0 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.

Type Tests (As per BS EN 50182)	AAC	AAAC
1. For Conductor		
(a) Surface condition	√	√
(b) Diameter	√	√
(c) Inertness	√	√
(d) Lay ratio and direction of lay	√	√
(a) Number and type of wires	√	√
(b) Mass per unit length	√	√
(c) Stress-strain curve	√	√
(d) Tensile breaking strength	√	√
(e) Stringing test	√	√
2. For Aluminium Wires		
(a) Diameter	√	√
(b) Tensile strength	√	√
(c) Elongation	-	√
(d) Resistivity	√	√
(e) Wrapping test	√	√
(f) Welding	√	√
3. For Grease		
(a) Mass per unit length	-	√
(b) Drop point	-	√

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) Chemical Composition
(ii) Comprehensive catalogues.
(iii) Dimensional drawings.
(iv) Complete mechanical properties including braking load, modulus of elasticity, co-efficient of thermal expansion etc.
(v) Electrical characteristics including D.C. resistance at 20°C, co-efficient of variation of resistance.
(vi) Schematic diagrams.
(vii) Calculations, graphs and tables.
(viii) Operational literature.

(b) Technical details about grease used as per clause 5.4.

(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 - C: 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 specimen samples of length 2 meter from offered category shall be supplied with the offer.

If the size of the conductor specified in the bid is not available with the manufacturer at the time of submitting the samples the manufacturer may submit a sample closest to the size of the conductor specified.

The grade of the Aluminium of the sample shall be same as specified. The manufacturer shall indicate clearly on the sample, the code name and the physical characteristics of the conductor sample.

10.0 SPARES

Not Applicable.

11.0 PACKING AND LABELING/MARKING

11.1. Packing

(a) The Conductors shall be supplied in wooden drums and shall be supplied in continuous length per drum as given in the Annexure A.

(b) Drums shall be stoutly constructed of good quality timber or steel and clearly marked with the length and type of conductor in a manner not easily removable. Drums shall be securely battened around the perimeter and shall be lined with approved impervious material to prevent contact between the contents and both the drum itself and any chemicals with which the drum has been treated. Drums shall be suitable for rolling on the flanges without causing damage to the conductor and the direction of rolling shall be clearly shown.

(c) All timber drums and battens shall be protected from deterioration by termite or fungus attack by an approved impregnation treatment at the works before dispatch. Such substance shall not be harmful to the conductor.

(d) All drums shall have spindle holes of diameter between 100mm to 120mm and the holes shall be stoutly reinforced with steel plates.

(e) The exposed end of the Conductor in each drum shall be crimp-sealed and clamped to the drum.

11.2. Labeling/Marking

Each drum shall be labelled with clear stencil on both sides of the drum with the following.

(a) CEYLON ELECTRICITY BOARD, TENDER NO :
(b) Manufacturer's name
(c) Direction of rolling
(d) Lifting instructions and limitations

The letters shall not be less than 75 mm of height and the ink used shall be water-proof. An Aluminium name plate shall be fixed to each drum clearly showing the following.

(a) Serial No. The serial numbers shall be from 001 onwards
(b) Conductor type, material and stranding
(c) Length of the conductor
(d) Net Weight
(e) Gross Weight
(f) Manufacturer's batch number.
(g) Winding date
(h) Approximate measurements of the drum

12.0 INSPECTION AND TESTING

12.1. Sample Tests

Depending on the choice of the applicable standards, the following Sample Test Certificates conforming to relevant standard shall be furnished for the observation of the Engineer appointed by the purchaser at the time of inspection. In addition, the sample test certificates shall be sent with the shipment of cables.

Sample Tests (As per BS EN 50182)	AAC	AAAC
1. For Conductor		
(a) Surface condition	√	√
(b) Diameter	√	√
(c) Inertness	√	√
(d) Lay ratio and direction of lay	√	√
(f) Number and type of wires	√	√
(g) Mass per unit length	√	√
2. For Aluminium Wires		
(a) Diameter	√	√
(b) Tensile strength	√	√
(c) Elongation	-	√
(d) Resistivity	√	√
(e) Wrapping test	√	√
3. For Grease		
(a) Mass per unit length	-	√
(b) Drop point	-	√

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

The following Acceptance / Sample Tests conforming to BS EN 50182 shall be witnessed by the representative of the CEB.

Sample Tests (As per BS EN 50182)	AAC	AAAC
1. For Conductor		
(e) Surface condition	√	√
(f) Diameter	√	√
(g) Inertness	√	√
(h) Lay ratio and direction of lay	√	√
(h) Number and type of wires	√	√
(i) Mass per unit length	√	√
2. For Aluminium Wires		
(f) Diameter	√	√
(g) Tensile strength	√	√
(h) Elongation	-	√
(i) Resistivity	√	√
(j) Wrapping test	√	√
3. For Grease		
(c) Mass per unit length	-	√
(d) Drop point	-	√

13.0 ANNEXES

Annex – A : Conductor Particulars

Annex – B : Price Variation

Annex – C1 : Schedule of Technical Requirements and Guaranteed Technical Particulars (For AAC)

Annex – C2 : Schedule of Technical Requirements and Guaranteed Technical Particulars (For AAAC)

Annex – D : Non-Compliance Schedule

ANNEX- A

Conductor Particulars

Description	Unit	Conductor		
		Fly	Willow	Elm
Calculated area of complete conductor	mm^2	60	89.8	211
No & Diameter of wires	No/mm	7/3.40	7/4.04	19/3.76
Overall diameter of conductor	mm	10.2	12.12	18.80
Approximate weight of conductor	kg/km	175.3	246.0	580.0
Calculated DC resistance at 20^0C	Ohm/km	0.452	0.366	0.156
Calculated breaking load	kN	10.5	25.10	59.10
Approximate weight of conductor per drum	kg	300-500	300	350

ANNEX- B

PRICE VARIATION

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

1. BASIS OF THE OFFER

(a) Bidders 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 Cash Seller's Midday Official Average Price of Aluminium High Grade 99.7% 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;**

$$[(B_0 \times US_0) + (FP \times CC_0)] \, MT$$

Where;

B_0 - Base Price which is the Cash seller's midday official average price of Aluminium High Grade 99.7% in USD per Metric Ton at the LME on the fixed date (Clause 1(b) above).

FP - Fixed Price Margin per Metric ton of Aluminium conductor in the currency allowed under Clause 1(c) above.

MT - Quantity of Aluminium conductor in Metric ton

CC_0 - Currency Conversion rate from the currency of choice of the Bidder to Sri Lanka Rupees prevailing on the 14th day before Bid opening.

US_0 - Currency Conversion rate from the US Dollars to Sri Lanka Rupees prevailing on the 14th day before Bid opening.

2. AWARD PRICE

(a) The FOB Award Price of foreign Bidders offering Aluminium Conductors shall be computed as;

$(B_1 \times MT)$ in US Dollars + **$[FP \times MT]$** in the currency of choice quoted.

(b) The Ex-factory Award Price of Local Bidders offering Aluminium Conductors shall be computed as;

$(B_1 \times MT) \times US_1 + (FP \times MT) \times CC_1$ in LKR

CEB Approved Specification
12/12/2019
Chairman Dist. Coordination Committee

Where;

B_1 - Base Price which is the LME Official Settlement Price of Aluminium High Grade 99.7% in USD per Metric Ton at the 3rd working day immediately after the day of award

CC1 - Currency Conversion rate from the currency of choice of the Bidder to LKR prevailing on the 3rd working day immediately after the day of award.

US_1 - Currency Conversion rate from the US Dollars to Sri Lanka Rupees prevailing at 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. CONVERSION OF CURRENCY

(a) For the purpose of the evaluation the Price **B_o** in US Dollars and the Fixed Price Margin (FP) in the currency of choice of the Bidder will be converted to Sri Lanka Rupees at the official Selling Exchange Rate of the Central Bank of Sri Lanka prevailing on the 14th day before Bid opening.

(b) The payment for the foreign Bidders for supply of Aluminium Conductors will be made at the contract price in the currency quoted for the Fixed Price Margin (FP). The base price **B_1** 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 bidders for the supply of Aluminium Conductors will be made in LKR. The Base Price **B_1** in US Dollars will be converted to LKR 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.

....
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**

CEB Approved Specification
12/12/2019
Chairman Dist. Coordination Committee

Annex – C1

SCHEDULE OF TECHNICAL REQUIREMENTS AND GURANTEED TECHNICAL PARTICULARS
Conductor Type – Fly (AAC)

(CEB Requirements shall be filled by the procurement entity and information of the offer shall be filled by the manufacturer)

			Offered
1.	Name of the Manufacturer		
2.	Country of Origin		
3.	Rated Voltage category , U_0/U (U_m)		
4.	Applicable Standards		
5.	Conductor Particulars		
	(a) Aluminium wires	Nos	
	(b) Overall diameter	mm	
	(c) Nominal cross sectional area of the conductor	mm^2	
	(d) Lay ratio for Aluminium layers	Max	
		Min	
	(e) Breaking load (min.)	kN	
	(f) D.C. Resistance at 20°C	Ω/km	
	(g) Coefficient of Linear expansion	/°C	
	(h) Modulus of Elasticity	N/mm^2	
6.	Aluminium Wire		
	(a) Diameter	mm	
	(b) Resistivity at 20°C	μΩ cm	
	(c) Coefficient of linear expansion	/°C	
	(d) Tensile strength (min.)	N/mm^2	
7.	Aluminium Re-Draw Rods used to manufacture AAC		
	(a) Purity of Aluminium	%	
	(b) Whether quality of Aluminium Re-Draw rods comply with the CEB Specification 001:2018	mm	
	(c) Maximum electrical resistivity	$\Omega.mm^2/m$	
	(d) Minimum tensile strength	MPa	
8.	Approximate weight of the conductor	kg/ km	
9.	Drum Particulars		
	(a) Material of the drum		

	(b) Dimensions	mm xmm	
	(c) Weight	kg	
	(d) Standard conductor length	m	
	(e) Weight of standard length with drum	kg	
	(f) Whether marking provided as per clause 11.2?	Yes/No	
10.	Whether a certified copy of ISO 9001:2015 or latest furnished with the offer?		
11.	Whether the entire Type Test Certificates in accordance with clause 6.3 furnished with the offer?	Yes/No	
12.	Whether all information provided as per clause 7.0?	Yes/No	

.....
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

CEB Approved Specification
12/12/2019
Chairman Dist. Coordination Committee

Annex – C2

SCHEDULE OF TECHNICAL REQUIREMENTS AND GURANTEED TECHNICAL PARTICULARS
Conductor Type – Willow/Elm (AAAC)

(CEB Requirements shall be filled by the procurement entity and information of the offer shall be filled by the manufacturer)

			Offered
13.	Name of the Manufacturer		
14.	Country of Origin		
15.	Rated Voltage category , (U_m)		
16.	Applicable Standards		
17.	Conductor Particulars		
	(i) Aluminium Alloy wires	Nos	
	(j) Overall diameter	mm	
	(k) Lay ratio for Aluminium Alloy layers	Max	
		Min	
	(l) Breaking load (min.)	kN	
	(m) D.C. Resistance at 20°C	Ω/km	
	(n) Coefficient of Linear expansion	/°C	
	(o) Modulus of Elasticity	N/mm²	
18.	Aluminium Alloy Wire		
	(e) Diameter	mm	
	(f) Resistivity at 20°C	μΩ cm	
	(g) Coefficient of linear expansion	/°C	
	(h) Tensile strength (min.)	N/mm²	
19.	Aluminium Alloy used to manufacture AAAC		
	(e) Purity of Aluminium	%	
	(f) Whether chemical composition comply with clause 5.3.1?	Yes/No	
	(g) Maximum electrical resistivity	Ω.mm²/m	
	(h) Minimum tensile strength	MPa	
20.	Type of grease used		
21.	Approximate weight of the conductor	kg/ km	
22.	Drum Particulars		
	(g) Material of the drum		

	(h) Dimensions	mm xmm	
	(i) Weight	kg	
	(j) Standard conductor length	m	
	(k) Weight of standard length with drum	kg	
	(l) Whether marking provided as per clause 11.2?	Yes/No	
23.	Whether a certified copy of ISO 9001:2015 or latest furnished with the offer?		
24.	Whether the entire Type Test Certificates in accordance with clause 6.3 furnished with the offer?	Yes/No	
25.	Whether all information provided as per clause 7.0?	Yes/No	

....

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**

CEB Approved Specification
12/12/2019
Chairman Dist. Coordination Committee

Annex – D

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

CEB Approved Specification
12/12/2019
Chairman Dist. Coordination Committee