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CEB
STANDARD

AERIAL BUNDLED CONDUCTORS

CEYLON ELECTRICITY BOARD
SRI LANKA

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SPECIFICATION FOR AERIAL BUNDLED CONDUCTORS

1.0 SCOPE

This specification covers the design, manufacture and testing of Aerial Bundled Conductors (ABC) for low voltage distribution systems.

2.0 SYSTEM PARAMETERS

(a)	Nominal Voltage	-	400/230 V
(b)	System highest Voltage (Rated Voltage)	-	440 V
(c)	System frequency	-	50 Hz.
(d)	Method of earthing	-	Effective earthing
(e)	System fault level	-	17.5 MVA

3.0 SERVICE CONDITIONS

a)	Annual average ambient temperature	-	30°C
b)	Maximum ambient temperature	-	40°C
c)	Maximum relative humidity	-	90%
d)	Environmental condition	-	Humid tropical climate with polluted atmosphere
e)	Operational altitude	-	From M.S.L. to 1900 metres above M.S.L.

4.0 APPLICABLE STANDARDS

The Aerial Bundled Conductors supplied shall be in accordance with the latest editions of the standards specified below and amendments thereof.

(a)	NFC 33-209		-	Aerial Bundled Conductors
(b)	IEC 502	1994	-	Extruded solid dielectric insulated power cables
(c)	IEC 1089	1991	-	Round wire concentric lay overhead electrical stranded conductors.
d)	IEC 228	1978	-	Conductors of Insulated Cables

The supplier may offer Aerial Bundled Conductors manufactured to the standards not less rigid than the National French Standard NFC 33-209. Offers of items manufactured to any other internationally recognised standards or specifications not less rigid shall be accompanied by an English translation of such standards or specifications.

5.0 DESCRIPTION OF AERIAL BUNDLED CONDUCTORS

5.1 Phase Conductors

The Conductor shall be of multi-strand round compacted hard drawn Aluminium conforming to IEC 1089 with XLPE insulation.

The Conductor wires shall not have any joints except for those made on the base wire or rod before final drawing.

The Phase Conductor for bundles shall conform to the following.

i)	Number of strands	12 or 19
ii)	Nominal cross sectional area	70 sq. mm
iii)	Max. linear resistance at 20°C	0.443 Ohms/Km
iv)	Minimum breaking strength	840 da N
v)	Diameter of compacted bare conductor	Max. 10.2mm Min. 9.7mm
vi)	Thickness of insulating sheath	Max. 1.8mm Min. 1.52mm at 1 point
vii)	Insulated cable outside diameter	Max. 14.2mm Min. 13.3mm

5.2 Street Lamp Wires

The Conductor shall be of multi-strand round compacted hard drawn Aluminium conforming to IEC 1089 with XLPE insulation.

The Conductor wires shall not have any joints except for those made on the base wire or rod before final drawing.

The Street Lamp Conductor shall conform to the following.

i)	Number of strands	07
ii)	Nominal cross sectional area	16 sq mm

iii)	Max. linear resistance at 20°F	1.91 Ohms/Km
iv)	Minimum breaking strength	190 da N
v)	Diameter of compacted bare conductors	Max. 5.1mm Min. 4.6mm
vi)	Thickness of insulating sheath	Max. 1.2mm Min. 0.98mm at 1 point
vii)	Insulated cable outside diameter	Max. 7.8mm Min. 7.0mm

5.3 Neutral Messenger

The Strain Bearing Neutral conductor shall consist of multi-strand round aluminium alloy conforming to IEC 1089 with XLPE insulation.

The conductor wires shall not have any joints except for those made on the base wire or rod before final drawing.

The aluminium alloy Neutral Messenger Conductor shall conform to the following.

i)	Number of strands	07
ii)	Cross sectional area	54.6 sq. mm
iii)	Max. linear resistance at 20°C	0.63 Ohms/Km
iv)	Minimum breaking strength	1660 da N
v)	Nominal diameter of strands	3.15mm
vi)	Co-efficient of linear expansion	23.10^{-6} per °C
vii)	Modulus of elasticity	62,000 Mpa
viii)	Nominal diameter of the bare conductor	Max. 9.6mm Min. 9.2mm
ix)	Average thickness of insulating sheath	Max. 1.6mm Min. 1.34mm
x)	Insulated cable outside diameter	Max. 13.0mm Min. 12.3mm

5.4 Insulating Sheath

5.4.1 Insulating Sheath Material

The Insulating Material shall be of black weather resistant cross linked thermosetting polyethylene (XLPE) conforming to NFC 32-020 and shall be suitable for Sri Lanka tropical climatic conditions.

The mechanical strength and other mechanical properties such as tensile strength, minimum elongation at break and physical/chemical properties shall conform to the relevant Clauses in NFC 32-020. The minimum tensile strength shall not be less than 14.5 Mpa. and the minimum elongation at break shall be 200%.

Adherence of the insulating sheath to the strain bearing neutral conductor shall be adequate enough to prevent the slipping of the insulating sheath when a pulling force of 500 daN is applied. The required adherence shall be achieved by the use of paper material or other technique.

The average thickness and minimum thickness shall be as specified above in Clauses 5.1, 5.2 and 5.3 for phase, street lamp, and neutral conductor respectively.

5.4.2 Extrusion of Insulating Sheath on Bare Conductor

The insulating sheath shall be fully pressure extruded on the bare conductors of the phases / street lamp / neutral messenger.

5.5 Properties of Completed Cables

The properties of individual cables and the bundle (such as lay pitch, Electrical and Mechanical properties) shall conform to relevant Clauses in NFC 33-209.

6.0 ADDITIONAL REQUIREMENTS

6.1 Marking of the Cables in a Bundle

The markings are to be either indented or embossed, as follows:

All cables in a bundle shall carry the mark "CEB" at intervals of 1M in addition to any other markings.

The phase identification marking shall either be Numerals or Ribs. When Ribs are provided to identify cores, they shall be so made to enable workmen to identify the cores easily.

a) Phase and Neutral Cores

One, two, and three Ribs to distinguish the three phase cores from each other and the neutral shall be plain without any Ribs.

b) Street Lamp Core

The markings shall be as described above, but it shall be plain without any Ribs in the case of single street lamp core.

6.2 Packing.

The completed Aerial Bundled Conductors shall be delivered in continuous lengths of 500 + or -5% metres.

They shall be supplied in drums suitable for outdoor storage of twelve (12) months.

7.0 TESTS

7.1 Type Tests

The ABC subjected to the following Type Tests conforming to the NFC 33-209 specified, shall have a proven design.

i) Mechanical strength of the conductors.

ii) Resistance of insulating sheaths to weathering.
This test shall be carried out for all conductors other than the strain bearing neutral conductor.

iii) Insulation resistance.

iv) To ensure that water cannot rise by capillary action.

v) Adherence of the insulating sheath on the conductor of the strain bearing neutral core.

vi) Dielectric strength.

vii) Impulse (voltage) withstand.

viii) Behavior of the strain bearing neutral core under thermal / mechanical stress.

ix) Electrical Resistance of phase, neutral and street lamp conductors.

7.2 Routine Tests

While manufacturing each batch of the ABC shall be subjected to the following Routine Tests conform to the standard specified

a) Mechanical strength of the conductor.
b) Insulation resistance.
c) To ensure that water cannot rise by capillary action.

d) Adherence of the insulating sheath on the conductor of the strain bearing neutral core.
e) Dielectric strength.
f) Impulse (voltage) withstand.

8.0 INFORMATION TO BE SUPPLIED WITH THE OFFER

The Bid shall be accompanied with the following;

a) English version of Catalogues describing the Aerial Bundled Conductors (ABC) and indicating the type / number.

b) Technical literature (in English) describing the constructional and operational features of the ABC.

c) The Standard to which the ABC has been manufactured and the English version of the Standard.

d) Recommended current carrying capacity.

e) Dimensioned drawings of the conductors.

f) Packing details.

g) Completed Schedule of Particulars as per Annexure - A.

h) Certificates of Type Tests on completed Aerial Bundled Conductor Systems as per Clause 7.1 above.

Test Certificates, Performance Curves etc., of the Type Test performed shall conform to NFC 33-209 specified.

The Test Certificates should clearly identify the ABC concerned, showing the manufacturer's identity, Type No. and Basic Technical Parameters.

The Test Certificates referred to shall be issued by a Recognised Independent Testing Authority acceptable to the purchaser.

Failure to furnish the above details and the Sample as per Clause 9.0 will result in the offer being rejected.

9.0 SAMPLE STUDY

Specimens of length 5 meter of Bundled Conductors offered shall be furnished with the offer to facilitate analysis and evaluation.

10.0 TECHNICAL LITERATURE AND DRAWINGS

The selected Bidder shall supply the relevant drawings, technical literature, Sag -Tension Chart, Routine Test Certificates etc. along with the Aerial Bundled Conductors, in order to facilitate installation and operation.

11.0 INSPECTION & TESTING

11.1 Inspection

The selected Bidder shall make necessary arrangements for inspection by an Engineer appointed by the Purchaser during manufacturer and before dispatch and also to carry out in his presence necessary acceptance/sample tests in accordance with the standard specified for the ABC offered.

11.2 Testing (Acceptance Test)

The following acceptance tests shall be witnessed by the engineer appointed by the purchaser and copies of the test certificates shall be furnished with the ABC.

a) Mechanical strength of the conductor.
b) Resistance of insulating sheaths to weathering.
   This test shall be carried out for all conductors other than the strain bearing neutral conductor.
c) Insulation resistance.
d) To ensure that water cannot rise by capillary action.
e) Adherence of the insulating sheath on the conductor of the strain bearing neutral core.
f) Dielectric strength.
g) Impulse (voltage) withstand.
h) Behavior of the strain bearing neutral core under thermal / mechanical stress.
i) Electrical Resistance of phase, neutral and street lamp conductors.

12.0 ANNEXURE

A - Schedule of Particulars

ANNEXURE - A

SCHEDULE OF PARTICULARS

1. Name of manufacturer -
2. Country of manufacture -
3. Applicable Standards -
4. Number of strands in
   - i) Phase Conductors -
   - ii) Street Lamp Wires -
   - iii) Neutral Messenger -
5. Nominal cross - sectional area of;
   - i) Phase Conductors -
   - ii) Street Lamp Wires -
   - iii) Neutral Messenger -
6. Maximum linear resistance at 20 deg. C for;
   - i) Phase Conductors -
   - ii) Street Lamp Wires -
   - iii) Neutral Messenger -
7. Maximum Breaking Strength of;
   - i) Phase Conductors -
   - ii) Street Lamp Wires -
   - iii) Neutral Messenger -
8. Nominal Diameter of Strands of;
   - i) Phase Conductors -
   - ii) Street Lamp Wires -
   - iii) Neutral Messenger -

9.	Diameter of Bare Conductors			
	i)	Phase Conductors	-	Max.
				Min.
	ii)	Street Lamp Wires	-	Max.
				Min.
	iii)	Neutral Messenger	-	Min.
			-	Min.
10.	Thickness of Insulating Sheath			
	i)	Phase Conductors	-	Max.
			-	Min.
	ii)	Street Lamp Wires	-	Max.
			-	Min.
	iii)	Neutral Messenger	-	Max.
			-	Min.
11.	Insulated Cable Outside Diameter			
	i)	Phase Conductors	-	Max.
			-	Min.
	ii)	Street Lamp Wires	-	Max.
			-	Min.
	iii)	Neutral Messenger	-	Max.
			-	Min.
12.	Co-efficient of Liner Expansion			
	i)	Aluminium Conductor	-	
	ii)	Aluminium Alloy Conductor	-	
13.	Modules of Elasticity			
	i)	Aluminium Conductor	-	
	ii)	Aluminium Alloy Conductor	-	
14.	Chemical Composition			
	i)	Aluminium Conductor	-	
	ii)	Aluminium Alloy Conductor	-	

SEAL AND SIGNATURE OF THE BIDDER / MANUFACTURER

Specification

for

AERIAL BUNDLED CONDUCTORS

CEB Standard 018 - 1 : 1996

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Amendment Slip No. 1
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Specification for Aerial Bundled Conductors

REVISED TEXT

September 1996

1. **Clause 5.0 DESCRIPTION OF AERIAL BUNDLED CONDUCTORS**

5.4.1 Insulating Sheath Material

To amend the first sentence of the third para to read as :

"Adherence of the insulating sheath to the strain bearing neutral conductor shall be at least equal to 18 daN.

2. **Clause 9.0 SAMPLE STUDY**

To add the following para to the Clause:

" The Purchaser will carry out the following tests on the sample.

a) Mechanical Strength of the Conductor

b) Resistance of Insulating Sheaths to weathering. This test shall be carried out for all Conductors other than the Strain Bearing Neutral Conductor.

c) Insulation Resistance.

d) To ensure that water cannot rise by capillary action.

e) Adherence of the Insulating Sheath on the Conductor of the Strain Bearing Neutral Core.

f) Dielectric strength

g) Impulse (voltage) withstand

h) Behaviour of the Strain Bearing Neutral Core under Thermal/Mechanical Stress.

i) Electrical Resistance of Phase, Neutral and Street Lamp Conductors".

Amendment Slip No. 2
effective from 5th Sept. 1997
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Specification for Aerial Bundled Conductors

REVISED TEXT

August 1997

12.0 ANNEXURE

To add the following to the Clause

"B - Price Variation

ANNEXURE-B

PRICE VARIATION

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

i. Basis of the Offer

(a) Suppliers of Aerial Bundled Conductors (ABC) 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 High Grade Aluminium 99.7% and Aluminium Alloy, at London Metal Exchange (LME) in US Dollars on the day of the closing of Bids or the previous working day if the day of closing of Bid is a non working day at the LME.

(c) The Fixed Price Margin (FP) shall be quoted in the currency of choice of the Bidder in the case of foreign Bidders and in Sri Lanka Rupees in the case of Local Bidders.

(d) Accordingly FOB Price of ABC of foreign Bidders and ex-factory price of ABC of local Bidders for the purpose of evaluation shall be computed as;
$\{[((A_0 \times MT1) + (B_0 \times MT2)) \times US_0] + (FP \times CC_0)\} \times TL$

Where A_0 - Base Price which is the Cash seller's midday official average price of Aluminium High Grade 99.7%, in US Dollars per Metric tone at the LME on the fixed date [Clause (1 b)].

B_0 - Base Price which is the Cash seller's midday official average price of Aluminium Alloy, in US Dollars per Metric tone at the LME on the fixed date [Clause (1 b)].

FP - ***Fixed Price Margin per kilometer of Aerial Bundled Conductors in the currency allowed under Clause 1(c) above.***

MT1 - ***Quantity of High Grade Aluminium 99.7% required in Metric Tone for the manufacture of one kilometer of Aerial Bundled Conductors.***

MT2 - ***Quantity of Aluminium Alloy required in Metric Tone for the manufacture of one kilometer of Aerial Bundled Conductors.***

TL - ***Total Length in kilometers of Aerial Bundled Conductors offered.***

CC_0 - ***Currency Conversion rate from the currency of choice of the Bidder to Sri Lanka Rs. prevailing on the data of Bid opening.***

US_0 - ***Currency Conversion rate from the US Dollars to Sri Lanka Rs. prevailing on the date of Bid opening.***

ii. Award Price

a) The FOB Award Price of foreign Bidders offering ABC shall be computed as;

$\{[(A_1 \times MT1) + (B_1 \times MT2) + FP] \times TL\}$ ***in US Dollars If the FP (the currency of choice) is in US Dollars***

If the FP (the currency of Choice) is any other currency (other than US Dollars the FOB Award Price shall be computed as;

$\{[(A_1 \times MT1) + (B_1 \times MT2)] \times TL\}$ ***in*** US_1 ***Dollars and*** $[FP \times TL]$ ***in the currency of choice quoted.***

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

$\{[((A_1 \times MT1) + (B_1 \times MT2)) \times TL] \times US_1\} + (FP \times TL)$ ***in Sri Lanka Rupees***

Where A_1 - Base Price which is the Cash seller's midday official average price of Aluminium High Grade 99.7%, in US Dollars per Metric tone at the LME on the first working day immediately after the day of award.

Where B_1 - Base Price which is the Cash seller's midday official average price of Aluminium Alloy, in US Dollars per Metric tone at the LME on the first working day immediately after the day of award.

FP - Fixed Price Margin per kilometer of Aerial Bundled Conductors in the currency of choice.

MT1 - Quantity of High Grade Aluminium 99.7% required in Metric Ton for the manufacture of one kilometer of Aerial Bundled conductors.

MT2 - Quantity of Aluminium Alloy required in Metric Ton for the manufacture of one kilometer of Aerial Bundled conductors.

TL - Total Length in kilometers of Aerial Bundled Conductors awarded.

US_1 - Currency Conversion rate from the US Dollars to Sri Lanka Rs. prevailing on the first working day immediately after the day of award.

(b) Intimation of the award will be faxed/telexed to the successful Bidder and or to his agent in Sri Lanka on the same day of the award.

iii. Conversion of Currency

a) For the purpose of the evaluation the Prices A_o and 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 Middle Exchange Rate of the Central Bank of Sri Lanka prevailing on the day of opening of Bids.

b) The payment for the foreign Bidders for supply of ABC will be made at the contract price in the currency quoted for the Fixed Price Margin (FP) and the prices of aluminium and aluminium alloy will be made in US Dollars.

c) The payment for local suppliers for the supply of ABC will be made in Sri Lanka Rupees. The Prices of aluminium and aluminium alloy in US Dollars will be converted to Sri Lanka Rupees at the official Middle Exchange rate at the Central Bank of Sri Lanka prevailing on the date of the letter of award.

iv. Variation Figures.

The Bidders shall furnish Fixed Price Margin and the Weight of High Grade Aluminium and Aluminium Alloy required to manufacture one kilometre of Aerial Bundled conductors offered as indicated below. Offers of Bidders who fail to furnish these particulars will be rejected.

a) Description of the ABC offered

i) Voltage Rating -------- V

ii) Cross sectional area of

1) Aluminium Conductor --------- mm²

2) Aluminium Alloy Conductor --------- mm²

b) Fixed Price Margin for manufacture of one kilometer of Aerial Bundled Conductors in the currency allowed in Clause 1(c) FP --------Metric tones/km

c) Weight in metric tones of High Grade Aluminium required for the manufacture of one Kilometer of Aerial Bundled Conductors. MT1-------Metric tones/km.

d) Weight in metric tones of Aluminium Alloy required for the manufacture of one Kilometer of Aerial Bundled Conductors. MT2 Metric tones/km.

Amendment Slip No. 3
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Specification for Aerial Bundled Conductors

REVISED TEXT

March 1998

1. Clause 12.0 ANNEXURE

To delete Sub Clause ***"ANNEXURE – B Price Variation"."***