Reference Drawings	
Drwg. No.	Title

Revisions				
		Name	Date	Notes

☐ Approval ☐ Approved as noted ☐ Returned for correction ☐ Approval

DATE: ..... SIGNITURE .....

GOVERNMENT OF THE REPUBLIC OF THE SUDAN

NATIONAL ELECTRICITY CORPORATION(NEC)

KHARTOUM - SUDAN

CONTRACTOR HPE

SUBCONTRACTOR NIEPC

Dongula - Wadi Halfa 220 kV Transmission Line Project

H	P	E	-	D	W	-	L	1	3	T	L	G	-	N	T	0	0	5

	Name	Date	
Prepared		May.28,2009	Design data - Towers
Drawn		May.29,2009	
Checked		May.30,2009	
Approved		May.31,2009	
Scale:		Size A4	NIEPC Reg No: REV. 0

DESIGN DATA - TOWERS

a. BASIC DATA

- WIND PRESSURE:
  - On Tower: 2.200 kN/M^2
  - On Insulator: 1.334 kN/M^2
  - On Conductor: 1.334 kN/M^2
  - On Ground Wire/Opgw: 1.334 kN/M^2
- DYNAMIC PRESSURE COEFFICIENT
  - For conductors: 1.0 as per VDE 0210
  - For Ground wire & OPGW: 1.1 as per VDE 0210
  - For Insulator string: 1.2
  - For Tower: 1.5
- TESION FOR TOWER DESIGN
  - Ultimate Tensile Strength(UTS)
    - Conductor: 86.46 kN
    - Ground Wire: 116.08 kN
    - OPGW: 91.10 kN
  - Maximum Working Tension
    - Conductor (40% of UTS): 34.584 kN
    - Ground Wire (25% of UTS): 29.020 kN
    - OPGW (28% of UTS): 26.029 kN
  - Every Day Tension (UTS)
    - Conductor (20% of UTS): 17.292 kN
    - Ground Wire (15% of UTS): 17.412 kN
    - OPGW (15% of UTS): 13.665 kN

- Maintenance Loads
  - The weight of lines man shall be considered for the maintenance: 2.0 kN
- SAFETY FACTOR FOR TOWER DESIGN
  - Normal Condition: 2.0
  - Broken Wire Condition: 1.5
- Body and Leg extensions:
  - For suspension towers:
    - -8,-6,-4,-2,±0,+2,+4,+6,+8,+10,+12,+14,+16 meter body extension will be used
    - -2,-1, ±0,+1,+2 meter leg extension will be used for each body extension
  - For tension towers:
    - ±0,+2,+4,+6, meter body extension will be used
    - -2,-1, ±0,+1,+2 meter leg extension will be used for each body extension
- Steel ultimate stress:
  - Ultimate stress in tension member=yield strength of steel
    - For mild steel: 235 Mpa with thickness up to 16 mm

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For high tensile steel(H): 345 Mpa with thickness up to 16 mm
325 Mpa with thickness above 16 mm

Ultimate stress in compression members according to the buckling formula of ASCE 10 Standard.

b. CLEARANCE FOR TOWER

ITEM	DESCRIPTION	UNITS	GUARANTEED
	SUSPENSION TOWERS		
	Clearance at vertical		
1	Clearance	m	2.3
	Clearance in still air		
2	Swing angle	°	0-40
3	Clearance	m	1.55
	Clearance at wind		
4	swing angle	°	40-60
5	Clearance	m	0.9
	TENSION TOWERS		
	Clearance in still air(jumper loop)		
6	Swing angle	°	0
7	Clearance	m	1.55
	Clearance in still air(jumper insulator)		
8	Swing angle	°	0-39
9	Clearance	m	1.55
	Clearance at wind(jumper loop)		
10	Swing angle	°	0-60
11	Clearance	m	0.9
	Clearance at wind(jumper insulator)		
12	Swing angle	°	20
13	Clearance	m	1.55

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c. CLEARANCE TO GROUND AND BY CROSSING

ITEM	DESCRIPTION	UNITS	GUARANTEED
1	Ground, including roads	m	8.0
2	Main(tarmac) road	m	8.0
3	Ground in area inaccessible to vehicle	m	7.0
4	Water at max. flood level except navigable rivers	m	7.0
5	Buildings or structures upon people may regularly stand	m	7.0
6	Metal clad or roofed buildings or other structures upon people may regularly stand	m	4.6
7	Overhead power or telecommunication line(to cradle)	m	4.0
8	Trees	m	3.6
9	Rivers (large) (ab. Max. flood level)	m	15.0

d. SLENDERNESS RATIO

The slenderness ratio KL/r for members have been limited as follows:

Tower legs, main compression members in crossarms and groundwire peaks	120
All other compression members carrying calculated stresses	200
Secondary compression members (Redundants)	250
Tension only members	350

e. TOWER TYPES

Table - 1

Tower Name	Tower Type	Angle of deviation	Wind Span (m)	Weight Span (m)	
				maximum	minimum
AA	Suspension	0~2°	400	550	220
AAw[1)]	Suspension	0~2°	450	720	220
AAL[2)]	Suspension – river crossing	0~2°	700	1300	220
BB	Angle Tension	0~10°	400	550	0
CC[3)]	Angle Tension	10~30°	400	550	**-150**
DD	Angle Tension	30~60°	400	550	**0**
EE[3)]	Angle Tension	60~90°	400	550	**-200**
FF	Dead end	0~45°	400	550	**-200**
TT	Transposition	0~10°	400	550	220

1) AAw is a proposed new suspension tower type suitable for large wind/weight span.
2) The maximum weight span for AAL tower have been increased according to the Nile river crossing section
3) EE/FF towers are combined.
4) CC/EE towers are proposed to be used in the location with uplift (negative weight) span.

f. MATERIALS

- Steel for tower members

WEPC DOCUMENTS

Mild steel: Q235-B

High Tensile Steel: Q345-B

The characteristics of steel **Table - 2**

Standard	Grade	Yield strength Fy (Mpa)		Minimum Tensile strength	Elongation	Sample Length	Impact work		Chemical composition %				
		T<=16	t>16	Mpa	%	mm	J	deg	C	Mn	Si	S	P
GB 700	Q235B	235	225	375	26	5.65SSo	27	20	0.14~0.2	0.3~0.65	0.3	0.045	0.045
GB 1591	Q345B	345	325	470	22	5.65SSo	34	20	0.2	1~1.6	0.5	0.045	0.045

- **Connection bolts according to ISO 898 in quality 6.8:**

Yield point 480 N/mm²

Ultimate stress for shearing 320 N/mm²

Ultimate stress for bearing against mild steel up to 16 mm 470 N/mm²

against H up to 16 mm 690 N/mm²

against H above 16 mm 650 N/mm²

g. MINIMUM SIZES

Stub members thickness 6mm

All other member thickness 4 mm

Gusset plate thickness 5 mm

Minimum bolt diameter 12 mm

The diameter of the corresponding hole shall be 1.5 mm greater.

Minimum flange size for bolts

M12	40 mm
M16	45 mm
M20	55 mm
M24	65 mm

Minimum end distance in direction of the force

	legs and cross arm tension members	other members
M12	25 mm	20 mm
M16	30 mm	25 mm
M20	35 mm	30 mm
M24	45 mm	40 mm

Minimum edge distance perpendicular to the direction of the force

M12	15 mm
M16	20 mm
M20	25 mm
M24	30 mm

Minimum distance hole to hole

M12	30 mm
M16	40 mm

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M20 50 mm

M24 60 mm

h. GALVANISING

According to ISO 1461, coatings in the form of extracts from chapter 6:
For section and plates (A zinc mass of 610g/m² is equivalent to zinc thickness of 85µm).

Table 2 — Coating minimum thicknesses on samples that are not centrifuged

Article and its thickness	Local coating thickness (minimum)[a] µm	Mean coating thickness (minimum)[b] µm
Steel ≥ 6 mm	70	85
Steel ≥ 3 mm to < 6 mm	55	70

For bolts (A zinc mass of 305g/m² is equivalent to zinc thickness of 43µm).

Table 3 — Coating minimum thicknesses on samples that are centrifuged

Article and its thickness	Local coating thickness (minimum)[a] µm	Mean coating thickness (minimum)[b] µm
Article with threads:		
≥ 20 mm diameter	45	55
≥ 6 mm to < 20 mm diameter	35	45
< 6 mm diameter	20	25

i. PROPERTIES OF SECTIONS TO BE USED

Table - 3

No.		b (mm)	b (mm)	t (mm)	A (cm^2)	i.min (cm)	i.x (cm)	i.y (cm)	b/t (-)	e (cm)	Wx (cm^3)	maxd (mm)	r (mm)
1	L	40	40	4	3.086	0.79	1.22	1.22	7.75	1.13	1.60	12	5.0
2	L	45	45	4	3.486	0.89	1.38	1.38	9.00	1.26	2.05	16	5.0
3	L	40	40	5	3.792	0.78	1.21	1.21	6.00	1.17	1.96	12	5.0
4	L	50	50	4	3.897	0.99	1.54	1.54	10.13	1.38	2.56	16	5.5
5	L	45	45	5	4.292	0.88	1.37	1.37	7.00	1.30	2.51	16	5.0
6	L	56	56	4	4.390	1.11	1.73	1.73	11.50	1.53	3.24	16	6.0
7	L	50	50	5	4.803	0.98	1.53	1.53	7.90	1.42	3.13	16	5.5
8	L	56	56	5	5.415	1.10	1.72	1.72	9.00	1.57	3.97	16	6.0
9	L	50	50	6	5.688	0.98	1.51	1.51	6.50	1.46	3.68	16	5.0
10	L	63	63	5	6.143	1.25	1.94	1.94	10.20	1.74	5.08	20	7.0
11	L	70	70	5	6.875	1.39	2.16	2.16	11.40	1.91	6.32	24	8.0
12	L	63	63	6	7.288	1.24	1.93	1.93	8.33	1.78	6.00	20	7.0
13	L	75	75	5	7.412	1.50	2.32	2.32	12.20	2.03	7.30	24	9.0
14	L	70	70	6	8.160	1.38	2.15	2.15	9.33	1.95	7.48	24	8.0

15	L	75	75	6	8.797	1.49	2.31	2.31	10.00	2.07	8.63	24	9.0
16	L	80	80	6	9.397	1.59	2.47	2.47	10.83	2.19	9.87	24	9.0
17	L	90	90	6	10.637	1.80	2.79	2.79	12.33	2.44	12.61	24	10.0
18	L	80	80	7	10.860	1.58	2.46	2.46	9.14	2.23	11.37	24	9.0
19	L	75	75	8	11.503	1.47	2.28	2.28	7.25	2.15	11.20	24	9.0
20	L	80	80	8	12.303	1.57	2.44	2.44	7.88	2.27	12.83	24	9.0
21	L	90	90	7	12.301	1.78	2.78	2.78	10.43	2.48	14.54	24	10.0
22	L	100	100	7	13.796	1.99	3.09	3.09	11.86	2.71	18.10	24	10.0
23	L	90	90	8	13.944	1.78	2.76	2.76	9.00	2.52	16.42	24	10.0
24	L	110	110	7	15.196	2.20	3.41	3.41	13.00	2.96	22.05	24	12.0
25	L	100	100	8	15.639	1.98	3.08	3.08	10.25	2.76	20.47	24	10.0
26	L	110	110	8	17.239	2.19	3.40	3.40	11.25	3.10	24.95	24	12.0
27	L	100	100	10	19.261	1.96	3.05	3.05	8.00	2.84	25.06	24	10.0
28	L	125	125	8	19.750	2.50	3.88	3.88	12.88	3.37	32.52	24	14.0
29	L	110	110	10	21.261	2.17	3.38	3.38	8.80	3.10	30.60	24	12.0
30	L	125	125	10	24.373	2.48	3.85	3.85	10.10	3.45	39.97	24	14.0
31	L	140	140	10	27.373	2.78	4.34	4.34	11.60	3.82	50.58	24	14.0
32	L	125	125	12	28.912	2.46	3.83	3.83	8.25	3.53	47.17	24	14.0
33	L	160	160	10	31.502	3.20	4.97	4.97	13.40	4.31	66.70	24	16.0
34	L	140	140	12	32.512	2.77	4.31	4.31	9.50	3.90	59.80	24	14.0
35	L	140	140	14	37.567	2.75	4.28	4.28	8.00	3.98	68.75	24	14.0
36	L	160	160	12	37.441	3.18	4.95	4.95	11.00	4.39	78.98	24	16.0
37	L	180	180	12	42.241	3.58	5.59	5.59	12.67	4.89	100.82	24	16.0
38	L	160	160	14	43.296	3.16	4.92	4.92	9.29	4.47	90.95	24	16.0
39	L	160	160	16	49.067	3.14	4.89	4.89	8.00	4.55	102.63	24	16.0
40	L	180	180	14	48.896	3.57	5.57	5.57	10.71	4.97	116.25	24	16.0
41	L	200	200	14	54.642	3.98	6.20	6.20	12.00	5.46	144.70	24	18.0
42	L	180	180	16	55.467	3.55	5.54	5.54	9.25	5.05	131.35	24	16.0
43	L	180	180	18	61.955	3.53	5.51	5.51	8.11	5.13	146.11	24	16.0
44	L	200	200	16	62.013	3.96	6.18	6.18	10.38	5.54	163.65	24	18.0
45	L	200	200	18	69.301	3.94	6.15	6.15	9.11	5.62	182.22	24	18.0
46	L	200	200	20	76.505	3.93	6.12	6.12	8.10	5.69	200.42	24	18.0
47	L	200	200	24	90.661	3.90	6.07	6.07	6.58	5.84	235.78	24	18.0

L40x4, L40x5, L45x4, L45x5, L50x4, L50x5, L50x6, L56x4 & L56x5 are available in mild steel only. All other sections in both steel grades.

NTEC DOCUMENTS