

**Government of
Democratic Socialist Republic of Sri Lanka**

Ministry of Power

CEYLON ELECTRICITY BOARD

**Request for Proposals
Development of 100 MW_{AC} Solar PV Power Plant on
Build, Own and Operate (BOO) Basis and Construction of
132 kV Transmission Facility on Turnkey Basis**

REQUEST FOR PROPOSALS

(APPENDIX 1-A)

**MANUFACTURERS, TECHNICAL PARTICULARS AND
GUARANTEES (TRANSMISSION LINE)**

APPENDIX 1-A
MANUFACTURERS, TECHNICAL PARTICULARS
AND GUARANTEES
(TRANSMISSION LINE)

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1. MANUFACTURERS, PLACES OF MANUFACTURE, TESTING, INSPECTION AND DESIGNING

1.1. MANUFACTURERS AND PLACES

Item	Manufacturer & Country	Place of Manufacture & Address
LINE CONDUCTORS		
ACSR Zebra Conductor		
- Aluminium Wires		
- Stranding Steel Wires		
- Stranding (Complete Conductor)		
LINE CONDUCTOR FITTINGS		
Mid-Span Joints – Conductor		
Repair Sleeves		
Vibration Dampers		
EARTH CONDUCTORS		
Galvanized Steel Wire		
EARTH CONDUCTOR FITTINGS		
Suspension Clamps		
Tension Clamps		
Mid-span Joints		
OPGW / OFAC		
Steel wires		
Optic Fiber		
Complete OPGW		
Optical Fiber Approach Cable (OFAC)		
Fittings & Accessories		
INSULATORS AND FITTINGS		
Suspension Insulator Discs, 120 kN		
Jumper Suspension Insulator Discs, 70 kN		
Suspension Insulator Hardware		
Tension Insulator Discs, 160 kN		

Item	Manufacturer & Country	Place of Manufacture & Address
Tension Insulator Hardware		
Suspension Clamps - Conductor		
Tension Clamps – Conductor		
STEEL TOWERS		
Steel Sections		
Fabrications		
Galvanising		
Nuts and bolts and other accessories		

1.2. TESTING

Item	Place of Testing	Address
Insulator Disc (Sample Test)		
Insulator String (Type Tests)		
Tower (Design/ Destructive Tests)		
ACSR Conductors (Sample Test)		
Earth wire (Sample Test)		
OPGW (Sample Test)		
Hardware Fittings (Sample Test)		

2. TECHNICAL PARTICULARS AND GUARANTEES

2.1. ACSR ZEBRA CONDUCTOR

Description	Unit	Required	Offered
Name of the conductor		ACSR Zebra	
Nominal Aluminium Area of Conductor	mm ²	400	
Actual Steel Area of Conductor	mm ²		
Actual Aluminium Area of Conductor	mm ²	484.5	
Number and Diameter of Aluminium Wires	mm	54/3.18	
Lay of Aluminium Wires			
- Inner Layer	mm		
- Middle Layer	mm		
- Outer Layer	mm		
Number and Diameter of Steel Wires	mm	7/3.18	
Lay Direction of Outermost layer		Right	
Overall Diameter	mm	28.62	
Standard Mass per km	kg	1621	
Greased Mass per km	kg		
Ultimate Tensile Strength	kN	≥ 131.9	
Modules of Elasticity	GPa	69000	
Coefficient of Linear Expansion	°C ⁻¹	19.3 × 10 ⁻⁶	
Maximum Length of Conductor on Drum	m		
Maximum mass of greased conductor plus drum	kg		
Minimum drop point Temp. of inter-strand grease	°C		
Maximum calculated DC resistance per km at 20°C	Ω/km	≤ 0.0674	
Individual Wires before stranding			
- Aluminium Wire			
Shape of wires		Round	

Diameter	mm	3.18	
Minimum Conductivity at 20° C	% IACS	61	
Minimum Tensile Strength	MPa	165	
Density at 20°C	g/cm ³	2.703	
Coefficient of linear expansion	°C ⁻¹	23 × 10 ⁻⁶	
- Core Wire			
Diameter	mm	3.18	
Resistivity at 20°C	nΩm	192	
Minimum Tensile Strength	MPa	1300	
Minimum Elongation on 250 mm Length on breaking	%	3.5	
Minimum stress at 1% extension	N/mm ²	1100	
Minimum No. of torsion twists	Nos	14	
Density at 20°C	g/cm ³	7.78	
Joints, Clamps, Compressors, Vibration dampers and Spacers			
Conductor Mid-Span Joint Type Number			
Conductor Repair Sleeve Type Number			
Conductor Dead End Clamp Type Number			
Conductor Jumper Lug Type Number			
Vibration Damper Type Number			
Distance from mouth of Suspension or Tension Clamp to Vibration Damper			
Distance between subsequent Vibration Dampers			
Details and Type Number of Compression tools			
Identification Numbers of Compressor Dies to be Supplied			
Aluminium part - Conductor			
Steel part - Conductor			

Jumper Terminal - Conductor			
Repair Sleeve - Conductor			

2.2. EARTHWIRE

Description	Unit	Required	Offered
Name of the Conductor		Galvanized Steel Wire (GSW)	
Cross Sectional Area	mm ²	58.07	
Number and Diameter of galvanised Steel Wires	mm	7/3.25	
Lay direction of outermost layer		Right	
Overall Diameter	mm	9.75	
Standard Mass per km	kg	460	
Ultimate Tensile Strength	kN	58.05	
Description Equivalent Modules of Elasticity	GPa		
Equivalent Coefficient of Linear Expansion	°C ⁻¹	11.5 x 10 ⁻⁶	
Maximum Length of Conductor on Drum	m		
Gross Weight of one drum	kg		
DC Resistance at 20°C	Ω/km		

Description	Unit	Required	Offered
Individual Wires before stranding			
Tensile Breaking Stress	MPa		
Conductivity at 20°C	%IACS		
Elongation on 250 mm Length on breaking	%		
Minimum Stress at 1% extension	N/mm ²		
Density at 20°C	g/cm ³	7.78	
Mass of Zinc	g/m ²	≥ 245	

Description	Unit	Required	Offered
Joints, Clamps, Compressors, Vibration dampers and Spacers			
Earthwire Mid-Span Joint Type Number			
Earthwire Dead End Clamp Type Number			
Conductor Jumper Lug Type Number			
Vibration Damper Type Number			
Distance from mouth of Suspension or Tension Clamp to Vibration Damper			
Distance between subsequent Vibration Dampers			
Details and Type Number of Compression tools			
Identification Numbers of Compressor Dies to be Supplied			
Earthwire			

2.3. OPTICAL FIBRE SYSTEM

2.3.1. OPGW

Description	Unit	Required	Offered
Optical Fibre Conductor			
Type		Composite Fibre Optic Earthwire	
Type reference			
Standards		According to IEC60793/ 60794, ITU-T G.652, IEEE 1138	
Construction of OPGW			
1) Overall			
- Type of construction		Loose tube	
- Type of optical fiber		Single mode ITU-T G.652D	
- Number of fibres	Nos.	24	
- Material of fibre		Silica (SiO ₂)	
- No of tubes	Nos.	1	

- Tube structure		Central (two concentric tubes)	
Inner Tube			
- Tube material		Stainless steel	
- Tube thickness	mm		
Outer tube			
- Tube material		Aluminium/Aluminium alloy	
- Tube thickness	mm		
Length of fibre per km of OPGW	km		
Filling compound		As per Chapter 03 of Volume 05 of 08	
Heat resistant barrier			
Material of fiber		Silica (SiO ₂)	
2) Inner layer			
- Material			
- Number of wires			
- Diameter of wires	mm		
- Cross-section	mm ²		
- Lay ratio			
3) Outer layer			
- Material			
- Number of wires			
- Diameter of wires	mm		
- Cross-section	mm ²		
- Lay ratio			
- Lay Direction		Right hand	
Total cross-sectional area	mm ²		
Rated outer diameter	mm		
Nominal weight	kg/km		
Minimum ultimate tensile strength	kN		
Maximum tensile strength for normal operation	kN		

DC resistance at 20°C	ohm/km	≤1 ohm/km	
Modulus of elasticity			
- Initial	kg/mm ²		
- Final	kg/mm ²		
Coefficient of linear expansion	/Deg. C		
Method of creep compensation			
Minimum bending radius			
- Short term	mm		
- Long term	mm		
Strain margin			
- Nominal	%		
- Maximum allowance	%		
Maximum allowable temperature and corresponding current			
- continuous	Deg. C/kA		
- for short circuit	Deg. C/kA		
- for lightning stroke	Deg. C/kA		
Minimum short circuit current rating			
- Double earth wire system	kA ² S		
- Single earth wire system	kA ² S	NA	
Minimum lightning withstands		According to IEC60794 Class 1	
Maximum length of cable on drum		5	
Details of Conductor grease		To be submitted with tender	
- Drop point	°C		
Type test certificates issued by an independent laboratory		Yes	
Weight of drum with maximum length of OPGW		kg	

Optical Fibre Unit			
Number of optical fibers in OPGW	No	24	
Mode		Single Mode	
Optimized wave length	nm	Dual windows 1310 and 1550	
Maximum cable cut off wave length at;	nm	≤1260 nm	
Maximum attenuation per km at			
- At 1,550 nm	dB/km	<0.22	
- At 1310 nm	dB/km	<0.35	
Chromatic Dispersion			
- At 1550 nm	ps/nm.km	< 3.5	
- At 1310 nm	ps/nm.km	< 18	
Transmission bandwidth	MHz/km	>10000	
Splicing loss (per splice)	dB	<0.05	
Fibre Identification (full details)		Details to be submitted with the tender	
Minimum bending radius	mm		
Nominal zero dispersion wavelength	nm	1310 nm	
Refractive index			
Core			
Cladding			
Material used in			
Core			
Cladding			
Primary coating			
Jacket			
Coating			
Optical attenuation corresponding to			
crush test	dB		
impact test	dB		
bend test	dB		
sheave test	dB		
Mode field diameter at 1310 nm	μm	8.6 to 9.2 μm	
Allowable deviation in mode field diameter		±0.4 μm	

Mode field non-circularity			
Outside (clad) diameter	μm	125 μm	
Tolerance in outside (clad) diameter	μm	±0.7 μm	
Core cladding concentricity error	μm	<0.6 μm	
Cladding non-circularity (%)	%	<1%	
Screening level/tensile proof test	GPa	>0.69	
Loose buffer design or Tight buffer design		Loose buffer	
Temporary change in attenuation at 20-degree C due to			
Temperature cycling	dB/km		
Lightning stroke	dB/km		
Short circuit current	dB/km		
Expected life time without degradation of characteristics	years	30	
Maximum allowable short time temperature of fiber	°C/ sec.	> 200	
Nominal optical attenuation at 20°C over a period of 30 years			
Bit error rate			
Optical cross talks			

2.3.2. Optical Fire Approach Cable

Manufacturer			
Country of origin			
Type reference			
Place of Manufacture			
Type of optical cable			
Standards		According to IEC 60793/ 60794, ITU-T G.652	
Type of optical fiber		Single mode ITU-T G.652D	

Nominal overall diameter	mm		
Optical wave-guide fibers similar to fibers in OPGW	Yes/No		
If answer to above item is No, details of fibers are provided	Yes/No	Yes	
Construction of cable			
- Type of construction		Loose tube	
- Type of optical fiber		Single mode	
- Number of fibers	Nos.	24	
- Material of fiber		Silica (SiO ₂)	
- Number of tubes			
- Number of fibers per tube			
- Tube diameter			
- Tube material			
- Length of each fiber per km of approach			
- Filling compound			
- Central strength member			
- Heat resistance barrier			
- Water Blocking barrier			
Outside Jacket			
- Material			
- Thickness			
Type of moisture barrier			
Maximum applicable tension			
Operating temperature range			
Minimum bending radius			
Short term	mm		
Long term	mm		
Maximum length of cable on drum	km	5	
Total cross-sectional area			
Crush resistance (at temperature of...)	N/cm		
Mass of cable (per km)	Kg		
Cable life expectancy	years	30	
Torsional strength			

Impact resistance (at temperature of...)	N		
Co-efficient of expansion per degree C	°C		
Suitable for laying in duct/direct burial/ both			
Length markers on cable in unit length of	m		
Rodent attack additive provided	Y/N	Yes	
HDPE pipe details		Corrugated flexible HDPE Pipe	
- Diameter	mm	50	
- Thickness of pipe	mm	≥2 mm	
- Pilot wire available inside pipe	Y/N	Yes	
- Suitable for laying on outdoor ducts and direct burial	Y/N	Yes	

2.3.3. Splice Enclosure (Joint Box)

Description	Unit	Required	Offered
Manufacturer			
Manufacturers type designation and model number			
Place of manufacture			
Standards			
Method of mounting and installation		Details to be submitted with Tender	
Housing			
- Material of Base		aluminium alloy	
- Material of covering		aluminium alloy	
Protection rating		IP 55	
Maximum number of splices		>24	
Number of cables			
Maximum diameter of cable	mm		
Maximum pull on cable	kg		
Dimension (H x W x D)			

Mass	kg		
Type test certificates issued by an independent laboratory	Y/N	Yes	

2.3.4. Optical Terminal Box (Patch Panel)

Description	Unit	Required	Offered
Manufacturer			
Type reference			
Place of manufacture			
Standards			
Method of mounting		Wall mounting	
Details of cable entry		Details to be submitted with Tender	
Minimum number of cable entries	No.	6	
Minimum number of fibers and optical connectors which can be accommodated	No.	24	
Type of optical connector		FC/PC	
Optical connector loss			
- Transmit side	dB	<0.5	
- Receive side	dB	<0.5	
Dimension (HxWxD)	mm		
Mass	kg		
Protection rating	IP std	IP54	
Lockable Front Cover	Yes/No	Yes	
Openable side wall covers for easy access of connector plane	Yes/No	Yes	

2.3.5. Armour Rods for OPGW

Description	Unit	Required	Offered
Number of layers per set	No		
Material of rods			

- Outer layer		Alum alloy	
- Inner layer		Alum alloy	
Number of rods per set			
- Outer layer	No		
- Inner layer	No		
Diameter of rods			
- Outer	mm		
- Inner	mm		
Lay of rods			
- Outer	mm		
- Inner	mm		
End form of rods			
- Outer	type	Ball-ended	
- Inner	type	De-burred	
Overall length of armor rod set			
- Outer	mm		
- Inner	mm		

2.4. INSULATORS AND FITTINGS

The bidder is required to fill the spaces in this schedule

	Unit	Normal Suspension	Heavy Suspension	Normal Tension	Jumper Suspension	Low duty Tension Upright	Low duty Tension Inverted
Insulator Disc							
Designation							
Disc Material (Toughened Glass or Ceramic)							
Classification		Ball & socket	Ball & socket	Ball & socket	Ball & socket	Ball & socket	Ball & socket

Unit Number							
Maker							
Maximum Working Load	kN						
Minimum Electro-Mechanical Failing Load	kN						
Outside Diameter of Unit	mm						
Diameter of Insulator Pin	mm						
Protected Creepage Distance per Unit	mm						
Minimum nominal Creepage Distance per Unit	Mm						
Minimum 50 Hz Puncture Voltage per Unit	kV						

	Unit	Normal Suspension.	Heavy Suspension	Normal Tension	Jumper Suspension	Low duty Tension Upright	Low duty Tension Inverted
Fittings							
Material of Clamp							
Length of Clamp							
Material of spacers							
Elastic Limit of Fittings							
Insulator String							
Number of Units in String	Nos						
Spacing of Unit in String	mm						
Minimum Failing Load of Complete Insulator Set	kN						
Total Creepage Distance	mm						
Total Protected Creepage Distance	mm						

Overall Length of Complete Suspension Set from Bottom of Conductor to Support Attachment Point	mm						
Length from Tension Set Jumper Lug to Support Attachment Point	mm						
Mass of Complete Set with all Fittings	kg						
Lift of Arcing Horn over Line End Unit	mm						
Arcing Distance between Line End Horn and Earth End Cap or Horn	mm						

	Unit	Normal Suspension.	Heavy Suspension	Normal Tension	Jumper Suspension	Low duty Tension Upright	Low duty Tension Inverted
Dry 1-minute 50 Hz Withstand of Normal Insulator Set Complete with all Fittings							
Wet 1-minute 50 Hz Withstand of Normal Insulator Set Complete with all Fittings							
Dry Impulse withstand Voltage (1.2/50) of Normal Insulator set complete with all fittings							
Positive wave +kV peak	kV						
Negative Wave –kV peak	kV						
Dry Impulse withstand Voltage (1.2/50) of Normal Insulator set as above without Arc horns							
Positive wave +kV peak	kV						
Negative Wave –kV peak	kV						

2.5. SUPPORT STEEL

The bidder is required to fill the spaces in this schedule.

Description	Units	Required	Offered
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Steel to ISO 630 Grade E 275: -			
Minimum upper yield stress	N/mm ²	275	
Ultimate stress in tension members	N/mm ²	410-540	
Ultimate stress in compression members (express as a function of L/R)	N/mm ²		
Steel to ISO 630 Grade E 355: -			
Minimum upper yield stress	N/mm ²	355	
Ultimate stress in tension members	N/mm ²	490-640	
Ultimate stress in compression members (express as a function of L/R)	N/mm ²		
ISO 898-1			
Ultimate shear stress on bolts	N/mm ²		
Ultimate bearing stress in bolts	N/mm ²		
Ultimate tensile strength of bolts	N/mm ²		
Minimum proof stress	N/mm ²		

2.5.1. Particulars of Towers

Voltage	kV	132				
Basic Span Length	m	300				
Normal Minimum Ground Clearance of Line Conductor at Maximum Temperature (including 0.3 m Allowance)	m	7				
Approximate Final Sag of Line Conductor in Still Air at Maximum Temperature for Basic Span	m					
Approximate Final Sag of Line in still Air at Everyday Temperature for Basic Span	m					
Approximate Final Sag of Earth Conductor in Still Air at Everyday Temperature for Basic Span	m					
Maximum working Tension of Line Conductor, for Tower Design Purposes	N					
Maximum working Tension of Earth Conductor, for Tower Design Purposes	N					
Type of Tower	Unit	TDL	TD1	TD3	TD6	TDT/ TD9

Approximate Height of the Lowest conductor above ground at Support	m					
Vertical Distance between Top and Bottom-Line Conductors	m					
Vertical Spacing Between Earth Conductor and Top Line Conductor	m					
Approximate Total Height of the Tower above Ground	m					
Approximate Width of Tower Body at Attachment Level of Bottom Cross arm	m					
Horizontal Distance of Insulator Attachment from Tower Centre line for each Cross arm	m					
Top	m					
Middle	m					
Bottom	m					
Approximate Overall Dimensions of Tower Base at Ground Level	m					
Transverse to line	m					
Parallel to line	m					
Approximate Mass of Complete Tower Steelwork (using Concrete Block Foundations)	kg					
Approximate Extra Mass of Steel for						
-3 m Extension	kg					
+3 m Extension	kg					
+6 m Extension	kg					
+9 m Extension	kg					
+12 m Extension	kg					
+15 m Extension	kg					
+18 m Extension	kg					
-3 m Leg Extension	kg					

-2 m Leg Extension	kg					
-1 m Leg Extension	kg					
+1 m Leg Extension	kg					
+2 m Leg Extension	kg					
+3 m Leg Extension	kg					
+4 m Leg Extension	kg					
+6 m Leg Extension	kg					
Total Ult. Transverse Overturning Moment at Ground level under Specified Maximum Normal Working Loads for Standard Tower	kg					
Approximate Ult. Longitudinal Overturning Moment at Ground Level under Broken Wire	kg					
Loading (Standard Tower)	Nm					
Approximate Ultimate Compression Load per Leg	Nm					
Approximate Ultimate Uplift Load per Leg						

2.6. GUARANTEES

2.6.1. Conductors and Earthwires

Conductors	Units	ZEBRA, ACSR
Ultimate Tensile Strength	N	
Diameter	mm	
Max. DC Resistance per km at 20°C	ohms	
Conductor weight per km (without grease)	kg	
Conductor weight per km (with grease)	kg	

Aluminium Clad Steel Earthwire		7/ 3.25 mm
Ultimate Tensile Strength	N	
Max Resistance per km at 20°C	ohms	

Optical Fibre Ground Wire (OPGW)		
Ultimate Tensile Strength	N	
Max Resistance per km at 20°C	ohms	

2.6.2. Insulators and Fittings

Minimum Failing Load for Complete Set		
Normal Suspension Sets	kN	
Heavy Suspension sets	kN	
Normal Tension Sets	kN	
Light duty Tension Sets	kN	
Positive Wave Impulse Withstand Voltage		
Normal Suspension Sets	kV peak	
Heavy Suspension sets	kV peak	
Normal Tension Sets	kV peak	
Light duty Tension Sets	kV peak	