

SECTION – III

TECHNICAL SPECIFICATIONS

FOR

TRANSMISSION LINE TOWERS

SECTION-III

DETAILED TECHNICAL SPECIFICATIONS FOR TRANSMISSION LINE TOWERS

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SECTION-III

DETAILED TECHNICAL SPECIFICATIONS FOR

TRANSMISSION LINE TOWERS

1.00 SCOPE:

This specification covers the preparation of fabrication/shop drawings, fabrication, galvanizing, Supply and delivery to site of power transmission line supporting structures (towers) including the supply of galvanised bolts and nuts, washers and tower accessories. The scope also covers design of any other types of towers required and their respective foundations, which shall be suitable for towers being supplied. It may be necessary at certain points to strengthen the cross arm and to provide leg extensions suitable for the towers being supplied to take care of increased weight span and to minimize the tower protection works. The successful bidder has to design strengthening of cross arms and leg extensions and to fabricate and supply these tower parts.

2.00 APPLICABLE STANDARDS:

Notwithstanding anything contained in the succeeding clauses the fabrication, galvanising and supply of towers and tower accessories shall conform to the following Bureau of Indian Standard Specifications (BIS or IS) with their latest amendments thereof:

<u>IS- Number</u>	<u>Particulars</u>
IS 209	Zinc
IS 278	Specifications for Barbed wires.
IS 388	Course and fine aggregates from natural sources and concrete
IS 432	Mild steel and medium tensile bars and

	hard drawn steel wire for concrete reinforcement
IS 456	Code of practice for plain and reinforced concrete.
IS 800	Code of practice for use of structural steel in building construction
IS 802 (Part-1/Sec-1) – 1995, 2015	Use of structural steel in overhead transmission line towers – Material & Loads (Materials, Loads and Design Strength)
IS 802 (Part-1/Sec-2) – 1992, 2015	Use of structural steel in overhead transmission line towers – Design Strength (Materials, Loads and Design Strength)
IS 802 (Part-2) – 1977	Fabrication, Galvanizing, Inspection and Packing
IS 802 (Part-3) – 1978	Proto type Tower Testing
IS 808 – 1989	Dimensions for rolled steels, beams, columns, channel and angle sections
IS 1239 – 1968–Part-I	Mild Steel Tubes
IS 1363 (Part – 3) – 1992	Hexagonal head bolts, screws and nuts of product grade C.
IS 1367 (Part – 6) – 1980	Mechanical properties and test methods for nuts with specified loads
IS 1367 (Part – 13) – 1985	Hot dip galvanized coatings on threaded fasteners
IS 1573 – 1986	Electroplated coatings of Zinc on iron and steel
IS 1730 – 1989	Dimensions for steel plates, sheets strips and flats
<u>IS-Number</u>	<u>Particulars</u>
IS 2629	Recommended practice for hot dip galvanizing of steel & iron
IS 2062 – 1992	Steel for general structural purposes
IS 2551 – 1982	Danger Notice Plates
IS 2633 – 1972	Methods of testing of uniformity of Zinc coating on Zinc coated articles
IS 3043	Code of practice for earthing
IS 3063 – 1972	Single coil rectangular section spring

	washers for bolts, nuts and screws
IS 3757 – 1985	High strength structural bolts
IS 4000 – 1992	Code of practice for high strength bolts in steel structures
IS 4091	Code of practice for design and construction of foundation, For transmission line towers.
IS 4759 – 1984	Hot dip zinc coatings on structural steel and other allied products
IS 5358	Hot dip galvanized coating on fasteners.
IS 5613 (Part-2/Sec-I) –1985	Code of practice for design installation and maintenance of overhead lines (Part-2 – Lines above 11 kV and up to and including 220 kV)
IS 5624 – 1970	Foundation bolts
IS 6610 – 1972	Heavy washers for steel structures
IS 6623 – 1985	High strength structural nuts (first revision)
IS 6639 – 1972	Hexagonal bolts for steel structures
IS 6649 – 1983	Hardened and tempered washers for high strength structural bolts and nuts (first revision)
IS 6745	Method determination of weight of zinc coating Of zinc coated iron and steel articles
IS 8500 – 1992	Structural steel – Micro-alloyed (Medium and high strength qualities) (First revision)
IS 10238 – 1982	Step bolts for steel structures
IS 12427 – 1988	Transmission line tower bolts

Reference /Abbreviation	Name and address from which the standards are available
IS	BUREAU OF INDIAN STANDARDS, Manak Bhavan, New Delhi, INDIA.

CSA	CANADIAN STANDARDS ASSOCIATION 178,Rexdale Boulevard Ontario CANADA
BS	BRITISH STANDARDS British Standard Institution Pentonville Road U.K.
DIN	DEUTSCHES INSTITUTE FIIR NOR Gurggarafenstrasse 4-10 Post Fach 1107 BERLIN-30
CEA	Central Electricity Authority, Sewa Bhawan, Rama Krishna Puram, Sector-1, New Delhi- 110066.

2.3 **SERVICE CONDITIONS:**

The towers covered under this contract are to be used entirely in the State of Karnataka and shall be suitable for the tropical climatic conditions prevailing in the area as listed below.

2.3.1 **TEMPERATURE:**

- a. Peak ambient day temperature in still air....40° C
- b. Minimum night temperature....10° C
- c. Average ambient day temperature between
February – June.....40° C
June – January.....30° C

2.3.2 **RELATIVE HUMIDITY:**

- a. Maximum - 90%
- b. Minimum - 10%

2.3.3 Average rainfall - As per the recent published Meteorological data

2.3.4 Average No. of rainy days - 150 between April and November.

2.3.5 Average No. of thunder storm days per year - 50 days between April and October.

- 2.3.6 Altitude - Varying from 100 to 1000 M above MSL.
- a) Nominal system voltage KV rms - 220KV/110KV/66KV
 - b) Highest system voltage KV rms - 245KV/123KV/72.5KV
 - c) Normal span meters - 320M /320M/275M
 - d) Wind span meters. - Same Normal Span
 - e) Maximum Weight span (meters) - 2 times Normal span
 - f) System of grounding - Effectively solidly earthed.
 - g) Basic insulation level KV Peak - 1050
 - h) Protective shielding angle - 30°
 - i) Power Conductor - ACSR Drake/Lynx/Coyote
 - j) Ground wire/OPGW - 7/3.15mm/ 24 fibre (DWSM)
 - k) Disc /Long rod Insulators - 255x145mm (90KN)
255x145mm (120KN)

	No. of insulators	Weight of string	
		Max	Min
a. Suspension	13/7/4 x 90KN	260/150/100	130/75/50
b. Tension	15/8/5 x 120KN & 90KN	300/160/120	150/80/60

3.0 STATUTORY REQUIREMENTS:

In accordance with clauses 3.1 & 3.2 of IS 802(Part-1/Sec-1) -1995 & 2015.

4.00 MATERIALS:

4.1 Structural Steel:

The structural steel to be used shall be in accordance with clauses 5.1 and 5.1.1 of IS 802 (Part-1/Sec-1) 1995/2015, that is steel conforming to IS 2062:1992, Grade-A designated Fe 410WA and Fe 490 IS 8500-1991-Fe490/490B.

4.2 Bolts:

In accordance with sub-clauses 5.2.1 to 5.2.4 of IS 802 (Part-1/Sec-1) – 1995/2015, only 16 mm etc, dia. bolts shall be used for the entire tower assembly as per Bill of Materials.

Bolts for Tower connections shall confirm to IS 12427

Foundation Bolts shall confirm to IS 5624

Step Bolts shall confirm to IS 10238

4.3 **Nuts:**

In accordance with sub-clauses 5.3.1 to 5.3.2 of IS 802 (Part-1/Sec-1) – 1995/2015.

Nuts shall conform to IS 14394. The mechanical properties shall conform to property Class 5 or Class 8 as the case may be.

4.4 **Washers:**

In accordance with sub-clauses 5.4.1 to 5.4.2 of IS 802 (Part-1/Sec-1)- 1995/2015.

Washers shall confirm to IS 2016

Spring washers shall confirm to Type B of IS 3063

Heavy washers shall confirm to IS 6610

Washers with high strength bolts & nuts shall confirm to IS 6649.

4.5 **Galvanisation:**

In accordance with sub-clauses 5.5.1 to 5.5.3 of IS 802 (Part-1/Sec-1) – 1995/2015.

4.6 **Other Materials:**

The other materials to be used in the construction and erection of the tower are the tower accessories such as number plates, circuit plates, phase plates, danger boards, earthing materials, anti-climbing devices. These are detailed separately under supply of tower accessories.

5.00 **TOWER DESIGNS:**

No fresh tower designs are required for 220kV, 110KV, 66KV D/C & MC and the same shall be fabricated and supplied as per the Structural Drawing and BOM of all types of structures to be furnished to the successful bidder.

Based on the Structural drawings of 220kV, 110KV & 66KV D/C & MC towers furnished to the successful Bidder, the fabrication drawings/shop drawings of each type of tower shall be prepared by the successful bidder and he shall make the proto type assemblies based on this for inspection and approval of the purchaser. The mass fabrication shall be taken only after approval of proto is obtained.

However, in case, other types of towers or extension pieces are required other than the ones furnished to the successful Bidder, the successful Bidder shall prepare the designs of such towers/extension pieces in accordance with the latest IS 802 and supply the same after preparing the fabrication/shop drawings.

The following are the weights of each type of structures and the various sizes of steel angle section are:

The Technical Parameters of the tower are tabulated below.

Technical Details of 220KV M/C Tower:

Conductor & ground wire used	ACSR "DRAKE"	7/3.15mm GW
Normal span in M	320	320
Wind Span in M	320	320
Weight Span in M (NC)		
a) Max	480	480
b) Min.	-480	-480
Maximum Sag in M	7.6	5.6
Tension at 320 C, Still air in kg	3544	1090
Max. Dgn. Tension at 320 C, FW (kg)	7168	2700
Maximum Temp in deg.C	75	53
Design wind pressure (kg/sq.m)	160	199

BASE WIDTH OF THE NORMAL TOWER TYPE KPTCL-2M-DGM:

The 'Back to Back' width of the tower at Plinth Levels is:

Particulars	'A' type	'B' type	'C' type	'D' type
Base width of the Normal tower in M.	6.0	9.0	-	11.0

The weight of Normal Tower, Extension pieces and the summary of steel sections adopted for each type of tower are tabulated as follows:

I. 220kV MULTI - CIRCUIT TOWER TYPE "MA" (Weight in MT)

a) NORMAL TOWER.

Sl. No.	Section	MS	HT	Total
1	150X150X12	0	2.378	2.378
2	130X130X12	0.489	0.652	1.141
3	110X110X10	0.457	0	0.457
4	100X100X10	0.095	0	0.095
5	100X100X8	0.017	0	0.017
6	90X90X6	0.201	0	0.201
7	65X65X6	0.363	0	0.363

8	65X65X5	0.756	0	0.756
9	60X60X4	0.755	0	0.755
10	55X55X5	0.004	0	0.004
11	55X55X4	0.192	0	0.192
12	50X50X4	0.532	0	0.532
13	45X45X4	1.062	0	1.062
14	45X30X4	0.439	0	0.439
15	10mm plates	0.129	0	0.129
16	8mm plates	0.076	0	0.076
17	6mm plates	0.243	0	0.243
18	50X6mm flat	0.006	0	0.006
	TOTAL	5.8106	3.03	8.846

b) +3M Extension Only

Sl. No.	Section	MS	HT	Total
1	150X150X12	0	0.33	0.33
2	130X130X12	0	0.04	0.04
3	60X60X4	0.13	0	0.13
4	50X50X4	0.054	0	0.054
5	45X45X4	0.044	0	0.044
6	45X30X4	0.107	0	0.107
7	8mm plates	0.024	0	0.024
8	6mm plates	0.006	0	0.006
	TOTAL	0.365	0.37	0.735

c) +6M Extension Only

Sl. No.	Section	MS	HT	Total
1	150X150X12	0	0.662	0.662
2	130X130X12	0	0.04	0.04
3	60X60X4	0.205	0	0.205
4	55X55X4	0.005	0	0.005
5	50X50X4	0.072	0	0.072
6	45X45X4	0.611	0	0.611
7	8mm plates	0.024	0	0.024
8	6mm plates	0.045	0	0.045
	TOTAL	0.962	0.702	1.664

220kV MULTI -CIRCUIT TOWER TYPE "MB"
(Weight in MT)

a) NORMAL TOWER

Sl. No.	Section	MS	HT	Total
1	150X150X16	0.745	3.499	4.244
2	150X150X12	0.677	0	0.677
3	130X130x10	0.418	0.168	0.586
4	100X100X8	0.121	0	0.121
5	100X100X7	0.963	0	0.963
6	90X90X7	0.558	0	0.558
7	90X90X6	2.144	0	2.144
8	80X80X6	1.274	0	1.274
9	75X75X6	0.265	0	0.265
10	75X75X5	0.344	0	0.344
11	65X65X6	0.221	0	0.221

12	65X65X5	0.89	0	0.89
13	60X60X5	0.065	0	0.065
14	60X60X4	0.086	0	0.086
15	55X55X4	0.075	0	0.075
16	50X50X4	0.517	0	0.517
17	45X45X4	1.03	0	1.03
18	45X30X4	0.428	0	0.428
19	12mm plates	0.219	0	0.219
20	8mm plates	0.242	0	0.242
21	6mm plates	0.282	0	0.282
22	4mm plates	0.005	0	0.005
23	5mm plates	0.005	0	0.005
24	2mm plates	0.001	0	0.001
TOTAL		11.575	3.667	15.242

b) +3M Extension Only

Sl. No.	Section	MS	HT	Total
1	150X150X16	0	0.44	0.44
2	130X130X10	0	0.028	0.028
3	90X90X6	0.191	0	0.191
4	80X80X6	0.17	0	0.17
5	75X75X6	0.284	0	0.284
6	65X65X6	0.105	0	0.105
7	65X65X5	0.19	0	0.19
8	60X60X5	0.005	0	0.005
9	45X45X4	0.166	0	0.166
10	45X30X4	0.02	0	0.02
11	12mm plates	0.038	0	0.038
12	8mm plates	0.021	0	0.021
13	6mm plates	0.005	0	0.005
14	50X5 flat	0.008	0	0.008
TOTAL		1.203	0.468	1.671

c) +6M Extension Only.

Sl. No.	Section	MS	HT	Total
1	150X150X16	0	0.883	0.883
2	130X130X10	0	0.029	0.029
3	90X90X6	0.268	0	0.268
4	80X80X6	0.239	0	0.239
5	75X75X6	0.137	0	0.137

6	65X65X6	0.105	0	0.105
7	65X65X5	0.188	0	0.188
8	60X60X5	0.201	0	0.201
9	55X55X4	0.088	0	0.088
10	50X50X4	0.22	0	0.22
11	45X45X4	0.203	0	0.203
12	45X30X4	0.041	0	0.041
13	12mmplates	0.038	0	0.038
14	8mm plates	0.021	0	0.021
15	6mm plates	0.04	0	0.04
16	5mm plates	0.004	0	0.004
TOTAL		1.793	0.912	2.705

III. 220kV MULTI - CIRCUIT TOWER TYPE "MD "(Weight in MT)

NORMAL TOWER

Sl. No.	Section	MS	HT
1	200X200X20	0	6.16
2	200X200X16	0	1.164
3	150X150X20	0	0.468
4	150X150X16	0	1.012
5	150X150X12	0.37	0
6	130X130X12	0.436	0
7	130X130X10	3.43	0
8	110X110X10	1.924	0
9	110X110X8	0.448	0
10	100X100X10	1.518	0
11	100X100X8	1.286	0
12	100X100X6	0.194	0
13	90X90X8	0.489	0
14	90X90X6	1.418	0
15	80X80X6	0.163	0
16	75X75X6	0.36	0
17	75X75X5	0.037	0
18	70X70X5	0.222	0
19	65X65X6	1.44	0
20	65X65X5	0.223	0
21	60X60X5	0.456	0
22	60X60X4	0.671	0
23	50X50X6	0.089	0

24	50X50X5	0.094	0
25	50X50X4	0.463	0
26	45X45X4	0.7	0
27	45X30X4	0.37	0
28	16mm plates	0.265	0
29	12mm plates	0.522	0
30	10mm plates	0.215	0
31	8mm plates	0.448	0
32	6mm plates	0.1	0
33	5mm plates	0.002	0
34	4mm plates	0.028	0
35	2mm plates	0.001	
	TOTAL	18.382	8.804

b) +3M Extension Only

Sl. No.	Section	MS
1	200X200X20	0
2	200X200X16	0
3	100X100X6	0.66
4	90X90X6	0.238
5	75X75X6	0.2
6	60X60X5	0.064
7	60X60X4	0.112
8	50X50X4	0.147
9	45X30X4	0.024
10	6mm plates	0.025
11	12mm plates	0.09
	TOTAL	1.56

c) +6M Extension Only

Sl. No.	Section	MS
1	200X200X20	0
2	200X200X16	0
3	100X100X8	1.025
4	100X100X6	0.338
5	90X90X6	0.03
6	80X80X6	0.17
7	75X75X6	0.536
8	70X70X5	0.098
9	65X65X5	0.074
10	60X60X6	0.265

11	60X60X5	0.05
12	60X60X4	0.084
13	55X55X4	0.05
14	50X50X4	0.057
15	45X45X4	0.103
16	45X30X4	0.024
17	12mm plates	0.089
18	8mm plates	0.052
19	6mm plates	0.027
20	5mm plates	0.005
	TOTAL	3.077

FOUNDATION DETAILS

Tower Type	Type of Soil	Earth exvn.	M10	M15	Steel
		Cmtr	Cmtr	Cmtr	Kgs
MA+0M, +3M, +6M	DFR	98.1	1.8	14.95	1608
	PS	236.20	2.82	20.24	2057
	FS	236	2.82	20.24	2059
	WS	191.84	2.24	17.16	1887
MB+0M, +3M, +6M	DFR	190.86	3.2	35.5	3602
	PS	520.94	6.73	61.06	6167
	FS	520.9	6.73	61.06	6167
	WS	400.71	5.10	47.96	4916
MD+0M, +3M, +6M	DFR	273	5.0	46.1	6190
	WFR	637.11	10.36	95.60	9930
	FS	767.37	9.8	106.3	8815
	WBC	933.15	12.0	145.96	11226

5.0.2 220KV D/C NARROW BASED TOWERS:

No fresh design of 220KV D/C Narrow base tower suitable for ACSR Drake/AAAC Moose is envisaged.

The design of 220kv D/C towers suitable for ACSR Drake/AAAC Moose with 200M normal span are available with KPTCL. The 'structural drawings' along with the 'bill of materials' of normal tower and body extension pieces pertaining to Narrow Based Towers will be furnished to the successful bidder. The following are the design parameters of the tower.

DESIGN PARAMETERS.

Technical Details of 220 kV D/C Narrow Base Tower of Type: KPTCL-2D-NB-HAL

Conductor & ground wire used	AAAC “MOOSE”	7/3.15mm GW
Normal span in M	200	200
Wind Span in M	200	200
Weight Span in M (NC)		
a) Max	300	300
b) Min.	-300	-300
Maximum Sag in M	6.6	2.21
Tension at 320 C, Still air in kg	1607	1142
Max. Design Tension at 32deg C, FW (kg)	3005	1736
Maximum Temp in 75deg.C	85	53
Design wind pressure (kg/sq.m)	96	119

BASE WIDTH OF THE NORMAL TOWER TYPE:

The ‘Back to Back’ width of the tower at Plinth Level is

Particulars	‘A’ type	‘B’ type	‘C’ type	‘D’ type
Base width of the Normal tower in M.	3.0	3.5	3.8	3.9

The weight of Normal Tower, Extension pieces and the summary of steel sections adopted for each type of tower are tabulated as follows:

Section summary of weights for 220KV D/C Narrow based towers

Sl. No.	Section	Type of tower							
		NB-DA (Wt. In Kg)		NB-DB (Wt. In Kg)		NB-DC (Wt. In Kg)		NB-DD (Wt. In Kg)	
		HT	MS	HT	MS	HT	MS	HT	MS
Stub									
1	150x150x20H	0		0		0	0	764	0
2	150x150x15H	0		0		580	0	0	0

3	150x150x12H	0		438		0	0	0	0
4	100x100x6H	0		60		64	0	92	0
5	100x100x10H	237		0		0	0	0	0
6	70x70x5H	32		0		0	0	0	0
	Total	269		498		644		856	
NORMAL TOWER									
1	45x45x4	0	128 1	0	701		928	0	1100
2	45x45x5	0	0	0	11		17	0	0
3	50x50x4	0	169	0	44		63	0	102
4	50x50x5	0	169	0	0		0	0	0
5	55x55x4	0	47	0	68		51	0	40
6	55x55x5	0	65	0	0		0	0	0
7	60x60x4	0	17	0	46		222	0	29
8	60x60x5	0	146	0	428		86	0	16
9	65x65x4	0	11	0	216		56	0	0
10	65x65x5	0	0	0	324		214	0	18
11	70X70x5	0	0	0	249		26	0	432
12	70X70x6	0	0	0	66		66	0	0
13	75X75x5	0	9	0	235		71	0	114
14	75X75x6	0	0	0	141		15	0	273
15	80X80x6	0	0	0	17		0	0	151
16	90X90x6	0	0	0	0	0	0	0	93
17	100X100x6	0	0	0	0	0	0	0	106
18	45x45x4H	82	0	122	0	35	0	30	0
19	55x55x5H	4	0	0	0	0	0	0	0
20	55x55x4H	0		0	0	0	0	0	27
21	50x50x4H	0	0	0	0	35	0	66	0
22	50x50x5H	0	0	0	0	181	0	0	0
23	60x60x4H	0	0	0	0	83	0	0	0
24	60x60x5H	66	0	0	0	62	0	57	0
25	65x65x4H	0	0	0	0	110	0	0	0
26	65x65x5H	5	0	111	0	0	0	127	0
27	70X70x5H	133	0	0	0	357	0	195	0
28	70X70x6H	0	0	135	0	129	0	531	0
29	75X75x5H	6	0	81	0	246	0	0	0
30	75X75x6H	0	0	197	0	155	0	118	0
31	80x80x6H	0	0	0	0	155	0	594	0
32	90x90x6H	39	0	10	0	0	0	0	0
33	90x90x7H	195	0	0	0	0	0	215	0
34	100X100X6H		0	12	0	11	0	0	0
35	100X100X7H	236	0	0	0	143	0	0	0

36	100X100X8H	286	0	270	0	15	0	17	0
37	110X110X8H	0	0	19	0	36	0	0	0
38	100X100X10H	468	0	236	0	222	0	0	0
39	130X130X10H	0	0	453	0	58	0	468	0
40	130X130X12H	0	0	545	0	754	0	0	0
41	150X150X12H	0	0	360	0	591	0	683	0
42	150X150X15H	0	0	0	0	439	0	460	0
43	150X150X18H					0		134 1	0
44	2mm plate	0	2	0	4	0	2	0	5
45	3mm plate	0	0	0	0	0	7	0	8
46	6mm plate	0	70	0	236	0	136	0	78
47	8mm plate					0	6	0	67
48	6mm plate H	68	0	23	0	0	104	0	145
49	8mm plate H	0	58	65	0	0	54	0	17
50	10mm plate H	0	0	3	0	0	60	0	160
51	12mm plate H	0	0	43	0	0	42	0	52
	Total	1588	2044	2685	2786	3817	2326	4902	3033
STUB SETTING TEMPLATE									
1	130x130x10		0		0		62		62
	110x110x10		25		50		0		0
	90x90x6		25		0		0		0
2	70X70x5		158		181		197		204
	60X60x4		0		0		0		42
	55X55x4		0		65		36		0
	50X50x4		0		0		31		32
3	45x45x5		128		0		0		0
	45x45x4				94		96		98
	Total		311		390		422		438
+3 M BODY EXTENSION									
1	150X150X20H	0	0	0	0	0	0	529	0
2	150X150X15H	0	0	0	0	406	0	0	0
3	150X150X12H	0	0	328	0	0	0	50	0
4	130X130X10H	0	0	0	0	29	0	0	0
5	110X110X10H	0	0	26	0	0	0	0	0
6	100X100X10H	179	0	0	0	0	0	0	0
7	90x90x6H	9	0	0	0	0	0	0	0
8	70x70x5H	0	0	0	0	0	0	107	0
9	65x65x4H	0	0	0	0	78	0	81	0
10	45x45x4H	0	0	0	0	15	0	0	0
11	65x65x5	0	0	0	92	0	0	0	0
12	60x60x4	0	0	0	70	0	72	0	0

13	50x50x4							0	62
14	45x45x4	0	195	0	84	0	136	0	134
15	45x45x4 Flat	0	0	0	1	0	1	0	0
16	6mm thk	10	0	0	13	0	13	0	22
17	6mm thk H	0	0	0	0	0	0	17	0
18	8mm thk H	0	0	25	0	0	0	0	0
19	10mm thk H	0	0	0	0	30	0	0	0
20	12mm thk H	0	0	0		0	0	52	0
	Total	198	195	379	260	558	222	836	218
+6 M BODY EXTENSION									
1	150X150X20H	0	0	0	0	0	0	106 0	0
2	150X150X15H	0	0	0	0	812	0	0	0
3	150X150X12H	0	0	656	0	0	0	50	0
4	130X130X10H	0	0	0	0	59	0	0	0
5	100X100X10H	358	0	26	0	0	0	0	0
6	90x90x6H	18	0	0	0	0	0	0	0
7	75x75x6H	0	0	0	0	0	0	205	0
8	70x70x5H	0	0	0	0	0	0	159	0
9	65x65x4H	0	0	0	0	78	0	0	0
10	45x45x4H					15	0	0	0
11	65x65x5	0	0	0	92	0	0	0	0
12	65x65x4	0	0	0	79	0	83	0	0
13	60x60x5	0	0	0	89	0	0	0	0
14	60x60x4	0	0	0	69	0	149	0	49
15	50x50x4	0	0	0	37	0	33	0	46
16	45x45x5	0	0	0	0	0	0	0	0
17	45x45x4	0	396	0	159	0	264	0	359
18	45x45x4 Flat	0	0	0	1	0	1	0	0
19	6mm thk	0	0	0	19	0	35	0	29
20	6mm thk H	20	0	0	0	0	0	21	0
21	8mm thk H	0	0	25	0	0	0	0	0
22	10mm thk H	0	0	0	0	61	0	0	0
23	12mm thk H	0	0	0	0	0	0	52	0
	Total	396	396	707	545	1025	565	1547	483

FOUNDATION DETAILS

Soil Classification		M10	M15	Steel
Tower Type	DFR	Cmtr	Cmtr	Kgs
DA+0M, +3M, +6M	110	1.74	22.94	1148
DB+0M, +3M	136	2.11	28.55	1483
DB+6M	154	2.38	31.32	1533
DC+0M, +3M, +6M	214	3	40	2060
DD+0M, +3M, +6M	235	3.28	51.8	2777

5.0.3

I. 220 kV DC Tower and Extensions of tower type KPTCL-2D-GDG:

Sl. No		220 kV DC 'DA'		220 kV DC 'DB'		220 kV DC 'DC'		220 kV DC 'DD'	
		Tower weight in Kgs	B & N	Tower weight in Kgs	B & N	Tower weight in Kgs	B & N	Tower weight in Kgs	B & N
1	Normal	3245.00	118.00	4678.00	139.00	5786.00	196.00	7264.00	257.00
2	+ 3 Mtr	514.00	17.00	840.00	24.00	1211.00	41.00	1513.00	53.00
3	+ 6 Mtr	976.00	33.00	1427.00	42.00	1708.00	58.00	2462.00	87.00
4	Stub	133.00	1.00	252.00	2.00	301.00	3.00	425.00	3.00
5	Steel section used mm	100x100x7 100x100x6 90x90x6 80x80x6 65x65x5 70x70x5 50x50x4 55x55x5 55x55x4 45x45x4 45x30x4 60x60x4 65x65x4		110x110x10 100x100x7 110x110x8 100x100x10 70x70x5 90x90x6 80x80x6 75x75x5 65x65x5 60x60x4 60x60x4 55x55x4 45x45x4 50x50x4 45x30x4		130x130x10 110x110x10 110x100x8 75x75x5 70x70x5 80x80x6 100x100x6 65x65x5 65x65x4 60x60x4 75x75x6 55x55x4 90x90x6 50x50x4 75x75x6 45x45x4 45x30x4		150x150x12 130x130x10 110x110x8 90x90x8 90x90x6 75x75x5 70x70x5 65x65x5 55x55x4 50x50x4 45x45x4	

II 110 kV MC Tower and Extensions of tower type KPTCL-1M-CPRI:

Sl. No.		110 kV MC 'MA'		110 kV MC 'MC'		110 kV MC 'MD'	
		Tower weight in Kgs	B & N	Tower weight in Kgs	B & N	Tower weight in Kgs	B & N

1	Normal	6901	317	12402	435	17280	512
2	+ 3 Mtr	864	33	1543	45	2013	50
3	+ 6 Mtr	1737	68	2900	96	3750	105
4	+9 Mtr	1761	67	3008	96	3888	105
5	Stub	362		820		1039	
6	Steel section used mm	130x130x12 130x130x10 110x110x10 110x110x8 110x110x7 80x80x6 90x90x8 75x75x6 65x65x6 50x50x5 50x50x4 45x45x4 45x45x5 45x30x4 40x40x4 80x80x6 60x60x5 65x65x5 60x60x4		200x200x16 150x150x16 150x150x12 130x130x12 130x130x10 110x110x10 100x100x7 90x90x8 90x90x7 90x90x6 80x80x6 75x75x6 75x75x5 70x70x5 65x65x6 65x65x5 60x60x5 50x50x5 50x50x4 45x45x4 45x45x5		200x200x20 150x150x16 150x150x12 130x130x12 130x130x10 110x110x10 100x100x7 90x90x8 90x90x7 90x90x6 80x80x6 75x75x6 75x75x5 70x70x5 65x65x6 65x65x5 60x60x5 55x55x4 55x55x5 50x50x5 50x50x4 45x45x4 45x45x5	

III. 110kV DC Narrow base tower of type KPTCL-1D-NB

Sl · N o.		110 kV DC 'DA'		110 kV DC 'DC'		110 kV DC 'DD'	
		Tower weight in Kgs	B & N	Tower weight in Kgs	B & N	Tower weight in Kgs	B & N
1	Normal	2793	200	4830	284	6297	163
2	+ 3 Mtr	415	19	773	34	983	23
3	+ 6 Mtr	810	20	1517	45	1921	23
4	+9 Mtr						
5	Stub	200		505		617	
6	Steel section used mm	100x100x10 90x90x6 65x65x6 100x100x8 50x50x6 X45x45x5 6mm plate		150x150x16 100x100x8 130x130x12 110x110x10 90x90x6 75x75x6 65x65x6 50x50x6 75x75x6 45x45x5 16mm plate 12 mm plate 10mm 6mm		150x150x12 100x100x8 150x150x16 150x150x20 130x130x10 90x90x6 65x65x6 80x80x6 75x75x6 50x50x6 45x45x5 20mm plate 16mm plate 10mm plate 8mm plate 6m plate 4mm plate	

IV. 110kV DC tower of type KPTCL-1D-AQS:

Sl. No		110 kV DC 'DA'			110 kV DC 'DB'			110 kV DC 'DC'			110 kV DC 'DD'		
		Tower weight in Kgs		B & N	Tower weight in Kgs		B & N	Tower weight in Kgs		B & N	Tower weight in Kgs		B & N
		HT	MS		HT	MS		HT	MS		HT	MS	
1	NT	942.96	191 ₁	135.45	1587.9	2058.6 ₈	181.35	2044.9	1862.0 ₂	203.6 ₈	2969.89	1649	204.1
2	3 Mtr	169.44	332.88	20.28	257.12	435.08	28.07	310.6 ₈	450.08	31.46	414.24	463.64	32.13
3	6 Mtr	366.24	689.80	40.19	594	849.88	55.87	688.1 ₂	917.8	62.64	861.80	982.68	64.54
5	Stub	147		3.24	210.44		4.86	236.8 ₈		4.86	301.56		6.86
6	Steel section used mm	100x6 HT 90x6 HT 80x6 HT 75x8 HT 70x6 HT 65x6 HT 60x6 HT 65x6 HT 60x6 HT 60x5 HT 65x5 HT 60x6 60x5 55x5 50x6 45x5 5mm plate 6mm plate			110x110x8 HT 100x100x6 HT 90x90x6 HT 45x45x5 HT 50x50x5 HT 60x60x6 HT 65x65x5 HT 70x70x6 HT 90x90x7 HT 75x75x5 70x70x5 65x65x6 60x60x5 55x55x5 50x50x5 45x45x5 12mm plate HT 5mm plate 6mm plate 8mm plate			110x110x8 HT 90x90x6 HT 75x75x5 HT 70x70x6 HT 70x70x5 HT 65x65x6 HT 65x65x5HT 60x60x6 HT 60x60x5 HT 45x45x5 HT 120x120x8 HT 110x110x8 HT 100x100x7 HT 100x100x6 HT 12mm plate HT 16mm plate HT 45x45x5 50x50x5 60x60x5 X65x65x5 70x70x5 6mm plate 8mm plate			110x110x10 HT 110x110x8 HT 120x120x10 HT 100x100x8 HT 100x100x6 HT 70x70x6 HT 70x70x5 HT 75x75x5 HT 80x80x6 HT 65x65x5 HT 60x60x5 HT 45x45x5 HT 65x65x6 HT 6mm plate HT 8mm plate HT 80x80x6 75x75x5 70x70x5 65x65x5 60x60x5 55x55x5 45x45x5 6mm plate 8mm plate 12 mm plate		

V. 66 kV DC Towers & Extensions of type KPTC-6D-NMGL:

No.		66 kV DC 'DA'		66 kV DC 'DB'		66 kV DC 'DC'		66 kV DC 'DD'	
		Tower weight in Kgs	B & N	Tower weight in Kgs	B & N	Tower weight in Kgs	B & N	Tower weight in Kgs	B & N
1	Normal	1224.00	66.00	1478.00	66.00	1738.00	68.00	2327.00	105.00
2	+ 3 Mtr	261.00	12.00	339.00	15.00	368.00	17.00	556.00	25.00
3	+ 6 Mtr	540.00	24.00	732.00	35.00	795.00	36.00	1205.00	54.00
4	Stub	82.00	1.00	102.00	1.00	158.00	2.00	208.00	2.00

5	Steel section used mm	75x75x5 70x70x5 55x55x5 50x50x5 50x50x4 55x55x4 40x40x4 45x45x4 45x30x4	90x90x6 80x80x6 75x75x6 65x65x4 65x65x5 60x60x4 55x55x5 55x55x4 50x50x5 45x45x5 100x100x8 100x100x6 110x60x4 55x55x4 45x30x4 50x50x4 130x130x10 75x75x6 90x90x6 75x75x5	100x100x7 60x60x4 90x90x6 55x55x4 50x50x4 75x75x5 60x60x5 45x45x4 45x30x4		
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IV. **66 kV MC Towers & Extensions of type KPTCL-6M-CPRI:**

Sl. No		66 kV MC 'MA'		66 kV MC 'MC'		66 kV MC 'MD'	
		Tower weight in Kgs	B & N	Tower weight in Kgs	B & N	Tower weight in Kgs	B & N
1	Normal	4178	259	6794	257	8688	356
2	+ 3 Mtr	557	29	1054	31	1317	39
3	+ 6 Mtr	1201	57	2223	68	2664	91
4	+9 Mtr	1295	57	2301	68	2780	95
5	Stub	297		550		712	
6	Steel section used mm	110x110x10 100x100x8 90x90x7 90x90x6 75x75x6 65x65x6 60x60x5 50x50x5 50x50x4 45x45x4 45x45x5		150x150x16 150x150x12 130x130x12 110x110x10 100x100x8 80x80x6 90x90x8 75x75x6 65x65x6 60x60x5 50x50x5 50x50x4 45x45x4 45x45x5		150x150x20 150x150x18 150x150x16 150x150x12 130x130x12 110x110x10 80x80x6 75x75x6 75x75x5 65x65x6 60x60x5 50x50x5 50x50x4 45x45x4 45x45x5 40x40x6	

6.00 TOWER TYPES AND FABRICATION/ERECTION MARK:

- i) Single circuit – A, B, C & D.
- ii) Double circuit – DA, DB, DC, DD.
- iii) Tower types/deviation limit/typical use.

Type of Tower	Deviation Limit	Typical use
A & DA	0° to 2°	To be used as tangent tower
B and DB	0° to 15°	Angle tower with tension insulator string. Tension tower for uplift forces resulting from a uplift span up to 200 Mts. Power line crossing with a suitable body extension. To be used as section tower.
C and DC	15° to 30°	Angle tower with tension insulator. To be used where unbalanced tension results due to unequal ruling span of 200 M and 400 M on each side of the tower. Tension tower for uplift forces due to uplift span.
D and DD	30° to 60°	Complete dead end. To be used for river crossing with longer wind span. Angle tower with tension insulator. Dead-end with 0 to 15deg deviations both on line and substation side (slack span).

NOTE: The above towers may also be used for longer span with smaller angle of deviations.

- iv) Erection Mark – These shall be done on each member with marking dies of 16 mm size before galvanizing and shall be legible after galvanizing. The notation shall be as follows:

A – BB – CC – DDD

A – Owner's Code – Alphabet – K

BB– Contractor's Mark – Number

CC – Tower Type Alphabet

DDD – Mark number – Numerical

- (v) The three phase conductors of the double circuit tower shall be in vertical formation (I, I, I)

7.00 **FABRICATION:**

The details of fabrication of towers shall be in conformity with IS:802 (Part – II) : 1992 & 2016 except to the extent modified herein.

Butt splices shall be used and the inside angle and outside plate shall be so as to transmit the load and the inside cleat angle shall not be less than half the thickness of heavier member connected plus 2 mm. Lap splice may be used for connecting members of unequal size. The inside angle of lap splice shall be rounded at the heel to fit the fillet of the outside angle. All splices shall develop full stress in the members connected through bolts. Butt as well as lap splice shall be made as close to the main panel point as possible.

Joints shall be so arranged as to avoid eccentricity as far as possible. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where the connections are such that the elimination of the gusset plates would result in eccentric joints or where more than three members are joining at a particular point, gusset plates and spacer plates may be used in conformity with modern practices. The thickness of the gusset plates, required to transmit stress, shall not be less than that of members connected.

The use of filler in connection shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate where necessary to avoid the use of filler and it shall be connected at the point of inter-section by one or more bolts.

The tower structures shall be accurately fabricated to bolt together easily at site without any undue strain on the bolts.

No angle member shall have the two leg flanges brought together by closing the angle.

The structure shall be such that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depressions are likely to hold water.

All similar parts shall be made strictly interchangeable. All steel sections before any work is done on them, shall be carefully levelled, straightened and made true to detailed drawings, by methods which will not injure the materials so that when assembled the adjacent matching surfaces are in close contact throughout. No rough edges shall be permitted in the entire structure.

8.00 DRILLING AND PUNCHING:

Before any cutting work is started, all steel sections shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.

Holes for bolts shall be drilled or punched with a jig but drilled holes shall be preferred. The following maximum tolerance of accuracy of punched holes is permissible.

- a) Holes must be perfectly circular and no tolerance in this respect is permissible.
- b) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8-mm i.e., the allowable taper in punched holes should not exceed 0.8 mm on diameter.

All burrs left by drills or punch shall be removed completely. When the tower members are in position the holes shall be truly opposite to each

other. Drilling or reaming to enlarge defective holes shall not be permitted.

The strain plate holes shall be chamfered properly and sharp edges removed.

9.00 GALVANISING:

Fully galvanised towers and stubs galvanised from the top up to 300 mm below ground level shall be used for the lines. Galvanising of the member of the towers shall conform to IS: 2629-1985 and IS: 4759-1996. All galvanised members shall withstand tests as per IS: 2633-1986. For fasteners, the galvanising shall be done after all fabrication work is completed, except that the nuts may be tapped or re-run after galvanising. Spring washers shall be electro-galvanised as per Grade 4 of IS: 1573-1070.

10.00 FASTENERS: BOLTS, NUTS AND WASHERS:

All bolts and nuts shall conform to IS: 6639 –1972 or IS: 12427 – 2001 as applicable and shall be of approved makes only. All bolts and nuts shall be galvanised and shall have hexagonal heads and nuts. The heads shall be forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight. Bidders shall procure Bolts and nuts from the approved vendor of KPTCL or Power grid.

Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members. All bolts shall be threaded to take the full depth of the nut and threaded enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3 mm and not more than 8 mm when fully

tightened. All nuts shall fit hand tight to the bolt. Threads of bolts and nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of the bolts.

Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be of steel electro-galvanised, positive lock type and as specified in Bill of Materials.

The contractor shall furnish bolt schedules giving thickness of members connected, the nut and the washer, the length of shank, the threaded portion of bolts and sizes of holes and any other detail of this nature.

The bolts shall be of class 5.6 and nuts shall be of property class 5. The ultimate shear stress and bearing stress on bolts shall be 3160 Kg/Sq.cm and ultimate bearing stress shall be as per IS.

To obviate bending stress in bolts or to reduce it to minimum, no bolt shall connect aggregate thickness of more than three (3) times its diameter.

Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.

The minimum bolt spacing and rolled edge distance and sheared edge distances of sections from the centres of bolt holes to be maintained are given in Table below:

Diameter of bolts (mm)	Hole diameter (mm)	Minimum bolt spacing(mm)	Minimum rolled distance (mm)	Minimum sheared edge distance (mm)
16	17.5	40	20	23
12	13.5	32	16	20

11.00 **TOWER ACCESSORIES:**

11.1 **Step Bolt Ladders:**

Each tower shall be provided with step bolts on one of the main legs, of not less than 16 mm diameter and 175 mm long, spaced not more than 450 mm apart and extending from about 3.5 metres above the ground level to the top of the tower. Each step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN and shall be used as a ladder for climbing. The step bolts shall conform to IS 10238 and shall have a hexagonal head.

11.2 **Anti-climbing devices:**

Fully galvanised barbed wire type anti-climbing device shall be provided at a height of approximately 3 metres as an anti-climbing measure. Four layers of barbed wires will be provided each inside and outside the tower in horizontal plane, spacing between the layers being 140 to 150 mm. The angle pieces with 12 mm x 12-mm notches for accommodating barbed wire shall be supplied with the towers along with provision for suitable bolt holes on leg members for fitting the angles. The barbed wire shall conform to IS-378 (1978). The anti-climbing devices shall in general conform to Fig-8 of IS-5613 (Part-II/Sec-I).

11.3 **Insulator strings and ground wire/OPGW clamp attachments:**

- a) For the attachment of suspension insulator strings a suitable swinging hanger on the tower shall be provided so as to obtain requisite clearance under extreme swinging conditions and free swinging of the string. The hanger shall be designed to withstand an ultimate tensile strength of more than 90 KN.
- b) For ground wires at suspension towers suitable 'U' Bolts strong enough to withstand the full designed loads shall be provided to accommodate the hook of the ground wire suspension clamps. For OPGW attachment please refer the technical specification for OPGW.
- c) At tension towers, horizontal strain plates of suitable dimensions on the underside of each power cross-arm tip and at the top ground wire peak shall be provided for taking the 'D' shackles of the tension insulator strings or groundwire tension clamps, as the case may be. For OPGW attachment please refer the technical specification for OPGW

11.4 **Caution Plates, Number Plates, Circuit Plates and Bird Guards:**

Each tower shall be fitted with Number Plates, Caution Plates (Danger Boards), Circuit plates and phase plates. These shall be provided at appropriate level from the ground level (about 2.5 m to 3.5 m from ground level) so that the man standing at the foot ground tower will be able to clearly identify the same. These plates shall be 2 mm thick and vitreous enameled on both back and front.

The letters, figures and the conventional skull and bones on danger plates are in signal red on the front side. On the number plate, the number of the tower location preceded by the letters defining the type of

the tower shall be inscribed. Phase plates shall be coloured red, yellow and blue to indicate the phase of the conductor. The letters on number plates shall be in red against white background. The number plates shall confirm to Fig-5 of IS: 5613 (Part-II/Sec-I). Similarly the plates and circuit plates to Figs. 6 & 7 in the said IS. The danger notice plates shall confirm to IS: 2551. Bird guards shall be of the saw tooth type and confirm to Fig.10 of IS (5613 Part-II/Sec-I).

11.5 **Earth Bonds:**

Earth bonds shall generally conform to drawing No.ECC(P)/MISC. 10 attached hereto and shall be supplied in lengths of 300 mm and 450 mm for use on suspension and tension towers respectively. These earth bonds shall be designed to carry a minimum current of 100 Amps.

11.6 **Earthing:**

Normal and counter poise earthing:

This shall be in accordance with clauses 11.0 and sub-clauses thereof as per IS:5613 Part-2/Sec-2, corresponding to figure 6 and where the desired tower footing resistance cannot be achieved, then it shall be by counter poise earthing corresponding to fig-9 in the said IS.

11.7 **Stub Setting Template:**

Stub setting templates shall be arranged for by the contractor at his own cost for all types of towers with or without extensions.

Stub templates for standard towers and towers with extensions shall be of the adjustable type. All stub templates shall be painted with anti-corrosive paints. The number of stub templates to be fabricated shall be

decided by the contractor to coincide with the approved erection programme.

12.00 **PACKING:**

The material shall be boxed or bundled for transport as per IS 802 (Part-II) – Clause – 11 and sub-clauses thereof. However

- a) Angles shall be packed in bundles securely wrapped four times around at each and every foot with No. weight of any bundle shall not exceed approximately 450 Kg and the length of any individual member not more than 6000 mm.
- b) Cleat angles, brackets, filler plates and similar small loose pieces shall be nested and bolted, together in multiples and securely wired together through holes, wrapped round at least four times with No.9 SWG wire with ends twisted tightly. Gross weight of each bundle shall not exceed approximately 70 Kgs.
- c) The correct number of bolts, nuts and washers plus 10% excess for each tower, extensions, cross arms, attachment to cross arms, etc. shall be packed in heavy gunny bags accurately tagged in accordance with the contents. 4 number of such bags shall be packed in a solid box of 22 mm thick lumbered work with paneled ends securely nailed and further reinforced with 22 mm x 75 mm battens round the sides, at the ends with 25 mm wire No.18 SWG gauge iron band stretched entirely around the battens with ends over lapping at least 150 mm. The gross weight of each box shall not exceed approximately 70 Kgs. All packaging shall be subject to the approval of the owner.

12.01 **Marking of packings:**

Each bundle or package shall have the following markings on it.

- a) The name designation of the consignee.
- b) Ultimate destination as required by the owner.
- c) The relevant marks and number of tower members, or reference number of bolts, nuts and small components like gusset plates, various attachments, etc for easy identification.

The marking shall be stenciled in indelible ink on the top members in the bundles of tower steel and on wooden boxes or gunny bags containing smaller components.

Detailed despatch instructions shall be sought for by the contractor from the owner at least four weeks ahead of the schedule date of despatch.

13.0 TOWER FOUNDATIONS:

No design of foundation is envisaged in the specification for 220kV DC/MC, 110KV DC/MC and 66kV DC/MC towers. Detail foundation drawing for each type of Tower, for all types of soil, will be furnished to the successful bidder, by KPTCL. However, for the purpose of quoting, the foundation quantities per tower are tabulated in Bid Proposal Sheets. Technical specification for design of tower foundations for 66kV DC towers for each type of towers and various type of soils is uploaded separately.

In case of any other type of foundation other than given in the specification is required then the contractor shall design the required foundations and send the same to the owner for approval. The designs shall be in accordance with IS-4091 with latest amendments. The factor of safety to be adopted shall be 2.0 under Broken and conditions 2.5 for normal conditions. The owner will supply the drawings of foundations

for Normal towers, 3M and 6M extension only for which the volumes are indicated in the Bid proposal sheets.

In respect of Black cotton soil, the foundations shall be designed for wet conditions only i.e. for Wet Black cotton soil only. However, for excavations, payment shall be made based on the rates for Normal dry if the soil is dry and based on the rates quoted for wet black cotton soil if the soil is wet.