010: 2012

CEB
SPECIFICATION

ALUMINIUM CONDUCTORS STEEL REINFORCED (ACSR CONDUCTORS)

(Revision -01)

CEYLON ELECTRICITY BOARD
SRI LANKA

Telephone: +94 11 232 0953 **Fax: +94 11 232 3935**

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SPECIFICATION FOR ALUMINIUM CONDUCTORS STEEL REINFORCED (ACSR CONDUCTORS)

1.0 SCOPE

This specification covers the manufacturing and testing of Aluminium Conductors Steel Reinforced (ACSR) for overhead power distribution systems.

2.0 SYSTEM PARAMETERS

(a)	Nominal voltage	11kV	33kV
(b)	System highest voltage	12kV	36kV
(c)	System frequency	50 Hz	50 Hz
(d)	Number of phases	03	03
(e)	Method of earthing	Effectively earthed	Non effectively earthed
(f)	System faults level	12.5kA rms	13.1kA rms

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.

4.0 APPLICABLE STANDARDS

The ACSR shall be manufactured in accordance with the latest editions of the standards specified below and amendments thereof.

(a)	BS 215-2 (1970)	Specification for Aluminium conductors and aluminium conductors, steel-reinforced for overhead power transmission
(b)	BS 2627 (1970)	Specification for wrought Aluminium for electrical purposes, Wire
(c)	ANSI/ASTM B233-97	Standard specification for Aluminium 1350 Drawing Stock for electrical purposes
(d)	BS EN 50189 (2000)	Conductors for over head lines. Zinc coated steel wires
(e)	IEC 61394 - 1997	Overhead lines – Characteristics of greases for aluminium, aluminium alloy and steel bare conductors
(f)	IEC 61089 – 1991-05	Round wire concentric lay overhead electrical stranded conductors

5.0 BASIC FEATURES

5.1 Design of Wire

(a) The Aluminium wire used in the manufacture of ACSR shall conform to BS 2627. Joints in the base rod or wire before final drawing shall be permitted in accordance with the clause 3.3.1 of BS 215 Part 2. Joints in the Aluminium wire shall not be permitted in the final drawing.

(b) The Coefficient of Linear Expansion is 23 x 10^{-6}/°C.

(c) The Galvanized Steel wire used in the manufacture of ACSR shall conform to BS EN 50189. Joints in the base steel rod or wire before final drawing shall be permitted in accordance with the clause 3.3.2 of BS 215 Part 2. Joints in the steel wire shall not be permitted in the final drawing.

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

(e) The sizes of Galvanized Steel wires and Aluminium wires shall be as stipulated in the Annex - A1 (Schedule of Technical Particulars - ACSR)

5.2 Construction of Aluminium Conductors Steel Reinforced (stranding)

(a) The ACSR shall be manufactured in accordance with BS 215 Part 2.

(b) The lay ratio of the different layers shall be within the limits given in Table 1 of BS 215 Part 2.

(c) 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.

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

(e) Steel wires shall be formed during stranding so that they remain inert when the conductor is cut.

(f) Steel core and the inner layers of Aluminium shall be covered with suitable grease during manufacture, but no grease shall be applied to the finished conductor. Sufficient grease shall be applied to the Steel and inner Aluminium strands to fill the inter-strand spaces (viz. Inner Layer Protection).

(g) The completed conductor shall be smooth and free from imperfections, dirt, grit, excessive amounts of drawing oil and other foreign deposits.

5.3 Materials

5.3.1 Aluminium Re - Draw Rods

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

The quality of Aluminium Re - Draw rods used for the manufacture of ACSR conductor shall be as stipulated below.

(a) The purity of the Aluminium Re-Draw rods shall not be less than 99.5%. The percentage composition of other elements shall not be more than the values stipulated in the below.

	Element	Allowed % Max
(i)	Silicon	0.10
(ii)	Iron	0.40
(iii)	Copper	0.05
(iv)	Manganese	0.01
(v)	Chromium	0.01
(vi)	Zinc	0.05
(vii)	Boron	0.05
(viii)	Gallium	0.03
(ix)	Vanadium plus titanium, total	0.02
(x)	Other elements, each	0.03
(xi)	Other elements, total	0.10
Total % of impurities shall not be more than		**0.5**

(b) Temper of the Aluminium Re - Draw Rods shall be H14 classification.

(c) The tensile strength of rods shall be between 103 MPa to 138 MPa.

(d) The maximum Electrical Resistivity of the Aluminium Re-Draw Rods at 20°C shall be 0.028080 μΩm.

(e) Quality Assurance certification conforming to ISO 9001:2008 shall be followed in the manufacture of the Aluminium Re - Draw Rods. The bidders shall furnish documentary evidence that the Aluminium Re - Draw Rods manufacturers have obtained ISO 9001:2008 certification.

Offers of bidders who fail to furnish the proof of ISO 9001:2008 certifications for Aluminium Re - Draw Rods will be rejected.

5.3.2 Reinforcement Steel wire

(a) The Galvanized Steel wire used for the reinforcement of the ACSR conductor shall conform to BS EN 50189 and the tensile strength grade of the Steel wire shall be conform to the Table 6 –mechanical properties of ST4A wires of BS EN 50189.

(b) The tensile strength and stress at 1% elongation values, calculated on the nominal dimensions of the finished wire, shall confirm to Table 6 of BS EN 50189.

(c) The elongation shall confirm to Table 6 of BS EN 50189, measured after fracture on an original gauge length of 250mm and the coefficient of linear expansion is 11.5 x 10^{-6}/°C.

(d) The steel wire shall not fracture when wrapped at a rate not exceeding 15 turns per minute around a cylindrical mandrel of diameter given in the appropriate column of Table 6 of BS EN 50189 to form a close helix of eight turns.

(e) The numbers of twists on a length of 100 times the wire diameter that causes fracture shall be confirm to Table 6 of BS EN 50189.

(f) The weight and uniformity of coating and zinc adhesion shall be in accordance with Table 2 of BS EN 50189.

(g) The tolerance on nominal diameter of the Galvanized Steel wire shall confirm to Table 6 of BS EN 50189.

(h) Quality Assurance certification conforming to ISO 9001:2008 shall be followed in the manufacture of the Galvanized Steel wire. The bidders shall furnish documentary evidence that the Galvanized Steel wire manufacturers have obtained ISO 9001:2008 certifications.

Offers of bidders who fail to furnish the proof of ISO 9001:2008 certification for Reinforcement Steel wire will be rejected.

5.3.3 Grease

The grease used for corrosion protection in the manufacture of ACSR shall have the following requirements satisfying IEC 61394.

(a) All the conductor is greased except the outer layer. (As indicated in 5.2 (f)).
(b) The weight of the grease shall confirm the values given in IEC 61089.
(c) It shall not flow or deteriorate at temperatures up to 75°C.
(d) It shall not be inimical to Aluminium or Galvanized Steel.
(e) It shall have good adhesive and cohesive properties and shall retain these qualities after weathering.
(f) It shall not extrude a surplus to the outside of the conductor after erection.
(g) It shall not present any risks to health and shall comply with all the usual health and safety standards.

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

5.4 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 or Aluminium wires 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 MANUFACTURING EXPERIENCE

The manufactures shall have a minimum experience of 5 years of manufacturing and supply of conductors similar to the requirements. The manufactures shall submit proof document such as supply records, the name & particulars of the purchaser, quantity sold & the year of sale.

7.0 ADDITIONAL REQUIREMENTS

7.1 Packing

(a) The ACSR shall be supplied in wooden drums. The ACSR shall be supplied in continuous length per drum as given in the Annex A1.

(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.

7.2 Labelling (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

8.0 QUALITY ASSURANCE

The manufacturer shall posses ISO 9001:2008 Quality Assurance certification for the manufacture of the ACSR conductor for the plant where the manufacture of conductor is done. The bidder shall furnish a copy of the ISO 9001:2008 certificates certified as true copy of the original by the Manufacturer, along with the offer.

9.0 INFORMATION TO BE SUPPLIED WITH THE OFFER

9.1 Bidders shall provide all the necessary information of the ACSR conductor as per the schedule of guaranteed technical particulars as per Annex A2.

9.2 Type Test Certificates

Following type test certificates for Aluminium wires, and Galvanized Steel wire used for the fabrication of ACSR and for the manufactured ACSR conductor carried out in accordance with the specified standard, by a recognised independent testing authority acceptable to the purchaser shall be provided with the bid. The test reports shall be complete including all the pages as issued by the testing authority. Parts of the Test Report shall not be acceptable.

9.2.1 Type Test Certificates for Aluminium Re-Draw Rods

(a) Tensile test
(b) Determination of chemical composition and purity
(c) Temper test
(d) Electrical resistivity test

9.2.2 Type Test Certificates for Aluminium wires

(a) Dimension tests
(b) Tensile test
(c) Wrapping test
(d) Resistivity test

9.2.3 Type Test Certificates for Steel wires

(a) Dimension tests
(b) Determination of stress at 1% elongation
(c) Tensile test
(d) Elongation test
(e) Wrapping test
(f) Galvanizing test

9.2.4 Type Test Certificates for Grease

For the type of grease used, the following test report carried out according to IEC 61394 should be submitted with the offer.

(a) Adherence test
(b) Stability and Aging test
(c) Corrosion test
(d) Oil Separation test

9.2.5 Type Test Certificates for Finished ACSR Conductor

(a) Dimension test
(b) Stress Strain Curves

10.0 INSPECTION & TESTING

10.1 Inspection

The selected bidder shall make necessary arrangements for inspection by an Engineer appointed by the CEB during manufacture and before dispatch and also to carry out in his presence necessary Acceptance/Sample tests of the materials offered.

10.2 Acceptance/Sample Tests

The following Acceptance / Sample Tests conforming to BS 2627, BS EN 50189 and BS 215, IEC 61089 and IEC 61394 shall be witnessed by the representative of the CEB.

10.2.1 Aluminium wires

(a) Dimension tests
(b) Tensile test
(c) Wrapping test
(d) Resistivity test

10.2.2 Steel wires

(a) Dimension tests
(b) Determination of stress at 1% elongation
(c) Tensile test
(d) Elongation test
(e) Wrapping test
(f) Galvanizing test

10.2.3 Grease

(a) Adherence test
(b) Stability and Aging test
(c) Corrosion test
(d) Oil Separation rest

10.2.4 ACSR Conductor

(a) Dimension test
(b) Breaking strength of conductor
(c) Electrical characteristic including D.C resistance value at $20^{o}C$
(d) Linear Density in kg/km

11.0 SAMPLE STUDY

The sample length of five meters of ACSR offered shall be furnished with the offer by the bidder to facilitate analysis and evaluation of bid.

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.

12.0 PRICE VARIATION

The bidders shall forward their offers on the basis of the Price Variation stipulated in Annex 3

13.0 ANNEX

Annex A1	Schedule of technical particulars for ACSR
Annex A2	Schedule of guaranteed technical particulars (To be filled by the bidders for each size)
Annex A3	Methodology for evaluating price variations

ANNEX - A1

SCHEDULE OF TECHNICAL PARTICULARS FOR ACSR (With Inner Layer Grease Protection)

Conductor Code	Nominal area of Complete Conductor mm²	No. & Diameter of Wires		Overall Diameter of Conductor mm	Approx. mass of Conductor kg/km	Calculated D.C. Resistance at 20°C Ω/km	Calculated Breaking Load kN	Modulus of Elasticity of Complete Conductor N/mm²	Coefficient of Linear Expansion /°C.	Length of Conductor per Drum km
		Aluminium mm	Steel mm							
Weasel	36.90	6/2.59	1/2.59	7.77	128	0.9077	11.45	79000	19.1×10^{-6}	3.0
Raccoon	91.95	6/4.09	1/4.09	12.27	319	0.3632	27.06	79000	19.1×10^{-6}	1.2
Dog	118.50	6/4.72	7/1.57	14.15	394	0.2733	32.70	75000	19.8×10^{-6}	1.2
Lynx	226.20	30/2.79	7/2.79	19.53	842	0.1576	79.80	80000	17.8×10^{-6}	1.6
Goat	400.00	30/3.71	7/3.71	25.97	1489	0.0894	135.13	80000	17.8×10^{-6}	1.6

ANNEX - A2

SCHEDULE OF GURANTEED TECHNICAL PARTICULARS

(To be filled by the bidder for each size)

(1) ALUMINIUM RE-DRAWS RODS (used for the manufacture Al wire for ACSR)

(i)	Tensile stress	N/mm²	
(ii)	Temper classification	H14	
(iii)	Electrical Resistivity	μΩm	
(iv)	Whether ISO 9001:2008 quality assurance certification is Furnished	Yes/No	
(v)	Whether the following Type Test Certificates provided		
	(a) Tensile test	Yes/No	
	(b) Determination of chemical composition and purity	Yes/No	
	(c) Temper test	Yes/No	
	(d) Electrical resistivity test	Yes/No	
(vi)	Whether the Type Test certificates provided are from a recognized independent testing authority	Yes/No	
(vii)	Chemical composition as indicated in the below		
	ELEMENT		
	(a) Silicon	% Max	
	(b) Iron	% Max	
	(c) Copper	% Max	
	(d) Manganese	% Max	
	(e) Chromium	% Max	
	(f) Zinc	% Max	
	(g) Boron	% Max	
	(h) Gallium	% Max	
	(i) Vanadium plus titanium, total	% Max	
	(j) Other elements, each	% Max	
	(k) Other elements, total	% Max	
	(l) **Total % of impurities shall not be more than**	**% Max**	

(2) ALUMINIUM WIRE

(i)	Diameter	mm	
(ii)	Resistivity at 20°C	μΩm	
(iii)	Coefficient of Linear Expansion	/°C	
(iv)	Tensile Stress (max.)	N/mm²	
(v)	Whether ISO 9001:2008 Quality Assurance certification is furnished	Yes/No	
(vi)	Whether the following Type Test certificates provided		
	(a) Dimension tests	Yes/No	
	(b) Tensile test	Yes/No	
	(c) Wrapping test	Yes/No	
	(d) Resistivity test	Yes/No	
(vii)	Whether the Type Test certificates provided are from a recognized independent testing authority	Yes/No	

(3) GALVANIZED STEEL WIRE

(i)	Diameter	mm	
(ii)	Tensile Stress	N/mm²	
(iii)	Stress at 1% elongation	N/mm²	
(iv)	Coefficient of linear expansion	/°C	
(v)	Resistivity at 20°C	μΩm	
(vi)	Whether ISO 9001:2008 Quality Assurance certification is furnished	Yes/No	
(vii)	Whether the following Type Test certificates provided		
	(a) Dimension tests	Yes/No	
	(b) Determination of stress at 1% elongation	Yes/No	
	(c) Tensile test	Yes/No	
	(d) Elongation test	Yes/No	
	(e) Wrapping test	Yes/No	
	(f) Galvanizing test	Yes/No	
(viii)	Whether the Type Test Certificates provided are from a recognized independent testing authority	Yes/No	

(4) GREASE

(i)	Name/Type of Grease		
(ii)	Melting Temperature	°C	
(iii)	Whether the grease is stable at 75°C	Yes/No.	
(iv)	Mass of Grease	Kg/km	
(v)	Whether the following Type Test certificates provided		
	(a) Adherence test	Yes/No	
	(b) Stability and Aging test	Yes/No	
	(c) Corrosion test	Yes/No	
	(d) Oil Separation rest	Yes/No	
(vi)	Whether the Type Test certificates provided are from a recognized independent testing authority	Yes/No	

(5) ACSR CONDUCTOR

(i)	Aluminium Wires	Nos.	
(ii)	Galvanized Steel Wires	Nos.	
(iii)	Overall Diameter	mm.	
(iv)	Nominal area of complete conductor	mm^2	
(v)	Lay ratio for Steel Core	Max Min	
(vi)	Lay ratio for Aluminium layers	Max Min	
(vii)	Ultimate Tensile Strength	kN	
(viii)	D.C. Resistance at 20°C	Ω/km	
(ix)	AC resistance and inductive reactance at 20°C, 50Hz (R+jX)	Ω/km	
(x)	Coefficient of Linear Expansion	/°C	
(xi)	Coefficient of Variation of Resistance	/°C	
(xii)	Linear Density	Kg/km	
(xiii)	Modulus of Elasticity	N/mm²	
(xiv)	Whether the following Type Test Certificates provided		
	(a) Dimension test	Yes/No	
	(b) Stress Strain curves	Yes/No	
(xv)	Whether the Type Test certificates provided are from a recognized independent testing authority	Yes/No	
(xvi)	Whether the drum details including drawing & dimension are provided	Yes/No	

..... **.....**

Seal and Signature of the bidder **Date**

ANNEX – A3

PRICE VARIATION

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

1. BASIS OF THE OFFER

(a) Suppliers of Aluminium Conductors Steel Reinforced 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 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.

(d) Accordingly FOB price of ACSR conductor of foreign bidders and ex-factory price of ACSR conductor of local bidders for the purpose of evaluation shall be computed as;

$$(B_0 \times MT \times È)\ US_0 + (FP \times MT)\ CC$$

Where;

B_0 Base Price which is the cash seller's midday official average price of Aluminium High Grade 99.7%, in US Dollars per Metric ton at the LME on the fixed date [clause 1. (b)].

FP Fixed Price Margin per Metric ton of ACSR in the currency choice

MT Quantity of ACSR required in Metric ton.

CC Currency Conversion rate from the currency of choice of the bidder to Sri Lanka Rs. prevailing on the date of bid opening.

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

È The percentage of Aluminium in the Aluminium Conductors Steel Reinforced as indicated in the table below:

(i)	Weight of Aluminium in 7/2.59 (Weasel) Conductor	68 %
(ii)	Weight of Aluminium in 7/4.09 (Racoon) Conductor	68 %
(iii)	Weight of Aluminium in 6/4.72,7/1.57 (Dog) Conductor	73 %
(iv)	Weight of Aluminium in 37/2.79 (Lynx) Conductor	60 %
(v)	Weight of Aluminium in 37/3.71 (Goat) Conductor	60 %

2. Award Price

(a) The FOB award price for Foreign bidders and ex-factory award price for local shall be computed as;

$$(B_1 \times MT \times È) + (FP \times MT)$$

Where

B_1 Cash seller's midday official average price of Aluminium High Grade 99.7% in US Dollars per Metric ton at the LME on the first working day immediately after the day of award.

FP Fixed Price Margin per Metric ton of ACSR in the currency of choice.

MT Quantity of ACSR offered in Metric ton

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

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 date of opening of bids.

b) The payment for the supply will be made to the supplier 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 exchange rates indicated in the bulletin of the LME applicable on the first working day immediately after the date of the award of the offer; where such exchange rate is not available for the currency of the FP in the bulletin the selling rate at the Central Bank of Sri Lanka shall be applicable.