

Functional Guarantee and Technical Particulars

400 kV Transmission Line

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
Minimum factors of safety to be applied to assumed simultaneous maximum loadings		
Line and earth conductors, based on ultimate strength	2.5	
Line and earth conductors at everyday temperature, still air, based on ultimate strength	5.0	
Complete insulators and fittings	2.5	
Steel supports, foundation structures, based on elastic limit of members in tension and on crippling loads of compression members, or on tests on complete supports (but not tests on the foundations):		
Suspension supports		
a. Normal conditions	2.5	
b. Unbalanced conditions (except cascade)	1.5	
c. Cascade collapse condition	1.0	
Tension supports		
a. Normal conditions	2.0	
b. Unbalanced conditions	1.5	
Foundations		
a. Normal conditions	2.5	
b. Unbalanced conditions	1.75	
Maintenance and Erection	2.0	
Particulars of spans		
Basic span	400 m	
Maximum sum of adjacent spans	880 m	
Maximum single span	600 m	
Wind span for tower design		
a. Suspension towers	440 m	
b. Tension towers	450 m	
Maximum weight spans		
a. Suspension towers	800 m	
b. Tension towers	900 m	
Minimum weight spans (for design purposes)		
a. Suspension towers	35% of sum of adjacent spans	
b. Tension towers (uplift net)	- 450 m	
Particulars of line conductors and fittings		
Nominal area per conductor	455 mm ²	
Numbers of conductors per phase	3 nos.	

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
Distance between conductor centres of one phase	400 mm	
Conductor code name	ACSR Condor	
Applicable standard	IEC 61089	
Applicable standard (Metric system, Condor)	ASTM B 232	
Material of conductor	Aluminum/ Galvanised steel	
Numbers and diameters of wires	Al 54/3.08 St 7/3.08 (No/mm)	
Overall diameter of stranded conductor	27.73 mm	
Resistance of conductor (dc) at 20deg.C	0.07173 ohm/km	
Mass of conductor (without grease)	1,522 kg/km	
Total mass of greased conductor (greased to Case 2 of IEC 61089)	- Kg/km	
Ultimate rated strength of conductor	125,440 Newton	
Maximum tension of conductor in still air at "everyday" temperature 25deg.C	25,088 Newton	
Assumed equivalent modulus of elasticity of conductor	68,650 N/mm ²	
Assumed equivalent coefficient of linear expansion of conductor	1.93 x 10 ⁻⁵ per deg.C	
Maximum length of conductor on drum	3 km	
Conductor grease		
Type		
Minimum drop-point temperature	120 deg.C	
Mass of grease per kilometre of conductor (all inner layers greased – Case 2 to IEC 61089)	- kg	
Vibration damping system		
Type of system (vibration damper + spacer or spacer damper)	Stockbridge type	
Type of vibration damper (if proposed and used)		
Standard applied	IEC 61897	
Conductor diameter range	- mm	
Mass of damper	- kg	
Maximum span length for		
a. One vibration damper at each end of span (2 in the span)	- m	
b. Two vibration dampers at each end of span (4 in the span)	- m	
c. Three vibration dampers at each end of span (6 in the span)	- m	
Distances from clamp mouth to vibration damper attachment		
a. First damper	- m	
b. Second damper when required	- m	
c. Third damper when required	- m	
Spacer or spacer damper		
Type of spacer or spacer damper		

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
Standard applied	IEC 61854	
Conductor diameter range	- mm	
Mass	- kg	
Symmetrical or asymmetrical in-span spacing		
Maximum sub-span length (distances between spacers)		
Particulars of OPGW and fittings		
Number of OPGW earth conductors	2 no.	
International Standard applied	IEEE 1138 IEC60794-4	
Material of OPGW conductors	Aluminium Alloy/ Aluminium clad steel	
Number and diameter of wires	- No/mm	
Total area of OPGW conductor	- mm ²	
Overall diameter of OPGW conductor	- mm	
Mass of OPGW conductor	< 850 kg/km	
Ultimate strength of OPGW conductor	>= 93,000 Newton	
Maximum tension of OPGW conductor in still air at "everyday" temperature 25 deg.C	> 18,500 Newton	
Assumed equivalent modulus of elasticity of OPGW conductor	>= 70,000 N/mm ²	
Assumed equivalent coefficient of linear expansion of OPGW conductor	<= 1.98 x 10 ⁻⁵ per deg.C	
Minimum bending radius	- mm	
Short circuit current rating	496 kA ² s	
Minimum length of OPGW conductor on drum	4 km	
Individual wires before stranding		
Aluminium alloy Standard applied	IEC 60104	
Minimum conductivity of aluminium wires at 20deg.C	52.5 % IACS	
Aluminium-clad steel Standard applied	IEC 60232	
Grade of Steel	20SA	
Vibration damping system of OPGW		
Maximum span for		
a. One vibration damper at each end of span (2 in the span)	- m	
b. Two vibration dampers at each end of span (4 in the span)	- m	
c. Three vibration dampers at each end of span (6 in the span)	- m	
Particulars of Fibre Optic Transmission System		
Type of Fibre optic data	Non-Zero Dispersion-Shifted Single-Mode as per ITU-T G.655	
Wavelength	1550/1625 nm	
Number of fibres	48 nos.	

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
Transmission attenuation		
a. at 1550 nm	< 0.22 dB/km	
b. at 1625 nm	< 0.24 dB/km	
Transmission bandwidth	> 10,000 MHz/km	
Fibre identification by	Colour code	
Chromatic dispersion		
a. at 1550 nm	< 2 ps/nm.km	
b. at 1625 nm	<12.4 ps/nm.km	
Splicing loss	< 0.1 dB	
Polarisation Mode Dispersion (PMD)	< 20 $\sqrt{\text{km}}$	
Minimum bending radius	- mm	
Particulars of Insulators and fittings		
Type of Insulator units	Long rod polymeric insulator	
Suspension units		
Shed profile	Aerodynamic, Compression (One-piece) molding type	
Appropriate IEC Number	IEC 61109	
Material	High temperature vulcanization silicone elastomer	
Coupling		
a. Standard applied	IEC 60120	
b. Type	Ball/Socket	
c. Size (recommended only)	16 mm	
Minimum failing load of unit	210 kN	
Outside diameter:	- mm	
Mass of unit	- kg	
Minimum dry lightning impulse withstand voltage (1.2/50 μs , negative)	1806 kV	
Minimum dry lightning impulse withstand voltage (1.2/50 μs , positive)	1806 kV	
Minimum dry power frequency withstand voltage (1 min.)	1070 kV	
Minimum wet power frequency withstand voltage (1 min.)	835 kV	
Creepage distance	16000 mm	
Tension units		
Shed profile	Aerodynamic, Compression (One-piece) molding type	

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Minimum dry power frequency withstand voltage (1 min.)	1070 kV	
Minimum wet power frequency withstand voltage (1 min.)	835 kV	
Creepage distance	16000 mm	
Particulars of Insulator set complete		
Suspension sets		
Number of insulator strings in parallel	2	
Minimum failing load, complete set	2 x 210 kN	
Overall length of set including clamps and all fittings	- mm	
Arcing Gap (recommended only)	4070 mm	
Mass of set, complete with all fittings	- kg	
Overall length of creepage path per string	16000 mm	
50 Hz voltage tests All withstand voltage levels corrected from 2500 m altitude at site to test voltages under normal temperature and pressure in accordance with BS 137 and IEC 60383.		
a. One minute dry withstand voltage of complete set	1070 kV	
b. One minute wet withstand voltage of complete set :	835 kV	
50% Impulse withstand voltage tests All withstand voltage levels corrected from 2500 m altitude at site to test voltages under normal temperature and pressure in accordance with BS 137 and IEC 60383.		
a. 1.2/50 μ s negative wave:	1806 kV	
b. 1.2/50 μ s positive wave:	1806 kV	
Corona test voltage	333 kV	
Set RI test voltage	275 kV	
Set radio noise level	45 dB	
Tension sets		
Number of insulator strings in parallel	2	

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
Elastic limit load of set fittings:		
a. Common to each string	- kN	
b. Common to conductor	- kg	
c. Separate for each sub-conductor	- kg	
Minimum failing load, complete set	2 x 210 kN	
Overall length of set including clamps and all fittings	- mm	
Arcing Gap (recommended only)	4070 mm	
Mass of set, complete with all fittings	- kg	
Overall length of creepage path per string	16000 mm	
50 Hz voltage tests		
All withstand voltage levels corrected from 2500 m altitude at site to test voltages under normal temperature and pressure in accordance with BS 137 and IEC 60383.		
a. One minute dry withstand voltage of complete set	1070 kV	
b. One minute wet withstand voltage of complete set :	835 kV	
50% Impulse withstand voltage tests		
All withstand voltage levels corrected from 2500 m altitude at site to test voltages under normal temperature and pressure in accordance with BS 137 and IEC 60383.		
a. 1.2/50 μ s negative wave:	1806 kV	
b. 1.2/50 μ s positive wave:	1806 kV	
Corona test voltage	333 kV	
Set RI test voltage	275 kV	
Set radio noise level	45 dB	
Earth conductor sets		
Minimum failing load		
a. Suspension set	- kN	
b. Tension set	- kN	

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
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Particulars of Tower Design

Maximum tension per phase, for purposes of tower design

a. Suspension towers	-	N	
b. Tension towers	-	N	
c. Downleads per conductor bundle	-	N	

Maximum tension per earth conductor for purpose of tower design and application: ACS Earthwire

a. Suspension towers	-	N	
b. Tension towers	-	N	
c. Earth conductor downleads	-	N	

Maximum tension per earth conductor for purpose of tower design and application: OPGW

a. Suspension towers	-	N	
b. Tension towers	-	N	
c. OPGW downleads	-	N	

Minimum clearance between live metal and tower steelwork:-

a. with suspension insulator set swing, at 65°	1200 mm	
b. with suspension insulator set swing, 0 - 10°	3600 mm	
c. with suspension insulator set swing 10 - 35°	2100 mm	

Minimum clearance to steelwork on which a man may stand for live line maintenance (crossarm floor)

5 m	
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Downleads – minimum clearances:

a. phase to phase clearance in still air	5600 mm	
b. phase to phase clearance under conditions of maximum (opposing) swing and sag	4200 mm	

Earth conductor suspension clamps, unobstructed transverse swing angle from vertical

0 - 50 deg.	
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Earth conductor maximum shielding angle from vertical at tower attachment point over outer line conductors

17 deg.	
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Maximum ratio of unsupported length of steel compression member to their least radius of gyration:

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
a. Main members	120	
b. Stressed bracings	200	
c. Unstressed bracings	250	
d. Tension only members	500	
Maximum ultimate stresses, for checking tower designs not subjected to test (unless otherwise approved):-		
Mild Steel		
a. Compression members, Tenderer to indicate his design assumptions	ASCE 10-97	
b. Tension members (elastic limit)	220 N/mm ²	
c. Shear on bolts Bolt Grade 5.6	- N/mm ²	
d. Material Bearing	- N/mm ²	
High Yield Steel:		
a. Compression members, Bidders to indicate his design assumptions	ASCE 10-97	
b. Tension members (elastic limit)	325 N/mm ²	
c. Shear on bolts Bolt Grade 8.8	- N/mm ²	
d. Material Bearing	- N/mm ²	
Particulars of Double Circuit Towers		
Type of Tower	ssb	
Type of insulator sets	Suspension	
Angles of deviation	0 - 2 deg.	
Basic span length	400 m	
Minimum ground clearance of line conductor at 80deg.C, normal ground	8.1 m	
Sag of line conductor in span length at 80deg.C	14 m	
Maximum distance of line conductor below crossarm	- m	
Height above ground of bottom conductor crossarm (Standard height tower)	27.75 m	
Minimum height of earth conductors above upper line conductor at tower	- m	
Minimum horizontal spacing between adjacent conductors	6.5 m	
Vertical spacing between line conductors at tower	11.0 m	
Overall tower height (Standard height tower)	39.75 m	
Maximum differential, foundation movement permitted under ultimate loads	- mm	
Clearance between conductors of one circuit and tower climbing leg of the other circuit:	9.0 m	
Horizontal distance, from tower centre line to insulator attachments	8.0 m	
Horizontal distance, from tower centre line to earth conductors	9.0 m	
Tower body dimensions at bottom crossarm level (transverse x longitudinal)	2.0 x 2.0 m	
Overall tower base dimensions at ground line (transverse x longitudinal):	- m	

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
Total transverse overturning moment at ground line of standard height tower, load case 1 (normal) with factor of safety	- kN-m	
Mass of complete tower above ground line		
a. Minus 3 metre height tower	- kg	
b. Standard height tower:	- kg	
c. 3 metre extended tower	- kg	
d. 6 metre extended tower	- kg	
e. 9 metre extended tower	- kg	
f. 12 metre extended tower	- kg	
Type of Tower	T10bb	
Type of insulator sets	Tension	
Angles of deviation	0 - 10 deg.	
Basic span length	- m	
Minimum ground clearance of line conductor at 80deg.C, normal ground	- m	
Sag of line conductor in span length at 80deg.C	- m	
Maximum distance of line conductor below crossarm	- m	
Height above ground of bottom conductor crossarm (Standard height tower)	- m	
Minimum height of earth conductors above upper line conductor at tower	- m	
Minimum horizontal spacing between adjacent conductors	- m	
Vertical spacing between line conductors at tower	- m	
Overall tower height (Standard height tower)	- m	
Maximum differential, foundation movement permitted under ultimate loads	- mm	
Clearance between conductors of one circuit and tower climbing leg of the other circuit:	- m	
Horizontal distance, from tower centre line to insulator attachments	- m	
Horizontal distance, from tower centre line to earth conductors	- m	
Tower body dimensions at bottom crossarm level (transverse x longitudinal)	- m x - m	
Overall tower base dimensions at ground line (transverse x longitudinal):	- m x - m	
Total transverse overturning moment at ground line of standard height tower, load case 1 (normal) with factor of safety	- kN-m	
Mass of complete tower above ground line		
a. Minus 3 metre height tower	- kg	
b. Standard height tower:	- kg	
c. 3 metre extended tower	- kg	
d. 6 metre extended tower	- kg	
e. 9 metre extended tower	- kg	
f. 12 metre extended tower	- kg	
Type of Tower	T30bb	

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
Type of insulator sets	Tension	
Angles of deviation	10 - 30 deg.	
Basic span length	- m	
Minimum ground clearance of line conductor at 80deg.C, normal ground	- m	
Sag of line conductor in span length at 80deg.C	- m	
Maximum distance of line conductor below crossarm	- m	
Height above ground of bottom conductor crossarm (Standard height tower)	- m	
Minimum height of earth conductors above upper line conductor at tower	- m	
Minimum horizontal spacing between adjacent conductors	- m	
Vertical spacing between line conductors at tower	- m	
Overall tower height (Standard height tower)	- m	
Maximum differential, foundation movement permitted under ultimate loads	- mm	
Clearance between conductors of one circuit and tower climbing leg of the other circuit:	- m	
Horizontal distance, from tower centre line to insulator attachments	- m	
Horizontal distance, from tower centre line to earth conductors	- m	
Tower body dimensions at bottom crossarm level (transverse x longitudinal)	- m x - m	
Overall tower base dimensions at ground line (transverse x longitudinal):	- m x - m	
Total transverse overturning moment at ground line of standard height tower, load case 1 (normal) with factor of safety	- kN-m	
Mass of complete tower above ground line		
a. Minus 3 metre height tower	- kg	
b. Standard height tower:	- kg	
c. 3 metre extended tower	- kg	
d. 6 metre extended tower	- kg	
e. 9 metre extended tower	- kg	
f. 12 metre extended tower	- kg	
Type of Tower	T60bb	
Type of insulator sets	Tension	
Angles of deviation	30 - 60 deg.	
Basic span length	- m	
Minimum ground clearance of line conductor at 80deg.C, normal ground	- m	
Sag of line conductor in span length at 80deg.C	- m	
Maximum distance of line conductor below crossarm	- m	
Height above ground of bottom conductor crossarm (Standard height tower)	- m	
Minimum height of earth conductors above upper line conductor at tower	- m	

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
Minimum horizontal spacing between adjacent conductors	- m	
Vertical spacing between line conductors at tower	- m	
Overall tower height (Standard height tower)	- m	
Maximum differential, foundation movement permitted under ultimate loads	- mm	
Clearance between conductors of one circuit and tower climbing leg of the other circuit:	- m	
Horizontal distance, from tower centre line to insulator attachments	- m	
Horizontal distance, from tower centre line to earth conductors	- m	
Tower body dimensions at bottom crossarm level (transverse x longitudinal)	- m x - m	
Overall tower base dimensions at ground line (transverse x longitudinal):	- m x - m	
Total transverse overturning moment at ground line of standard height tower, load case 1 (normal) with factor of safety	- kN-m	
Mass of complete tower above ground line		
a. Minus 3 metre height tower	- kg	
b. Standard height tower:	- kg	
c. 3 metre extended tower	- kg	
d. 6 metre extended tower	- kg	
e. 9 metre extended tower	- kg	
f. 12 metre extended tower	- kg	
Type of Tower	T90bb	
Type of insulator sets	Tension	
Angles of deviation	60 - 90 deg.	
Basic span length	- m	
Minimum ground clearance of line conductor at 80deg.C, normal ground	- m	
Sag of line conductor in span length at 80deg.C	- m	
Maximum distance of line conductor below crossarm	- m	
Height above ground of bottom conductor crossarm (Standard height tower)	- m	
Minimum height of earth conductors above upper line conductor at tower	- m	
Minimum horizontal spacing between adjacent conductors	- m	
Vertical spacing between line conductors at tower	- m	
Overall tower height (Standard height tower)	- m	
Maximum differential, foundation movement permitted under ultimate loads	- mm	
Clearance between conductors of one circuit and tower climbing leg of the other circuit:	- m	
Horizontal distance, from tower centre line to insulator attachments	- m	
Horizontal distance, from tower centre line to earth conductors	- m	

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
Tower body dimensions at bottom crossarm level (transverse x longitudinal)	- m x - m	
Overall tower base dimensions at ground line (transverse x longitudinal):	- m x - m	
Total transverse overturning moment at ground line of standard height tower, load case 1 (normal) with factor of safety	- kN-m	
Mass of complete tower above ground line		
a. Minus 3 metre height tower	- kg	
b. Standard height tower:	- kg	
c. 3 metre extended tower	- kg	
d. 6 metre extended tower	- kg	
e. 9 metre extended tower	- kg	
f. 12 metre extended tower	- kg	

Particulars of Foundation Design

Assumed density of concrete for foundation dry	2240 kg/m ³	
Assumed density of concrete for foundation submerged	1200 kg/m ³	
Maximum angle between side of concrete foundation base and frustum of soil for uplift "frustum" to be considered to withstand uplift force from base of foundation	70 deg.	
Maximum allowable design stresses in standard concrete foundation design, under ultimate conditions, which shall be in accordance with BS 8110 or BS 5328, with the following requirement:		
a. 28 day concrete cube strength (characteristic strength)	25 N/mm ²	
b. Minimum proportion of stub load to be allowed for in the design of stub cleats	100 %	
Foundation excavation dimensions for ssb type foundation in class 2 soil (a x b x depth)	- m x - m x - m	
Concrete volume for ssb type foundation in class 2 soil	- m ³	

Particulars of Quality of Tower Materials

Steel members		
Grade/standard:	EN 10025-2	
a. Mild steel	S235	
b. High tensile steel	S355	
Tensile breaking stress:		
a. Mild steel	235 N/mm ²	
b. High tensile steel	355 N/mm ²	
Elongation on breaking		
a. Mild steel	- %	
b. High tensile steel	- %	

Functional Guarantee and Technical Particulars	Required	Proposed by the Bidder
Yield point as percentage of breaking stress		
a. Mild steel	- %	
b. High tensile steel	- %	
Steel nuts and bolts		
Grade/standard:		
a. Mild steel	5.6	
b. High tensile steel	8.8	
Tensile breaking stress		
a. Mild steel	- N/mm ²	
b. High tensile steel	- N/mm ²	
Elongation on breaking		
a. Mild steel	- %	
b. High tensile steel	- %	