भारत सरकार/Government of India
विद्युत मंत्रालय/Ministry of Power
केन्द्रीय विद्युत प्राधिकरण/Central Electricity Authority
विद्युत प्रणाली अभियांत्रिकी एवं प्रौद्योगिकी विकास प्रभाग
Power System Engineering & Technology Development Division

दिनांक: 13.09.2024

विषय: **Draft calculation sheet for the report of the Committee for calculation of reduction of Right-Of-Way (ROW) width through technological options**

महोदया/महोदय,

A committee was constituted as per CEA's letter dated 25.07.2023 for calculation of reduction of Right-Of-Way (ROW) width through technological options.

2. The Term of reference of the committee is as under:
   a. Calculation of Right of Way (ROW) Width in case of Insulated Cross Arm Insulators
   b. Calculation of Right of Way (ROW) Width in case of Monopole Towers.
   c. Calculation of Right of Way (ROW) Width in case of HTLS Conductors.

3. Five (5) Numbers of meetings of the committee held dated 23.08.2023, 31.10.2023, 01.03.2024, 15.05.2024 and 13.09.2024, the constitution of the committee is as under:

1.	Chief Engineer (PSE&TD), CEA	Chairperson
2.	Representative of M/s Powergrid	Member
3.	Representative of M/s KPTCL	Member
4.	Representative of M/s Mahatransco	Member
5.	Representative of M/s GETCO	Member
6.	Representative of M/s PTCUL	Member
7.	Representative of M/s DTL	Member
8.	Representative of EPTA	Member
9.	Representative of M/s CTC Global	Member
10.	Representative of M/s Tokyo Rope highway (TRI)	Member
11.	Chief Engineer(CEI), CEA	Member
12.	Chief Engineer(PCD), CEA	Member
13.	Director (PSE&TD), CEA	Member & Convener

4. Ministry of Power (MoP) vide letter no. 3/4/2016-Trans dated 11-08-2016 has constituted committee under the Chairmanship of Ms Shalini Prasad, Additional

Secretary Ministry of Power to analyze the issue relating to RoW for laying of transmission lines in the urban area of the country. The committee finalized its recommendations for payment of compensation towards damages in regard to Right of Way for transmission lines, which was issued by MoP letter dated 15th October, 2015 and the report was finalized (copy attached). In addition to the options available in the report, other technological option i.e. Monopole tower, HTLS conductor and combinations thereof have been identified for which RoW width has been calculated based on the certain assumption which are attached as Annexure-I.

5. In this regard, please find the enclosed draft calculation sheet for the report of the Committee for calculation of reduction of Right-Of-Way (ROW) width through technological options for your inputs/comments by 18.09.2024 at ce-psetd@gov.in.

भवदीय,

13/09/2024

(भंवर सिंह मीना /Bhanwar Singh Meena)

निदेशक/Director

Copy to:

1. JS (Trans.), MoP
2. Chief Engineer (CEI) ,CEA
3. Chief Engineer (PCD), CEA
4. Chief Engineer (PSPA-I/II), CEA
5. Chief Engineer (PSPM), CEA
6. SA to Chairperson, CEA
7. SA to Member (PS), CEA
8.

To:

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Assumptions considered for the calculation of RoW are as following:

(i). RoW for pole structure is calculated for conventional ACSR, CFCC, ACSS, GAP conductors at different voltage levels.

(ii). RoW has been indicated for different insulator string configuration (I, V and tension type Insulator string configuration).

(iii). Swing angle has been fixed at 35 degree.

(iv). For pole structures, X i.e. the maximum horizontal distance of conductor attachment point from center of Pole has been taken as per design and submission of M/s Powergrid.

(v). For lattice structures, X i.e. the maximum horizontal distance of conductor attachment point from center of tower has been taken from MoP's *guidelines for payment of compensation in regard to Right of Way (RoW) for transmission lines in urban areas.*

(vi). The RoW has been defined for Aluminium Conductor Steel Supported (ACSS) conductor at 250 degree Celsius, Carbon Fiber Composite Core (CFCC) conductor at 180 degree Celsius and GZTACSR: Gap-type Aluminium Conductor Steel Reinforced (GAP conductor) conductor at 210 degree Celsius.

(vii). I string drop has been considered from MoP's "*Guidelines For Payment Of Compensation In Regard To Right Of Way (Row) For Transmission Lines In Urban Areas"*

(viii). Sag in meter (m) of Aluminum Conductor Steel Reinforced (ASCR) conductors at different design span for defining RoW widths for Pole structures has been taken from submission of M/s Powergrid.

RIGHT OF WAY CALCULATION FOR NORMAL ROUTE, FOREST AREA, URBAN AREA / POPULATED AREA / APPROACH SECTION NEAR SUBSTATION FOR POLE STRUCTURES with ACSR Conductor

Sno.	Voltage Level	Configuration	Conductor type	Terrain	Design Span(m)	String Type	sag(m)	Suspension Polymer Insulator String Length/ Drop (m)	Horizontal clearance (2.0m+0.3 M for every additional 33 kV or part thereof) (m) (H)	Maximum Horizontal distance of Conductor attachment point from centre of Pole (m) (X)	Horizontal displacement from Conductor attachment point due to swing (m) (D)	ROW width (m) R=2*(H+D+X)
1	765kV S/C	Vertical DELTA	ACSR BERSIMIS	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	200	Tension	4.792	0	9	11.05	2.7	46
				Normal route without constraint Forest area Urban area/Populated area/approac	250	I STRING	6.772	7.6	9	9	8.2	52

				h section near substation							
				Normal route without constraint Forest area Urban area/Populated area/approach section near substation	250	V STRING	6.772	0	9	6	3.9	38
2	400kV D/C	Vertical	ACSR MOOSE	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	200	Tension	4.296	0	5.6	6.25	2.5	29
				Normal route without constraint Forest area Urban area/Populated area/approac	250	I STRING	6.078	4.5	5.6	6.5	6.1	36

				h section near substation							
				Normal route without constraint	250	V STRING	6.078	0	5.6	5.5	3.5	29
				Forest area Urban area/Populated area/approach section near substation								
3	220kV D/C	Vertical	ACSR ZEBRA	Normal route without constraint	350	Tension	10.553	0	3.8	4.6	6.1	29
						I STRING	10.553	2.8	3.8	4.5	7.7	32
						V STRING	10.553	0	3.8	4.0	6.1	28
				Forest area	250	Tension	6.079	0	3.8	4.6	3.5	24
						I STRING	6.079	2.8	3.8	4.5	5.1	27
						V STRING	6.079	0	3.8	4.0	3.5	23
				Urban area/Populated area/approach section near substation	200	Tension	6.079	0	3.8	4.6	3.5	24
						I STRING	4.297	2.8	3.8	4.5	4.1	25
						V STRING	4.297	0	3.8	4.0	2.5	21
4	132 kV D/C	Vertical	ACSR PANTHER	Normal route without constraint	325	V STRING	8.338	0	2.9	4.9	4.8	25
						I STRING	8.338	2.6	2.9	4.5	6.3	27

						V STRING	8.338	0	2.9	3.4	4.8	22
				Forest area	200	V STRING	3.844	0	2.9	4.9	2.2	20
						I STRING	3.844	1.9	2.9	4.5	3.3	21
						V STRING	3.844	0	2.9	3.4	2.2	17
				Urban area/Populated area/approach section near substation	150	V STRING	2.491	0	2.9	4.9	1.4	18
						I STRING	2.491	2.6	2.9	4.5	2.9	21
						V STRING	2.491	0	2.9	3.4	1.4	15

RIGHT OF WAY CALCULATION FOR NORMAL ROUTE, FOREST AREA, URBAN AREA / POPULATED AREA / APPROACH SECTION NEAR SUBSTATION FOR LATTICE STRUCTURES with HTLS conductor

Carbon Fiber Composite Core (CFCC); Sag is calaculated at 180 °C.

Aluminium Conductor Steel Supported (ACSS): Sag is calculated at 250 °C.

GZTACSR: Gap-type Aluminium Conductor Steel Reinforced (GAP conductor); Sag is calculated at 210 °C.

***Note:** Sag for the above conductors are as per design mentioned in CEA's Guidelines for Rationalised use of High Performance Conductors*

S. No.	Voltage level (kV)	Ckt type	Configuration	Conductor type	Tower Type	String Type	Suspension Polymer Insulator String Length/Drop (m)	Swing angle	Terrain	Design Span (m)	Horizontal clearance (2.0m+0.3 M for every additional 33 kV or part thereof) (m) (H)	Sag at Max continuous operating Temp Deg. C (in m)	Horizontal displacement from Conductor attachment point due to swing (m) (D)	Maximum Horizontal distance of Conductor attachment point from centre of Pole (m) (X)	ROW width (m) R=2*(H+D+X)
1	765	DC	Vertical	CFCC	Conventional Tower	I string	7.60	35	Normal Route	400	9.00	8.73	9.37	12.50	**62**
2	765	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Normal Route	400	9.00	8.73	5.01	9.70	**47**
3	765	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Normal Route	400	9.00	8.73	5.01	14.50	**57**
4	765	DC	Vertical	ACSS	Conventional Tower	I string	7.60	35	Normal Route	400	9.00	15.52	13.26	12.50	**70**
5	765	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Normal Route	400	9.00	15.52	8.90	9.70	**55**
6	765	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Normal Route	400	9.00	15.52	8.90	14.50	**65**
7	765	DC	Vertical	GAP	Conventional Tower	I string	7.60	35	Normal Route	400	9.00	14.22	12.52	12.50	**68**
8	765	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Normal Route	400	9.00	14.22	8.16	9.70	**54**
9	765	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Normal Route	400	9.00	14.22	8.16	14.50	**63**
10	400	DC	Vertical	CFCC	Conventional Tower	I string	4.00	35	Normal Route	400	5.60	10.65	8.40	7.50	**43**
11	400	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Normal Route	400	5.60	10.65	6.11	5.50	**34**

12	400	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Normal Route	400	5.60	**10.65**	6.11	9.70	**43**
13	400	DC	Vertical	ACSS	Conventional Tower	I string	4.00	35	Normal Route	400	5.60	**16.60**	11.82	7.50	**50**
14	400	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Normal Route	400	5.60	**16.60**	9.52	5.50	**41**
15	400	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Normal Route	400	5.60	**16.60**	9.52	9.70	**50**
16	400	DC	Vertical	GAP	Conventional Tower	I string	4.00	35	Normal Route	400	5.60	**14.67**	10.71	7.50	**48**
17	400	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Normal Route	400	5.60	**14.67**	8.41	5.50	**39**
18	400	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Normal Route	400	5.60	**14.67**	8.41	9.70	**47**
19	220	DC	Vertical	CFCC	Conventional Tower	I string	2.50	35	Normal Route	400	3.80	**7.73**	5.87	4.60	**29**
20	220	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Normal Route	400	3.80	**7.73**	4.43	4.10	**25**
21	220	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Normal Route	400	3.80	**7.73**	4.43	5.70	**28**
22	220	DC	Vertical	ACSS	Conventional Tower	I string	2.50	35	Normal Route	400	3.80	**14.32**	9.65	4.60	**36**
23	220	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Normal Route	400	3.80	**14.32**	8.21	4.10	**32**
24	220	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Normal Route	400	3.80	**14.32**	8.21	5.70	**35**
25	220	DC	Vertical	GAP	Conventional Tower	I string	2.50	35	Normal Route	400	3.80	**12.69**	8.71	4.60	**34**
26	220	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Normal Route	400	3.80	**12.69**	7.28	4.10	**30**
27	220	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Normal Route	400	3.80	**12.69**	7.28	5.70	**34**
28	132	DC	Vertical	CFCC	Conventional Tower	I string	2.30	35	Normal Route	320	2.90	**5.07**	4.23	3.90	**22**
29	132	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Normal Route	320	2.90	**5.07**	2.91	2.81	**17**
30	132	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Normal Route	320	2.90	**5.07**	2.91	5.30	**22**
31	132	DC	Vertical	ACSS	Conventional Tower	I string	2.30	35	Normal Route	320	2.90	**9.16**	6.57	3.90	**27**
32	132	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Normal Route	320	2.90	**9.16**	5.25	2.81	**22**
33	132	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Normal Route	320	2.90	**9.16**	5.25	5.30	**27**

34	132	DC	Vertical	GAP	Conventional Tower	I string	2.30	35	Normal Route	320	2.90	**8.32**	6.09	3.90	**26**
35	132	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Normal Route	320	2.90	**8.32**	4.77	2.81	**21**
36	132	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Normal Route	320	2.90	**8.32**	4.77	5.30	**26**
37	66	DC	Vertical	CFCC	Conventional Tower	I string	1.90	35	Normal Route	250	2.30	**3.31**	2.99	2.50	**16**
38	66	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Normal Route	250	2.30	**3.31**	1.90	1.62	**12**
39	66	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Normal Route	250	2.30	**3.31**	1.90	3.50	**15**
40	66	DC	Vertical	ACSS	Conventional Tower	I string	1.90	35	Normal Route	250	2.30	**6.98**	5.09	2.50	**20**
41	66	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Normal Route	250	2.30	**6.98**	4.00	1.62	**16**
42	66	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Normal Route	250	2.30	**6.98**	4.00	3.50	**20**
43	66	DC	Vertical	GAP	Conventional Tower	I string	1.90	35	Normal Route	250	2.30	**8.32**	5.86	2.50	**21**
44	66	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Normal Route	250	2.30	**8.32**	4.77	1.62	**17**
45	66	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Normal Route	250	2.30	**8.32**	4.77	3.50	**21**
46	765	DC	Vertical	CFCC	Conventional Tower	I string	7.60	35	Forest	300	8.90	**5.01**	7.23	12.50	**57**
47	765	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Forest	300	8.90	**5.01**	2.87	9.70	**43**
48	765	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Forest	300	8.90	**5.01**	2.87	14.50	**53**
49	765	DC	Vertical	ACSS	Conventional Tower	I string	7.60	35	Forest	300	8.90	**10.00**	10.09	12.50	**63**
50	765	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Forest	300	8.90	**10.00**	5.74	9.70	**49**
51	765	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Forest	300	8.90	**10.00**	5.74	14.50	**58**
52	765	DC	Vertical	GAP	Conventional Tower	I string	7.60	35	Forest	300	8.90	**8.71**	9.36	12.50	**62**
53	765	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Forest	300	8.90	**8.71**	5.00	9.70	**47**
54	765	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Forest	300	8.90	**8.71**	5.00	14.50	**57**
55	400	DC	Vertical	CFCC	Conventional Tower	I string	4.00	35	Forest	300	5.60	**6.15**	5.82	7.50	**38**

56	400	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Forest	300	5.60	6.15	3.53	5.50	**29**
57	400	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Forest	300	5.60	6.15	3.53	9.70	**38**
58	400	DC	Vertical	ACSS	Conventional Tower	I string	4.00	35	Forest	300	5.60	10.70	8.43	7.50	**43**
59	400	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Forest	300	5.60	10.70	6.14	5.50	**34**
60	400	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Forest	300	5.60	10.70	6.14	9.70	**43**
61	400	DC	Vertical	GAP	Conventional Tower	I string	4.00	35	Forest	300	5.60	8.87	7.38	7.50	**41**
62	400	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Forest	300	5.60	8.87	5.09	5.50	**32**
63	400	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Forest	300	5.60	8.87	5.09	9.70	**41**
64	220	DC	Vertical	CFCC	Conventional Tower	I string	2.50	35	Forest	300	3.80	4.42	3.97	4.60	**25**
65	220	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Forest	300	3.80	4.42	2.54	4.00	**21**
66	220	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Forest	300	3.80	4.42	2.54	5.70	**24**
67	220	DC	Vertical	ACSS	Conventional Tower	I string	2.50	35	Forest	300	3.80	9.34	6.79	4.60	**30**
68	220	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Forest	300	3.80	9.34	5.36	4.00	**26**
69	220	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Forest	300	3.80	9.34	5.36	5.70	**30**
70	220	DC	Vertical	GAP	Conventional Tower	I string	2.50	35	Forest	300	3.80	7.75	5.88	4.60	**29**
71	220	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Forest	300	3.80	7.75	4.45	4.00	**24**
72	220	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Forest	300	3.80	7.75	4.45	5.70	**28**
73	132	DC	Vertical	CFCC	Conventional Tower	I string	2.30	35	Forest	200	2.90	2.00	2.47	3.90	**19**
74	132	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Forest	200	2.90	2.00	1.15	2.81	**14**
75	132	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Forest	200	2.90	2.00	1.15	5.30	**19**
76	132	DC	Vertical	ACSS	Conventional Tower	I string	2.30	35	Forest	200	2.90	4.73	4.03	3.90	**22**
77	132	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Forest	200	2.90	4.73	2.71	2.81	**17**

78	132	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Forest	200	2.90	**4.73**	2.71	5.30	**22**
79	132	DC	Vertical	GAP	Conventional Tower	I string	2.30	35	Forest	200	2.90	**3.91**	3.56	3.90	**21**
80	132	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Forest	200	2.90	**3.91**	2.24	2.81	**16**
81	132	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Forest	200	2.90	**3.91**	2.24	5.30	**21**
82	66	DC	Vertical	CFCC	Conventional Tower	I string	1.90	35	Forest	150	2.30	**1.24**	1.80	2.50	**13**
83	66	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Forest	150	2.30	**1.24**	0.71	1.62	**9**
84	66	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Forest	150	2.30	**1.24**	0.71	3.50	**13**
85	66	DC	Vertical	ACSS	Conventional Tower	I string	1.90	35	Forest	150	2.30	**3.44**	3.06	2.50	**16**
86	66	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Forest	150	2.30	**3.44**	1.97	1.62	**12**
87	66	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Forest	150	2.30	**3.44**	1.97	3.50	**16**
88	66	DC	Vertical	GAP	Conventional Tower	I string	1.90	35	Forest	150	2.30	**2.44**	2.49	2.50	**15**
89	66	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Forest	150	2.30	**2.44**	1.40	1.62	**11**
90	66	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Forest	150	2.30	**2.44**	1.40	3.50	**14**
91	765	DC	Vertical	CFCC	Conventional Tower	I string	7.60	35	Urban/Populated	250	8.90	**3.51**	6.37	12.50	**56**
92	765	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Urban/Populated	250	8.90	**3.51**	2.01	9.60	**41**
93	765	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Urban/Populated	250	8.90	**3.51**	2.01	14.50	**51**
94	765	DC	Vertical	ACSS	Conventional Tower	I string	7.60	35	Urban/Populated	250	8.90	**7.69**	8.77	12.50	**60**
95	765	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Urban/Populated	250	8.90	**7.69**	4.41	9.60	**46**
96	765	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Urban/Populated	250	8.90	**7.69**	4.41	14.50	**56**
97	765	DC	Vertical	GAP	Conventional Tower	I string	7.60	35	Urban/Populated	250	8.90	**6.41**	8.04	12.50	**59**
98	765	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Urban/Populated	250	8.90	**6.41**	3.68	9.60	**44**
99	765	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Urban/Populated	250	8.90	**6.41**	3.68	14.50	**54**

100	400	DC	Vertical	CFCC	Conventional Tower	I string	4.00	35	Urban/Populated	250	5.60	**4.26**	4.74	7.50	**36**
101	400	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Urban/Populated	250	5.60	**4.26**	2.44	5.50	**27**
102	400	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Urban/Populated	250	5.60	**4.26**	2.44	9.70	**35**
103	400	DC	Vertical	ACSS	Conventional Tower	I string	4.00	35	Urban/Populated	250	5.60	**8.20**	7.00	7.50	**40**
104	400	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Urban/Populated	250	5.60	**8.20**	4.70	5.50	**32**
105	400	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Urban/Populated	250	5.60	**8.20**	4.70	9.70	**40**
106	400	DC	Vertical	GAP	Conventional Tower	I string	4.00	35	Urban/Populated	250	5.60	**6.48**	6.01	7.50	**38**
107	400	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Urban/Populated	250	5.60	**6.48**	3.72	5.50	**30**
108	400	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Urban/Populated	250	5.60	**6.48**	3.72	9.70	**38**
109	220	DC	Vertical	CFCC	Conventional Tower	I string	2.50	35	Urban/Populated	250	3.80	**3.09**	3.21	4.60	**23**
110	220	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Urban/Populated	250	3.80	**3.09**	1.77	4.00	**19**
111	220	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Urban/Populated	250	3.80	**3.09**	1.77	5.70	**23**
112	220	DC	Vertical	ACSS	Conventional Tower	I string	2.50	35	Urban/Populated	250	3.80	**7.18**	5.55	4.60	**28**
113	220	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Urban/Populated	250	3.80	**7.18**	4.12	4.00	**24**
114	220	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Urban/Populated	250	3.80	**7.18**	4.12	5.70	**27**
115	220	DC	Vertical	GAP	Conventional Tower	I string	2.50	35	Urban/Populated	250	3.80	**4.22**	3.85	4.60	**25**
116	220	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Urban/Populated	250	3.80	**4.22**	2.42	4.00	**20**
117	220	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Urban/Populated	250	3.80	**4.22**	2.42	5.70	**24**
118	132	DC	Vertical	CFCC	Conventional Tower	I string	2.30	35	Urban/Populated	150	2.90	**1.14**	1.97	3.90	**18**
119	132	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Urban/Populated	150	2.90	**1.14**	0.65	2.81	**13**
120	132	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Urban/Populated	150	2.90	**1.14**	0.65	5.30	**18**
121	132	DC	Vertical	ACSS	Conventional Tower	I string	2.30	35	Urban/Populated	150	2.90	**3.20**	3.15	3.90	**20**

122	132	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Urban/Populated	150	2.90	**3.20**	1.84	2.81	**15**
123	132	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Urban/Populated	150	2.90	**3.20**	1.84	5.30	**20**
124	132	DC	Vertical	GAP	Conventional Tower	I string	2.30	35	Urban/Populated	150	2.90	**2.44**	2.72	3.90	**19**
125	132	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Urban/Populated	150	2.90	**2.44**	1.40	2.81	**14**
126	132	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Urban/Populated	150	2.90	**2.44**	1.40	5.30	**19**
127	66	DC	Vertical	CFCC	Conventional Tower	I string	1.90	35	Urban/Populated	100	2.30	**0.56**	1.41	2.50	**12**
128	66	DC	Vertical	CFCC	Conventional Tower	V	0.00	35	Urban/Populated	100	2.30	**0.56**	0.32	1.62	**8**
129	66	DC	Vertical	CFCC	Conventional Tower	Tension	0.00	35	Urban/Populated	100	2.30	**0.56**	0.32	3.50	**12**
130	66	DC	Vertical	ACSS	Conventional Tower	I string	1.90	35	Urban/Populated	100	2.30	**2.00**	2.24	2.50	**14**
131	66	DC	Vertical	ACSS	Conventional Tower	V	0.00	35	Urban/Populated	100	2.30	**2.00**	1.15	1.62	**10**
132	66	DC	Vertical	ACSS	Conventional Tower	Tension	0.00	35	Urban/Populated	100	2.30	**2.00**	1.15	3.50	**14**
133	66	DC	Vertical	GAP	Conventional Tower	I string	1.90	35	Urban/Populated	100	2.30	**1.24**	1.80	2.50	**13**
134	66	DC	Vertical	GAP	Conventional Tower	V	0.00	35	Urban/Populated	100	2.30	**1.24**	0.71	1.62	**9**
135	66	DC	Vertical	GAP	Conventional Tower	Tension	0.00	35	Urban/Populated	100	2.30	**1.24**	0.71	3.50	**13**

RIGHT OF WAY CALCULATION FOR NORMAL ROUTE, FOREST AREA, URBAN AREA / POPULATED AREA / APPROACH SECTION NEAR SUBSTATION FOR POLE STRUCTURES with HTLS Conductor

Carbon Fiber Composite Core (CFCC); Sag is calculated at 180 °C.

Aluminium Conductor Steel Supported (ACSS): Sag is calculated at 250 °C.

GZTACSR: Gap-type Aluminium Conductor Steel Reinforced (GAP conductor); Sag is calculated at 210 °C.

Note: *Sag for the above conductors are as per design mentioned in CEA's Guidelines for Rationalised use of High Performance Conductors*

Sno.	Voltage Level	Configuration	Conductor type	Terrain	Design Span(m)	String Type	sag(m)	Suspension Polymer Insulator String Length/Drop (m)	Horizontal clearance (2.0m+0.3 M for every additional 33 kV or part thereof) (m) (H)	Maximum Horizontal distance of Conductor attachment point from centre of Pole (m) (X)	Horizontal displacement from Conductor attachment point due to swing (m) (D)	ROW width (m) R=2*(H+D+X)
1	765k V S/C	Vertical DELTA	CFCC	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	200	Tension	2.27	0	9	11.05	1.3	43
			CFCC	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	250	I STRING	3.51	7.6	9	9	6.4	49
			CFCC	Normal route without constraint	250	V String	3.51	0	9	6	2.0	34

				Forest area Urban area/Populated area/approach section near substation								
2	765k V S/C	Vertical DELTA	ACSS	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	200	Tension	5.63	0	9	11.05	3.2	47
			ACSS	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	250	I STRING	7.69	7.6	9	9	8.8	54
			ACSS	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	250	V String	7.69	0	9	6	4.4	39
3	765k V S/C	Vertical DELTA	GAP	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	200	Tension	4.43	0	9	11.05	2.5	45
			GAP	Normal route without constraint	250	I STRING	6.41	7.6	9	9	8.0	52

				Forest area Urban area/Populated area/approach section near substation								
			GAP	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	250	V String	6.41	0	9	6	3.7	37
4	400k V D/C	Vertical	CFCC	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	200	Tension	2.82	0	5.6	6.25	1.6	27
			CFCC	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	250	I STRING	4.26	4.5	5.6	6.5	5.0	34
			CFCC	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	250	V String	4.26	0	5.6	5.5	2.4	27
5	400k V D/C	Vertical	ACSS	Normal route without constraint	200	Tension	5.98	0	5.6	6.25	3.4	31

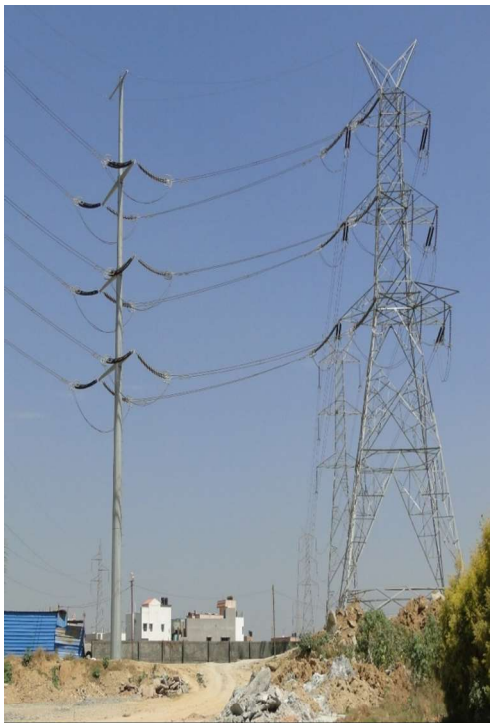
				Forest area Urban area/Populated area/approach section near substation							
			ACSS	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	250	I STRING	8.2	4.5	5.6	6.5	7.3	39
			ACSS	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	250	V String	8.2	0	5.6	5.5	4.7	32
6	400k V D/C	Vertical	GAP	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	200	Tension	4.42	0	5.6	6.25	2.5	29
			GAP	Normal route without constraint Forest area Urban area/Populated area/approach section near substation	250	I STRING	6.48	4.5	5.6	6.5	6.3	37
			GAP	Normal route without constraint	250	V String	6.48	0	5.6	5.5	3.7	30

				Forest area Urban area/Populated area/approach section near substation								
10	220k V D/C	Vertical	CFCC	Normal route without constraint	300	Tension	4.42	0	3.8	4.6	2.5	22
						I STRING	4.42	2.8	3.8	4.5	4.1	25
						V	4.42	0	3.8	4.0	2.5	21
			CFCC	Forest area	250	Tension	3.09	0	3.8	4.6	1.8	20
						I STRING	3.09	2.8	3.8	4.5	3.4	23
						V	3.09	0	3.8	4.0	1.8	19
			CFCC	Urban area/Populated area/approach section near substation	200	Tension	2.02	0	3.8	4.6	1.2	19
						I STRING	2.02	2.8	3.8	4.5	2.8	22
						V	2.02	0	3.8	4.0	1.2	18
11	220k V D/C	Vertical	ACSS	Normal route without constraint	300	Tension	9.34	0	3.8	4.6	5.4	28
						I STRING	9.34	2.8	3.8	4.5	7.0	31
						V	9.34	0	3.8	4.0	5.4	26
			ACSS	Forest area	250	Tension	7.18	0	3.8	4.6	4.1	25
						I STRING	7.18	2.8	3.8	4.5	5.7	28
						V	7.18	0	3.8	4.0	4.1	24
			ACSS	Urban area/Populated area/approach section near substation	200	Tension	5.26	0	3.8	4.6	3.0	23
						I STRING	5.26	2.8	3.8	4.5	4.6	26
						V	5.26	0	3.8	4.0	3.0	22
12	220k V D/C	Vertical	GAP	Normal route without constraint	300	Tension	7.75	0	3.8	4.6	4.4	26

						I STRING	7.75	2.8	3.8	4.5	6.1	29
						V	7.75	0	3.8	4.0	4.4	24
			GAP	Forest area	250	Tension	4.42	0	3.8	4.6	2.5	22
						I STRING	4.42	2.8	3.8	4.5	4.1	25
						V	4.42	0	3.8	4.0	2.5	21
			GAP	Urban area/Populated area/approach section near substation	200	Tension	3.91	0	3.8	4.6	2.2	21
						I STRING	3.91	2.8	3.8	4.5	3.8	24
						V	3.91	0	3.8	4.0	2.2	20
13	132 kV D/C	Vertical	CFCC	Normal route without constraint	320	Tension	5.07	0	2.9	4.9	2.9	21
						I STRING	5.07	2.6	2.9	4.5	4.4	24
						V	5.07	0	2.9	3.4	2.9	18
			CFCC	Forest area	200	Tension	2	0	2.9	4.9	1.1	18
						I STRING	2	2.6	2.9	4.5	2.6	20
						V	2	0	2.9	3.4	1.1	15
			CFCC	Urban area/Populated area/approach section near substation	150	Tension	1.14	0	2.9	4.9	0.7	17
						I STRING	1.14	2.6	2.9	4.5	2.1	19
						V	1.14	0	2.9	3.4	0.7	14
			CFCC	Urban area/Populated area/approach section near substation	100	Tension	0.53	0	2.9	4.9	0.3	16
						I STRING	0.53	2.6	2.9	4.5	1.8	18
						V	0.53	0	2.9	3.4	0.3	13
14	132 kV D/C	Vertical	ACSS	Normal route without constraint	320	Tension	9.16	0	2.9	4.9	5.3	26

						I STRING	9.16	2.6	2.9	4.5	6.7	28
						V	9.16	0	2.9	3.4	5.3	23
			ACSS	Forest area	200	Tension	4.73	0	2.9	4.9	2.7	21
						I STRING	4.73	2.6	2.9	4.5	4.2	23
						V	4.73	0	2.9	3.4	2.7	18
			ACSS	Urban area/Populated area/approach section near substation	150	Tension	3.2	0	2.9	4.9	1.8	19
						I STRING	3.2	2.6	2.9	4.5	3.3	21
						V	3.2	0	2.9	3.4	1.8	16
			ACSS	Urban area/Populated area/approach section near substation	100	Tension	1.87	0	2.9	4.9	1.1	18
						I STRING	1.87	2.6	2.9	4.5	2.6	20
						V	1.87	0	2.9	3.4	1.1	15
15	132 kV D/C	Vertical	GAP	Normal route without constraint	320	Tension	8.32	0	2.9	4.9	4.8	25
						I STRING	8.32	2.6	2.9	4.5	6.3	27
						V	8.32	0	2.9	3.4	4.8	22
			GAP	Forest area	200	Tension	3.91	0	2.9	4.9	2.2	20
						I STRING	3.91	2.6	2.9	4.5	3.7	22
						V	3.91	0	2.9	3.4	2.2	17
			GAP	Urban area/Populated area/approach section near substation	150	Tension	2.44	0	2.9	4.9	1.4	18
						I STRING	2.44	2.6	2.9	4.5	2.9	21
						V	2.44	0	2.9	3.4	1.4	15

			GAP	Urban area/Populated area/approach section near substation	100	Tension	1.24	0	2.9	4.9	0.7	17
						I STRING	1.24	2.6	2.9	4.5	2.2	19
						V	1.24	0	2.9	3.4	0.7	14



REPORT OF THE COMMITTEE FOR FINALISATION OF COMPENSATION IN REGARD TO RIGHT OF WAY (ROW) FOR TRANSMISSION LINES IN URBAN AREAS

INDEX

Report of the Committee for finalisation of compensation in regard to Right of Way (RoW) for transmission lines in urban areas.

1. Background

1.1 The transmission of power on overhead line will continue to dominate over other mode of power transmission due to techno-economic considerations / reasons. Right of Way (RoW) compensation issue has become very critical and completion of many important transmission lines is held up due to stiff resistance from the landowners whose land falls in the RoW and demand of enhanced compensation. Hence, focus is to explore the possibilities of reduction / optimisation of transmission corridor width through various technological options.

1.2 The matter of RoW for laying of transmission lines in the country was deliberated during the Power Ministers' Conference on 9-10 April 2015 at Guwahati and a committee under the Chairmanship of Special Secretary, Ministry of Power was constituted to analyse the issues related to Right of Way for laying of transmission lines in the country and to suggest a uniform methodology for payment of compensation on this account. The committee comprised of Chairperson, CEA, Principal Secretary (Energy) of M.P., U.P, Maharashtra, Karnataka, Kerala, Jt. Secretary (Trans), MoP, CMD/Dir (Projects), POWERGRID and Chief Engineer (SP&PA), CEA as convener and Member Secretary.

1.3 The Committee met three times (20.04.2015, 30.04.2015 and 1.06.2015) before finalizing its recommendations. The committee finalized its recommendations for payment of compensation towards damages in regard to Right of Way for transmission lines, which was issued via MoP OM No. 3/7/2015-Trans dated 15th October, 2015. The guidelines are applicable only for transmission lines of 66 kV and above voltage level. The guidelines recommended compensation for 85% of the land value for tower footing and 15% of the land value for RoW of the line. The above guidelines were communicated by the Ministry of Power to Chief Secretaries of all the States with the request to take suitable decision regarding adoption of the guidelines considering that acquisition of land is a state subject.

1.4 Further, MoP has constituted a committee to analyze the issues related to RoW for laying of transmission lines in the urban areas of the country and to suggest a methodology for payment of compensation on this account.

2. Constitution of committee and Terms & reference of Committee

2.1 Ministry of Power (MoP) vide letter no. 3/4/2016-Trans dated 11-08-2016 has constituted a committee under the Chairmanship of Ms Shalini Prasad, Additional Secretary Ministry of Power to analyse the issue relating to RoW for laying of transmission lines in the urban areas of the country and to suggest a methodology for payment of compensation on this

account (**copy enclosed at Appendix-I**). The composition of the Committee is given below:

(i) Ms. Shalini Prasad, Additional Secretary, Ministry of Power
(ii) Smt. Jyoti Arora, Joint Secretary, Ministry of Power
(iii) Chairperson/Member (PS). Central Electricity Authority
(iv) Principal Secretary/Secretary (Energy) Govt. of Karnataka
(v) Principal Secretary/Secretary (Energy) Govt. of Kerala
(vi) Principal Secretary/Secretary (Energy) Govt. of Maharashtra
(vii) Principal Secretary/Secretary (Energy) Govt. of U.P
(viii) Principal Secretary/Secretary (Energy) Govt. of Haryana
(ix) CMD PGCIL
(x) Chief Engineer PSPA-I. CEA Convener & Member Secretary

2.2 The Terms of Reference (ToR) of the Committee include:

(i) To review/analyse existing procedures for compensation and suggest possible modification to address following issues.
   a. Possible changes in assessment process
   b. Procedure for timely release of compensation payment
   c. Measure to stop payment to ineligible persons
   d. Possibilities of releasing certain percentage in advance to reduce resistance

(ii) To suggest procedure to assess eligibility and subsequent compensation for structure/hut/bore well etc. including measure to ensure their shifting/removal after payment of Compensation.
(iii) To explore possibility of enlarging scope of survey to include land scheduling for complete ROW width including name of land owners to facilitate payment of diminution of land value compensation to all eligible persons.
(iv) To suggest strategy/mechanism for ensuring compliance/implementation by State Govt.
(v) To explore possible methodology for direct online payment, say through Jan Dhan Yojana.
(vi) To explore the technological options for reducing the tower footing/base, area/corridor requirements.
(vii) To explore possibility of reduction of transmission corridor width/selective restricted use of corridor in urban zones by using technical advances/ raising heights of towers/ adequate safety measures/revisiting clearance requirements especially for 220 kV and 132 kV levels.

3. Proceeding of Committee

3.1 The 1st meeting of the Committee was held under the Chairmanship of Ms. Shalini Prasad, Additional Secretary, MoP on 30-08-2016 and the following decisions were taken after detailed deliberations.

(i) CEA shall explore the different technical option available for further optimizing the Right of Way width, Safety clearances such as:

(a) New compact tower design

(b) Possibility of including caging of conductor in the existing/new tower to reduce swing of conductor.

(c) Feasibility of underground cable laying for EHV lines.

(d) Feasibility of Gas insulated lines.

The Minutes of Meeting (MoM) is enclosed at **Appendix-1I**

3.2 As per decision of 1st meeting, Chief Engineer (PSP&PA-I), CEA and Convener & Member Secretary of the Committee had taken a meeting on 23-09-2016 to explore different technical options available for further optimizing the RoW width, safety clearances etc. After detailed deliberations, the broad parameters / factors were listed down (type of conductor, design span, conductor operating temperature, configuration of insulator string, swing angle, cage width, minimum safety clearance) to carry out the calculation of RoW for different voltage types and it was decided that M/s Powergrid, M/s Sterlite Grid Limited, M/s Kalpatru Power Transmission Ltd. and M/s Essel Infraprojects Limited shall furnish the calculations of RoW within a week's time.

The Minutes of Meeting (MoM) is enclosed at **Appendix-III.**

3.3 The 2nd meeting of the Committee was held under the Chairmanship of Ms. Shalini Prasad, Additional Secretary, MoP on 30-09-2016 and the following decisions were taken after detailed deliberations.

(a) To further explore any other technological options available for reduction of RoW based on worldwide practices and the cost implication.

(b) PGCIL to provide international practices for addressing the RoW issue in urban/populated/forest areas.

(c) To explore the possibility of framing detailed guidelines to incorporate RoW consideration at micro planning stage and to explore various options for optimum utilization of the existing Row as far as possible right at planning stage

(d) To explore the possibility of dividing the route of transmission lines into few broad categories such as normal route, route through Reserved forest area and route through Urban areas/Populated area and notifying different RoW for different category suggesting specific technical measures for urban/populated area/ forest areas.

The Minutes of Meeting (MoM) is enclosed at **Appendix-IV**

3.4 The 3rd meeting of the Committee was held under the Chairmanship of Ms. Shalini Prasad, Additional Secretary, MoP on 02-11-2016 and the following decisions were taken after detailed deliberations.

(a) A committee comprising of representatives CEA, PGCIL, Maharashtra and Kerala will calculate and create matrix for RoW requirements considering all factors influencing the RoW (span, conductor, I/V string, swing angle) for one wind zone, say wind zone 4.
(b) Chief Town planners or other concerned authority who is involved in town planning would be invited in the next meeting to discuss the provisions of RoW for laying of transmissions lines.
(c) The next meeting is proposed for 21st November, 2016 for reviewing the calculation submitted by the committee.
(d) The state utilities shall come out with suggestions regarding methodology for calculation of compensation.

The Minutes of Meeting (MoM) is enclosed at **Appendix-V**

3.5 In the 3rd meeting of the Committee, held on 02-11-2016, it was decided to constitute a Committee comprising representatives from CEA, PGCIL, Govt. of Kerala and Govt. of Maharashtra under the Chairmanship of Chief Engineer (PSE&TD), CEA, to study all the factors influencing the RoW for a particular Wind zone and to bring out the requirement for different combinations. Accordingly, a Committee was constituted with the following composition:

(a) Chief Engineer (PSE&TD), CEA -Chairman
(b) Chief Electrical Inspector, CEA
(c) Representative of PGCIL
(d) Representative of Govt. of Kerala
(e) Representative of Govt. of Maharashtra

3.6 The 4th meeting of the Committee was held under the Chairmanship of Ms. Shalini Prasad, Additional Secretary, MoP on 08-12-2016. In the meeting, Chief Engineer (PSETD), CEA presented the RoW matrix prepared in consultation with POWERGRID and Kerala considering various factors (span, conductor, I/V string, swing angle) influencing the RoW for wind zone 4 and the following decisions were taken after detailed deliberations.

(a) A sub-committee comprising of representatives from CEA, Punjab, Uttarakhand, Himachal Pradesh and TATA Power and few others would deliberate and finalise RoW requirements for 33 kV transmission lines
(b) Deliberations to be held with Chief Town planners or other concerned authority, who are involved in town planning, to discuss about dedicated corridor for laying of transmission lines for greenfield projects.

(c) CEA to consider framing of guidelines stipulating use of monopole structure / multi-circuit / multi-circuit & multi-voltage towers in urban areas and in approach section near substation. The use of such structures can be considered by Utilities for other areas based on economics.

(d) CEA and PGCIL to prepare a Draft Report concluding the decisions taken by the Committee.

(e) The issue regarding compensation methodology would be discussed further by MoP with state utilities.

The Minutes of Meeting (MoM) is enclosed at **Appendix-VI.**

3.7 The 5th meeting of the Committee was held on 08-02-2017 wherein the following decisions were taken:

(a) Additional compensation in form of Non-usability allowance of 15% of the land value for the width of RoW corridor would be applicable in the notified urban areas. No construction activity of any kind would be permitted under the RoW of the transmission line.

(b) The RoW for 33 kV transmission lines as finalized by the committee for the purpose would be included in the draft report of the Committee on Row compensation for urban areas and the same would be circulated to members of the committee for their comments.

(c) After receipt of the comments from the members of the committee, the final report of the committee would be issued.

(d) Chief Electrical Inspectorate, CEA would initiate / circulate a discussion paper allowing construction activity under the RoW of the transmission line.

The Minutes of Meeting (MoM) is enclosed at **Appendix-VII.**

3.8 The committee constituted by MoP vide its OM dated 20.1.2017, under the chairmanship of Chief Engineer, PSPA-I, CEA to deliberate and finalise the Right of Way (RoW) requirements for lines at 33 kV level submitted its report on 07.04.2017. The same is enclosed at Appendix**-VIII.**

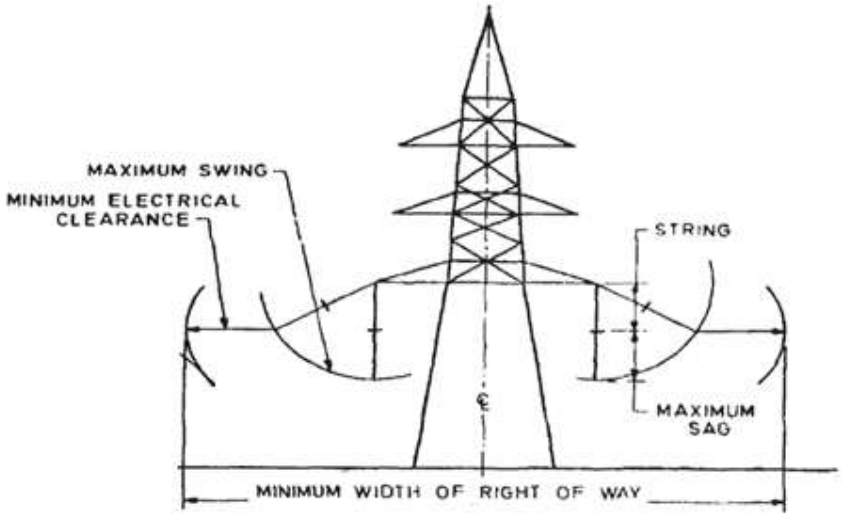
3.9 The 6th meeting of the Committee was held under the Chairmanship of Ms. Shalini Prasad, Additional Secretary, MoP on 09-05-2017. The recommendations made in the Draft Report for finalization of compensation concerning Right of Way (RoW) for transmission line falling in urban areas were circulated to the members of the Committee before the meeting. In the meeting, the recommendations made in the draft report were discussed item-wise and Members of the Committee were in agreement on the Draft Report except for some minor changes. The Committee members were requested to send their additional comments, if any, within a week so that the report could be released after incorporation of the same. No comment has been received from the Committee members.

The Minutes of Meeting (MoM) is enclosed at **Appendix-IX.**

4. Detail Report

4.1 Generally, the transmission line towers are of two types (a) self-supporting type (lattice structure / steel pole structure) (b) Guyed type. In India, self-supporting lattice structures are being most commonly used for EHV transmission lines. In recent years, use of monopole structures are also increasing in specific areas due to much reduced footprints, less component and faster erection & commissioning. The high cost, difficulty in transportation, increase in number of poles due to reduction in design span, special design consideration for multi-circuit towers and limited manufacturing facility are some of the bottlenecks in construction of transmission lines with monopole structure.

4.2 Right of Way (RoW) is the strip of land immediately below and adjacent to a transmission line. The width of RoW required for a transmission line is based on the consideration for safety clearances as per CEA (Measures relating to safety and Electric supply) Regulations 2010, Electromagnetic Field (EMF) exposure limits and design consideration for tower structure. The RoW also provide an access corridor for maintenance of transmission lines,



4.3 As per current practice, the width of RoW / corridor requirement for the transmission lines of different voltage levels are as follows.

Table -1

Voltage Level	Corridor Requirement (m)
66kV AC	18
110kV AC	22
132kV AC	27

220kV AC	35
400kV AC Single Circuit (Horizontal configuration)	52
400kV AC Double Circuit / 400kV S/C (Vertical / delta configuration)	46
765kV AC Single Circuit (Horizontal configuration)	85
765kV AC Single Circuit (Delta / Vertical configuration)	64
765kV AC Double Circuit	67
1200kV AC	89
+/- 500kV HVDC	52
+/- 800kV HVDC	69

4.4 The current practice in India for RoW width / corridor requirement of transmission lines for various voltage level is more or less similar to worldwide practice.

4.5 Ministry of Environment & Forest (MOEF) guidelines also follow the above RoW width for transmission lines traversing through forest area. The various other provisions in MoEF guidelines relating to transmission lines are enclosed at **Appendix-X**.

4.6 RoW requirement for transmission line depends on following factors:

a) Configuration of Tower [S/C (Horizontal / Delta / Vertical) or D/C (Vertical)]
b) Span length
c) Sag of Conductor, which depends on type of conductor used, maximum operating temperature of the conductor, and Span length
d) Wind velocity and angle of swing
e) Projection of Cross arm or distance of conductor attachment point from centre line of tower, which depends on wind velocity, swing angle, metal clearance, cage width or tower body width at bottom conductor level
f) Minimum horizontal & Vertical safety clearance as per CEA (Measures relating to safety and Electric supply) Regulations, 2010.
g) Configuration of insulators [I / V / Y configuration] and Length of insulator string
h) Electric field limits below bottom most conductor and at edge of RoW

4.7 With the increasing operating voltage, the concern for the ground level electric field & magnetic field effects of overhead transmission lines have increased. The electric fields are especially important because their effects on human beings and animals has been a matter of concern. The minimum ground clearance for transmission lines dependent upon interference limits including Electric Field, Audible Noise (AN), Radio Interference (RI), Television Interference (TVI) etc. and become ruling condition specifically for

transmission lines of Voltage levels above 400 kV. International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines are generally being followed for the Electric & Magnetic field effect / exposure within the Right of Way (RoW). In India, Electric field limits below bottom most conductor and at the edge of the RoW at a height of about 1.8m above ground level is 10kV/m and 5kV/m respectively.

4.8 A matrix has been prepared for RoW under following assumptions:

(a) Conventional ACSR conductor used at different voltage levels

(b) Different design spans for normal route, forest areas and urban areas / approach section near the substation

(c) Different insulator string configuration (I, V, Y type Insulator string configuration) for suspension type towers

(d) Wind speed corresponding to Wind Zone -4, swing angle 35 degree and safe horizontal & vertical clearance as per CEA (Measures relating to safety and Electric supply) Regulations ,2010.

4.9 The RoW matrix provides values for following two conditions.

- Specifying RoW for different voltage level for calculation of compensation
- Specifying the safety clearance requirement including swing of conductor and giving opportunity for optimizing the design of tower for further reduction in RoW requirement.

4.10 The V-type / Y-type / I-type insulator string configuration are being used in suspension towers. It was reported that V-type insulator string configuration of insulators has some maintenance issues. The use of V-type insulator strings is not very common in EHV AC transmission lines and hence may be restricted to areas with constraints. But the V/Y type insulator string configuration is more commonly used in HVDC lines to meet high creepage distance requirement.

4.11 The detailed calculation for RoW requirement for various voltage levels in different areas is given at **Appendix-XI (Table -2)** and is summarized in **Table -3.**

4.12 The **Table-3 (Detailed)** provides RoW requirement for both insulator configurations (I / V type insulator configuration) for suspension towers as well as for tension towers for different voltage levels and span lengths. The maximum of three values i.e. I-type & V-type insulator string configuration (for suspension towers) and tension insulator strings (for tension towers) has been considered as the RoW in normal route without constraint. Similarly, the maximum of two values i.e V-type insulator string configuration (for suspension towers) and tension insulator strings (for tension towers)

has been considered as the RoW in forest areas and urban / populated areas / approach section near the substation. The maximum horizontal displacement of the conductor due to its swing for different voltage levels and for different span, beyond the conductor attachment point on either side of the tower, has been given as "H" in the Table-2. The maximum horizontal distance of bottom conductor attachment point from centre of tower is also given under **column (7)** in the **Table-3 (Detailed)** for different voltage levels. This dimension can be optimized to reduce the overall ROW. Similarly, the base width of the tower can be optimized.

4.13 The individual span along the route of the transmission line is generally different from design span. It is not desirable to calculate RoW requirement based on individual span for the purpose of compensation payment as it will be extremely difficult and practically impossible to calculate compensation on case to case basis. The process will be very complex, non-uniform across the country and it may lead to increase in legal disputes. Hence although reduction in RoW is achievable by optimization of the tower design or by adoption of various technological options**, but Compensation in different areas shall be paid for RoW as given at Table-3 (Summarized) / under column (10) in the Table-3 (Detailed) for different voltage levels**. Similarly, the base width of the tower can be optimized, but the **compensation shall be paid for actual base width (i.e leg to leg) of tower.** The indicative base width of tower is given under column (12) in the **Table-3 (Detailed)** for different voltage levels. However, the transmission licensees have the option to optimize the tower design / dimension to compensate additional amount paid towards compensation.

4.14 The constraint in getting the required RoW for construction of overhead transmission line is a matter of serious concern for all utilities. Reduction in RoW is essential, particularly in urban areas / populated areas and forest areas. Adoption of various technical measures is required, particularly in forest areas, and urban / populated areas, as availability of transmission corridor has become extremely difficult. Utilities are forced to consider various technological options for optimization and optimum utilisation of RoW. Various technological options available for optimisation and optimum utilization of RoW including urban / forest areas are as follows:

a) Reduction in Span length
b) Reduction in foot print of tower base [i.e use of Steel pole structure, Narrow based lattice structure]
c) Use of V- type insulator strings for suspension towers and use of tension towers
d) Use of multi-circuit and multi-circuit & multi-voltage towers
e) Use of lattice / Steel pole structure with one side stringing
f) Use of XLPE cable or Gas Insulated Transmission Line (GITL), GITL shall be exclusively used for high power transmission and where multi cable per phase is required.
g) Use of compact towers with insulated cross arm
h) Use of covered conductors upto 66kV level

i) Upgrading of the existing line to higher voltage AC / converting to HVDC or uprating with high Ampacity conductor [High Temperature (HT) / High Temperature Low Sag (HTLS)] in the existing corridor

j) Use of multi-circuit / multi-voltage with raised tower height to save trees (without cutting of trees) maintaining required safety clearance over the trees [e.g. multi-circuit & multi voltage tower used in Jaldapara Reserve forest area executed by PGCIL]

k) Exploring the possibility of use of Voltage Source Converter (VSC) based HVDC transmission on overhead line or underground cable

5. Recommendations for laying of transmission lines 66 kV and above in urban/populated area/ forest area in the country

5.1. To review/analyse existing procedures for compensation and suggest possible modification.

a) Ministry of Power, Govt. of India vide its letter dated 15-10-2015, has issued guidelines for determining the compensation payable towards "damages" as stipulated in Indian Telegraphic Act, in addition to the compensation towards normal crop and tree damages. This amount will be payable for transmission lines for 66kV and above and not for sub-transmission and distribution lines below 66kV voltage level. The recommendations regarding compensation values in the guidelines are given below:

(i) Compensation @85% of land value as determined by District Magistrate or any other authority based on circle rate / Guideline value / Stamp Act rates for tower base area (between four legs) impacted severely due to installation of tower / pylon structure;

(ii) Compensation towards diminution of land value in the width of RoW corridor due to laying of transmission line and imposing certain restriction would be decided by the states as per categorization / type of land in different places of states, subject to a maximum of 15% of land value as determined based on circle rate / Guideline value / stamp Act rates;

The above recommendation are yet to be adopted by most of the States.

b) Additional compensation in form of Non-usability allowance of 15% of the land value for the width of RoW corridor would be applicable in the notified urban areas. No construction activity of any kind would be permitted under the RoW of the transmission line.

c) Onetime compensation for RoW for urban area / forest areas. But in case of rural areas, the compensation for RoW could be one time or on annuity basis for a

period of 10-20 years with option to pre-close the annuity payment by disbursing a lump sum amount on a mutually agreed terms.

5.2. ***To suggest procedure to assess eligibility and subsequent compensation for structure/hut/bore well etc. including measure to ensure their shifting/removal after payment of Compensation.***

(i) The transmission line routing to be done to avoid any structure/hut/borewell etc. Necessary safety clearances needs to be maintained as per CEA (Measures relating to Safety and Electric Supply) in case of unavoidable circumstances.

5.3. ***To explore possibility of enlarging scope of survey to include land scheduling for complete ROW width including name of land owners to facilitate payment of diminution of land value compensation to all eligible persons.***

(i) The Committee suggested to include the name of landowners along the RoW of the transmission line after carrying out the check survey at the time of execution.

5.4. ***To suggest strategy/mechanism for ensuring compliance/implementation by State Govt.***

(i) The respective state government are advised to adopt the guidelines on RoW compensation.

5.5. ***To explore possible methodology for direct online payment, say through Jan Dhan Yojana.***

(i) Committee suggested payment of compensation through various digital modes of payment such as Aadhar enabled payment system (AEPS), Unified Payment Interface (UPI) etc,, where feasible.

5.6. ***To explore the technological options for reducing the tower footing/base, area/corridor requirements &***

5.7. ***To explore possibility of reduction of transmission corridor width/selective restricted use of corridor in urban zones by using technical advances/ raising heights of towers/ adequate safety measures/revisiting clearance requirements especially for 220 kV and 132 kV levels.***

(i) The Route of transmission line (66kV and above voltage level) can be divided into three (3) broad sections / categories.

- Normal Route of the line without constraint
- Route of the line through forest area

- Route of the line through Urban areas/Populated area/approach section near substations.

(ii) The design span at different voltage levels, depending on the terrain / areas (specified above) through which the transmission line traverses, shall be as follow**s:**

Table-4

Voltage level	**Design Span (m)**		
	Normal Route without constraint	Forest area	Urban areas / Populated area / approach section near substation
765kV & 400kV	400	300	250
220kV / 230 kV	350	250	200
132kV / 110 kV	320	200	150
66kV	250	150	100

(iii) In case of EHV AC transmission lines, the use of V-type insulator string configuration (on suspension towers) shall be restricted to areas with constraints. It is recommended to use suspension towers with V- type insulator string and / or tension towers in urban and forest area to reduce RoW.

(iv) The RoW to be considered for compensation, in different areas for transmission lines at different voltage levels, is given at **Table 3 (Summarized)** and under column (10) in the **Table-3 (Detailed)**. The conductor sag at maximum operating temperature is independent of wind zones and while calculating RoW width requirement, a reasonable swing of conductor (35 degree) has been considered. Therefore, the indicated RoW width is applicable for all wind zones. The base width of the tower can be optimized, but **the compensation shall be paid for actual base width (i.e leg to leg) of tower**. The indicative base width of tower given under column (12) in the **Table-3 (Detailed)** for different voltage levels. However, the transmission licensees have the option to optimize the tower design / dimension.

(v) For ±500 kV HVDC, ± 800 kV HVDC and 1200 kV HVAC lines, the reduction in RoW (52 m , 69 m and 89 m respectively) is not possible as it violates the minimum electrical field requirement at the edge of RoW (i.e 5kV/m at 1.8m height)

(vi) CEA (Technical Standard for Construction of Electric Plants and Electric Lines) Regulations and CEA (Measures relating to safety and Electric supply) Regulations, 2010, which are under revision, shall include RoW requirement at different voltage levels and shall mandate use of steel pole structure / multi-circuit / multi-circuit & multi-voltage towers in urban areas and in approach section near substation for effective use of available corridor.

(vii) The transmission licensees have the flexibility to use appropriate technology options such as Use of steel pole structure, narrow based lattice towers, multi-circuit & multi-voltage towers, lattice / steel pole structure with one side stringing, XLPE cable or GITL, compact towers with insulated cross arm, , multi-circuit / multi-voltage with raised tower height, and VSC based HVDC transmission on overhead line or underground cable etc. depending upon the constraints encountered in availing RoW in different areas.

(viii) The Ministry of Urban Development to take up the issue of providing a dedicated corridor for the interstate and intra-state transmission lines and space for establishment of substations in all green field and brownfield projects at the planning stage itself with State Governments / State Urban development authorities. In this regard, State Governments / State Urban development authorities may consult with State Transmission Utility / CTU.

6. Recommendations for RoW requirement for laying of 33 kV transmission line.

6.1. The RoW width for (a) 33kV overhead transmission lines for different types of structures, commonly used ACSR conductor (with maximum operating temperature of 85 degree) & normal design span and (b) for 33kV lines with covered conductor mounted on pole type structure shall be as indicated below.

33 kV RoW requirement for various configuration

<table>
<tr><th>Conductor</th><th>Structure Type</th><th>Design Span (in m)</th><th>String Type</th><th>RoW recommended (in m)</th></tr>
<tr><td rowspan="5">Commonly used ACSR Bare conductor</td><td rowspan="4">Lattice type/ Steel Steel pole</td><td rowspan="2">250</td><td>"I" String/Suspension</td><td rowspan="2">15 meter</td></tr>
<tr><td>Tension</td></tr>
<tr><td rowspan="2">150</td><td>"I" String/Suspension</td><td rowspan="2">12 meter</td></tr>
<tr><td>Tension</td></tr>
<tr><td></td><td>100</td><td>Pin Insulator</td><td>9 meter</td></tr>
</table>

	(Concrete Pole/Rail pole/H pole/ Single steel pole)	60	Pin Insulator	8 meter
Covered	Pole	100		6 meter

6.2. The CEA Safety Regulations, 2010 are under revision, wherein it has been proposed that in case of transmission lines of 33 kV and below voltage level passing through National Parks, Wildlife Sanctuaries and Wildlife Corridors, underground cables or overhead covered conductors shall only be used to prevent accidental death of animals due to electrocution. The RoW width of 6m recommended for 33kV transmission lines with covered conductors mounted on Pole type structure would be further looked into, if required, as and when amendments in Safety regulations, 2010 will come into effect.

6.3. The possibility of reduction in minimum safe horizontal clearance of 2m, and reduction in the RoW width for 33kV lines with covered conductors mounted on Pole type structure would be deliberated further while bringing out the revision of (Measures relating to Safety and Electric Supply) Regulations,2010.

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Appendix-I

No. 3/4/2016-Trans
Government of India
Ministry of Power
Shram Shakti Bhawan, Rafi Marg, New Delhi- 110001

Dated, 11th August, 2016

OFFICE MEMORANDUM

Subject:- Constitution of the Committee for finalization of compensation in regard to Right of Way (RoW) for transmission lines in urban areas.

The undersigned is directed to inform that during a review meeting of critical transmission lines, taken by Secretary (Power), Govt. of India on 19.7.2016, it has *inter alia* been decided to constitute a Committee under the chairmanship of Ms. Shalini Prasad, Additional Secretary, Ministry of Power to analyse the issues relating to RoW for laying of transmission lines in the urban areas of the country and to suggest a methodology for payment of compensation on this account.

2. Accordingly, a Committee is hereby constituted with the following composition:-

1 Ms. Shalini Prasad, Additional Secretary, Ministry of Power – Chairperson
2 Smt. Jyoti Arora, Joint Secretary, Ministry of Power
3 Chairperson/ Member (PS), Central Electricity Authority
4 Principal Secretary/ Secretary (Energy), Govt. of Karnataka
5 Principal Secretary/ Secretary (Energy), Govt. of Kerala
6 Principal Secretary/ Secretary (Energy), Govt. of Maharashtra
7 Principal Secretary/ Secretary (Energy), Govt. of UP
8 Principal Secretary/ Secretary (Energy), Govt. of Haryana
9 CMD, PGCIL
10 Chief Engineer, PSPA-I, CEA - Convener& Member Secretary

3. Committee may invite representatives from various power utilities in its meetings, as and when deemed necessary.

4. Terms of Reference (ToR) of the committee include:

1. To review/ analyse existing procedures for compensation and suggest possible modification to address following issues:

   a) Possible changes in assessment process;
   b) Procedure for timely release of compensation payment;
   c) Measures to stop payment to ineligible persons;
   d) Possibilities of releasing certain percentage in advance to reduce resistance.

2. To suggest procedure to assess eligibility and subsequent compensation for structure/ hut/ bore well etc. including measure to ensure their shifting/ removal after payment of compensation.

Contd…

3. To explore possibility of enlarging scope of survey to include land scheduling for complete RoW width including name of land owners to facilitate payment of diminution of land value compensation to all eligible persons.

4. To suggest strategy/ mechanism for ensuring compliance/ implementation by State Govt.

5. To explore possible methodology for direct online payment, say, through Jan DhanYojna.

6. To explore the technological options for reducing the tower footing/ base area/ corridor requirements.

7. To explore possibility of reduction of transmission corridor width/ selective restricted use of corridor in urban zones by using technical advances/ raising heights of towers/ adequate safety measures/ revisiting clearance requirements especially for 220 kV and 132 kV levels.

5. The Committee shall submit the report within two months.

(Ghanshyam Prasad)
Director (Trans)
Tele: 011-2371 6674

To,

1 Chairperson/ Member (PS), Central Electricity Authority
2 Principal Secretary/ Secretary (Energy), Govt. of Karnataka
3 Principal Secretary/ Secretary (Energy), Govt. of Kerala
4 Principal Secretary/ Secretary (Energy), Govt. of Maharashtra
5 Principal Secretary/ Secretary (Energy), Govt. of UP
6 Principal Secretary/ Secretary (Energy), Govt. of Haryana
7 CMD, PGCIL
8 Chief Engineer, PSPA-I, CEA.

Copy to: PPS to Secretary (Power)/ SS (BPP)/ AS (SP)/ JS (Trans)/ Director (Trans)/ US (Trans), Ministry of Power.

Appendix-II

Minutes of the meeting taken by Ms. Shalini Prasad, Additional Secretary, Ministry of Power on 30.08.2016 regarding finalization of compensationinregard to Right of Ways (RoW) for transmissionlines in urban areas.

List of participant is placed at**Annex-I.**

2. Additional Secretary, MoP, welcomed the participants and informed that the Right of Way compensation issue has become very critical and completion of many important transmission lines is held up due to severe resistance and demand of enhanced compensation.

3. Joint Secretary(Trans), MoP informed that the guidelines issued vide MoP letter dated 15.10.2015 is a stepping stone towards resolving complex RoW compensation issue and emphasized for its adoption by the States. She also enquired about the steps taken by Karnataka for resolving the compensation issue relating to many PGCIL lines held up in and around Bangalore. She also enquired about the initiative taken by Kerala for reduction/optimization of RoW width through a design based bid for 400 kV lines which has shown promising result and could achieve reduction in width of RoW by 10 m approx.

4. Chief Engineer (PSPA-I), CEA informed that various technical options viz. narrow based towers, multi circuit towers, mono pole towers with only one side stringing, XLPE cables, and gas insulated lines along with other technological interventions are being explored for optimizing RoW. Raising height of towers by having additional extension may also be considered. However, heavy financial implications associated with such technologies needs to be considered for project's economic viability.

5. ED, PGCIL explained the measures taken by POWERGRID for resolving the issue through technical measures like installing pole type, multi-circuit towers in and around major towns. PGCIL also made a brief presentation on RoW compensation issues vis-à-vis legal requirements and actual ground conditions.

6. Additional Chief Secretary, Karnataka and CMD, MAHATRANSCO informed that with the existing 85% and 15% provision, ROW clearance in metro cities shall not be possible as the land cost in metros, particularly in Bangalore, Mumbai and Pune are phenomenally high. They suggested CEA to come out with the design which reduces the restriction for building in the Right of Way. After deliberation, it was agreed that CEA will review the safety guidelines issued in 2010 to further optimize the restriction on account of electrical clearance.

7. CMD MAHATRANSCO also stated that since diminution of land value in case of rural areas is lesser as compared to urban areas, possibility for different compensation level for corridors may also be explored.

8. Director (Trans), Kerala informed that they are implementing an innovative technology by using special design of towers and High performance conductors such as High Temperature Low Sag (HTLS) conductors that will not only reduce the footprint of the towers but will also reduce the Right of Way requirement. She further stated that the prototype test of such tower is lined up in approaching months. Further, she expressed her view that for high voltage line in urban area we may consider reduced RoW through reduced span or by using Monopole towers. She also

suggested that a comprehensive analysis may be carried out for looking into viability of upgrading existing line by various technological initiatives.

9. Superintending Engineer (SE), HVPN informed that around Panchkula they have constructed special Multi-circuit towers of 66 kV which have resulted in tremendous saving of ROW as well as provision for future expansion. They also informed that they are going to replicate the scheme in Yamuna Nagar district and requested committee to visit Panchkula for on the spot review/assessment.

10. PGCIL informed that they have already taken a policy decision to use Multi-circuit tower for all incoming and outgoing lines up to 2 km to reduce ROW requirement and impact on agriculture land around the substation.

11. Additional Secretary, MOP desired that an advisory regarding reserving a dedicated corridor for transmission line be issued to the town planners for all upcoming/planned new cities & towns. She also enquired about the criteria adopted for locating EHV substations around major towns and emphasized that as far as possible such substations be located away from urban/semi-urban areas.

12. After detailed deliberations on various issues, following decisions were taken:

i) CEA shall explore the different technical option available for further optimizing the Right of Way width, Safety clearances such as:

a) New compact tower design.
b) Possibility of including caging of conductor in the existing/ new tower to reduce swing of conductor.
c) Feasibility of underground cable laying for EHV lines.
d) Feasibility of Gas insulated lines.

It was also decided that CEA shall give a presentation on various technical options available, in the next meeting of the Committee.

ii) The other Ministries/Departments which deal with the different type of linear utilities like Urban Development, Railways, and Irrigation etc. may be asked to explore possibilities of including margin/space for transmission/ distribution line while planning such linear projects.

iii) Joint Secretary, MoP asked all member states to provide brief write up on possible solutions/ measures on compensation issue to CE, CEA and ED, PGCIL.

iv) Decision regarding inviting representative from Ministry of Urban Development, Railway, and Road etc. shall be taken at appropriate time after reviewing the proposed technical measures.

13. Meeting ended with a vote of thanks to chair.

Annex-I
F.No. 3/4/2016-Trans

Date/time of the meeting: 30.08.2016 at 11.00 am
Venue: Ministry of Power, NPMC Room
Shram Shakti Bhawan, New Delhi-110001

Sub: First meeting of the committee for finalization of compensation in regard to Right of Way (RoW) for transmission line falling in urban areas.

List of Participants

Ministry of Power

1. Ms. Shalini Prasad, Additional Secretary - In the chair
2. Smt. Jyoti Arora, Joint Secretary (Trans)

Central Electricity Authority (CEA)

3. Shri K.K. Arya, Chief Engineer (PSPA-I)
   Phone: 26102045/Email: kkarya_2001@rediffmail.com
4. Shri Awdhesh Kumar Yadav, Director
   Phone: 26732318/Email: awd.cea@gmail.com

Power Grid Corporation of India Limited (PGCIL)

5. Shri Atul Trivedi, ED
   Mobile: 9873549029/Email: atul.trivedi@powergridindia.com
6. Dr. R.K. Srivastava, AGM (ESMD)
   Mobile: 9910378134/Email: rks@powergridindia.com

STATE SECTOR

Govt. of Karnataka, Bengaluru

7. Shri P. Ravi Kumar, Addl. Chief Secretary (Energy)
   Phone: 080-22252373/Mobile: 09448124242
   Email: prs-energy@karnataka.gov.in
8. Shri A.K. Tiwari, Resident Commissioner
   Mobile: 9868393900/Email: rckarnatakanewdelhi@gmail.com

Govt. of Maharashtra/MAHATRANSCO

9. Shri Rajeev Kumar , CMD
   Phone: 022-26591253/26595000/Fax: 022-26598595/Mob:09769446924
   Email: md@mahatransco.in
10. Shri Chavan R.D., Director (Projects)
    Mobile: 09769006280/Email: dirprj@mahatransco.in

Government of Uttar Pradesh/UPPTCL, Lucknow

11. Shri Ravi Prakash Dubey, CE (TW)
    Mobile: 09412749801/Email: director_project@upptcl.org,cetw@upptcl.org
12. Shri Yatendra Kumar, SE

Government of Kerala

13. Smt. VijayaKumari P., Director (Transmission)
    Mobile: 09446008444/Email: mtkseb@ksebnet.com

Government of Haryana/HVPNL

14. Shri Kuldeep Singh, SE/TS Panchkula
    Mobile: 09316369271/Email: setshvpnpkl@gmail.com

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Appendix-III

Minutes of the meeting taken by Chief Engineer (PSP&PA-I), CEA on 23.09.2016 to explore the different technical options available for optimizing the Right of Way width for transmission lines

List of participants is enclosed at **Annexure-I.**

Chief Engineer (PSP&PA-I) welcomed the participants and informed that a Committee that has been constituted under chairmanship of Ms. Shalini Prasad, Additional Secretary, Ministry of Power (MoP) regarding finalization of compensation in regard to Right of Way (RoW) for transmission line in Urban areas. In the first meeting of the Committee held on 30.08.2016, it was inter-alia decided that CEA shall explore different technical options available for further optimizing the Right of Way width, Safety clearances such as:

a) New compact tower design.

b) Possibility of including caging of conductor in the existing/ new tower to reduce swing of conductor.

c) Feasibility of underground cable laying for EHV lines.

d) Feasibility of Gas insulated lines etc.

2. Director (PSP&PA-I) stated that the relevant Terms of Reference of the Committee, that needs to be deliberated are:

(i) To explore the technological options for reducing the tower footing /base area/ corridor requirements

(ii) To explore possibilities of reduction of transmission corridor width/selective restricted use of corridor in urban zones by using technical advances /raising heights of towers/adequate safety measures/revisiting clearance requirements especially for 220 kV and 132 kV levels.

He requested all the transmission licensees to share their suggestions based on their field experience.

3. Chief Engineer, PSETD, CEA stated that the developers have the flexibility to use appropriate technology such as special tower design and configuration, HTLS Conductors, varied span length etc depending upon the constraints encountered by them in availing RoW in different areas. However, in order to optimize the area for which compensation needs to be paid by the developer, there is a need to recalculate the RoW width for different voltage lines. He further stated that possibility of reduction in RoW should be explored based on certain logical considerations like average design span, type of conductor, swing angle etc. meeting electrostatic field and safety clearance requirement. Once the RoW corridor width is generalized, further optimization of ROW by reduction of span length and use of tension towers etc., may be considered for forest and urban areas.

The reduction in RoW on case to case basis will be difficult to implement.

4. Director (EI), CEA stated that first we need to identify the factors that determines the width of RoW and then explore the technical options that could be used for optimizing/ minimizing each factor to achieve overall reduction in the RoW requirement. After discussions among all the participants, following options emerged out:

S.no	Factors contributing to the RoW width	Options available for optimization of RoW
1.	Configuration of the Tower	a) Use of Narrow Base Multi circuit Tower b) Use of different voltage levels on Multi circuit tower
2.	Live Metal Clearance	No options available for optimization as clearances are to be maintained as per Standards
3.	Horizontal Clearances	No options available for optimization as Horizontal Clearance based on Safety norms cannot be compromised.
4.	Swing and Sag	a) Use of V Suspension String b) Use of HTLS Conductor c) Use of Tension tower d) Tower span

5. After detailed deliberations, the broad parameters/factors were listed down (enclosed at **Annexure II**) to carry out the calculation of RoW for different voltage types and it was decided that M/s Powergrid, M/s Sterlite Grid Limited, M/s Kalpatru Power Transmission Limited and M/s Essel Infraprojects Limited shall furnish the calculations of RoW within a week's time at the following email ids:
   (i) kkarya_2001@rediffmail.com
   (ii) skrmohapatra@rediffmail.com

6. Director (PSP&PA-I) stated that during the meeting on 30.08.2016 it was also agreed that CEA will review the safety guidelines issued in 2010 to further optimize the restriction on account of electrical clearances. Director (EI), CEA clarified that under section 61 of the Central Electricity Authority (Measures relating to Safety and Electric Supply), Regulations 2010 it is mentioned that - An overhead line shall not cross over an existing building as far as possible and no building shall be constructed under an existing overhead line. And there is no scope of reduction in clearances as the human safety is involved.

7. Chief Engineer (PSP&PA-I), CEA stated that in areas where corridor is too congested for construction of overhead transmission lines, alternatives such

as XLPE cable and Gas Insulated line can be explored.

8. The representative of M/s Siemens Ltd. gave a brief presentation on GIL wherein he apprised the participants of the applications where use of GIL can offer a better solution and the areas where GIL proves better than EHV cable. GIL needs no reactors upto 70 km, requires no maintenance once installed and offers adequate overload capability.

The meeting ended with thanks to chair

Annexure-I

List of participants of the Meeting held on 23.09.2016 at CEA to explore the different technical options available for optimizing the Right of Way width for transmission lines.

Sl. No.	Name Shri/Smt	Designation
1.	K.K.Arya	- Chief Engineer (PSP&PA-I), CEA- in chair
2.	S. K. Ray Mohapatra	- Chief Engineer (PSETD), CEA
3.	Awdhesh Kumar Yadav	- Director (PSP&PA-I), CEA
4.	Upender Kumar	- Director, CEA
5.	Manjari Chaturvedi	- Dy. Director, CEA
6.	Santosh Kr. Yadav	- Dy. Director, CEA
7.	Shiva Suman	- Dy. Director, CEA
8.	C.N. Devarajan	- Dy. Director, CEA
9.	Priyam Srivastava	- Assistant Director, CEA
10.	Vikas Sachan	- Assistant Director, CEA
11.	Nitin Deswal	- Assistant Director, CEA
12.	A.K. Vyas	- Addl. GM, PGCIL
13.	Raj Kumar Singh	- Asstt. GM, PGCIL
14.	Vijay Pal	- Sr. Consultant, WAPCOS
15.	T.A.N. Reddy	- VP, Sterlite Power Ltd.
16.	S.G. Mohanty	- AVP, Sterlite Power Ltd.
17.	Bigyan Parija	- AVP, Sterlite Power Ltd.
18.	J. Raghu Ram	- GM, Sterlite Power Ltd.
19.	D.K. Ashok	- Manager (Engg.), Sterlite Power Ltd.
20.	Rajiv Kesarwani	- Sr, Manager, Kalpatru Power Transmission Ltd.
21.	P.K. Chaubey	- VP, Manager, Kalpatru Power Transmission Ltd.
22.	Neeraj Verma	- Manager, ESSEL INFRA Ltd.
23.	Dinesh Parakh	- GM (Comm), Patran Transmission Co. Ltd.
24.	Ramesh Bahri	- CEO, Techno Electric & Engineering Co. Ltd.
25.	Bhaskar Roy	- Manager, Siemens Ltd.

	Parameters freezed for undertaking calculation of RoW width for different Voltage Levels										
S.no	**Parameters affecting RoW**	**Voltage Levels**									
		66 kV D/C	**110 kVD/C**	**132 kVD/C**	**220 kVD/C**	**400 kVD/C**	**500 kV HVDC**	**800 kV HVDC**	**765 kV S/C (Horizontal/Delta)**	**765 kV D/C**	**1200 kV S/C**
1	Type of Conductor	Wolf	Panther	Panther	Zebra	Twin/Quad Moose	Quad Lapwing	Hexa Lapwing	Quad Bersimis	Hex Zebra	Octa Moose
2(a)	Design Span (in metres)	250	320	320	350	400					
(b)		200				250					
3	Conductor Operating Temperature	85 degrees Centigrade (maximum)									
4	String type	I String				I & V String both					
5	Cage Width	Narrow Base & Conventional broad base towers. Tower outline diagram showing various dimensions and clearances with maximum swing									
6	Swing Angle	35 degrees									
7 (a)	Minimum Safety (line conductor to ground object) Clearances	To withstand Lightening Surges				To withstand Switching surges					
(b)		Minimum horizontal clearances as per Safety Regulations									

Appendix-IV

Minutes of the Second meeting of the committee for finalization of compensation in regard to Right of Way (RoW) for transmission line falling in urban areas taken by Ms. Shalini Prasad, Additional SecretaryMinistry of Power (MoP) on 30.09.2016

List of participants is placed at Annex-I.

2 Additional Secretary, MoP welcomed the participants and stated that the Committee in its first meeting decided that for long-term solution on the issue of finalization of compensation in regard to Right of Way (RoW) for transmission line falling in urban areas, two pronged approach is needed i.e.

- Technical measures for reduction of RoW width to reduce the area of impact
- Revised principles for calculating compensation

Chief Engineer, CEA was requested to make a brief presentation on the technical measures.

3. Chief Engineer (PSP&A-I), CEA informed that a meeting was convened was on 23.09.2016 with different transmission licensees to explore the different technical options available for optimizing the Right of Way width for transmission lines. The possibilities of reduction of transmission corridor width and optimum use of corridor in urban zones by using various technological options like raising heights of towers maintaining adequate safety clearance using monopole structures, multi-circuit multi-voltage transmission towers, use of HTLS conductors, use of Gas insulated lines (GIL) / XLPE cable etc were discussed. M/s Powergrid, M/s Sterlite Grid Limited, M/s Kalpatru Power Transmission Limited and M/s Essel Infra projects Limited have been entrusted with the task of furnishing the calculations of RoW for different voltages within a week's time based on the broad parameters/factors like Type of conductor, Design Span, string type, swing angle, meeting safety clearance and electrostatic field requirement. These parameters were finalized during the meeting held on 23.9.2016 held in CEA.

4. Chief Engineer (PSETD), CEA made a brief presentation (copy enclosed as **Annexure II**) apprising the members of the Committee about the

    - Options available for optimization and Optimum utilization of RoW including Urban / Forest areas and ;
    - Revisions currently being undertaken by CEA in the Regulations on Safety and Technical Standard for construction of Electric Lines for addressing growing congestion in existing corridor of transmission network and RoW problems.

    He further suggested that there is a possibility of dividing the route of transmission line into three broad categories such as normal route, Route through Reserved forest areas and Route through Urban areas/Populated areas and notifying different RoW for different category. Specific technical measures may be taken in forest areas and urban areas /populated areas for optimization / optimum utilization of existing RoW.

5. Joint Secretary, MoP stated that there is a need to explore more such innovative solutions like Gas Insulated transmission lines for urban / city areas like Bengaluru where cost is not the major issue but availability of RoW / transmission corridor is extremely difficult. She asked CEA, Powergrid and states to look into the worldwide / international practices to overcome such problem and come out with other technical options vis-à-vis comparison of their cost.

6. Representative from Haryana stated that there is a need to incorporate RoW consideration right from micro planning stage and various options should be explored for optimum utilization of the existing RoW as far as possible. The capacity of existing transmission lines with lower capacity of conductors can also be increased by increasing the size of the conductor or using higher capacity conductors or using multi circuit towers. Before planning new transmission system, the existing capacity should be optimally utilized by upgrading the transformers as well as existing transmission lines in the existing

ROW.

7. Representative from UP stated that more & more use of narrow based towers, monopoles, re-conductoring with HTLS conductors (wherever feasible)etc should be considered. It would be preferrable to reduce the number of transformation level i.e. going for 220/33 kV substations instead of 220/132/33 kV sub-stations (eliminating 132kV level).

8. Joint Secretary, MoP asked CEA to explore the possibility of coming out with some detailed guidelines with regard to Inclusion of Narrow Base, monopole towers, Multi circuit towers, use of with high ampacity conductors right from the planning stage keeping in view future RoW constraints.

9. Representative from Powergrid and KPTCL suggested for modifying the safety Regulations of CEA for allowing construction of buildings upto a certain height under an overhead line in urban areas keeping adequate safety margin by raising of towers heights.

10. Director (CEI), CEA disagreed with the above proposal of Powergrid stating that vertical and horizontal clearance are primarily decided based on the minimum safety clearance and electric field exposure of human being beneath the bottom most conductor and at the edge of the ROW at 2 m above the ground level. As per present practice theses values are kept 5 kV/m at the edge of RoW and 10 kV/m just below the bottom most conductor, keeping in view the human safety. If construction of buildings is allowed under the existing line, then the land owner would be free to make any unauthorized construction under the line which may endanger the human safety as it would not be possible to stop such construction activities and it may not be possible always to have spans free from mid span joints. The representative of UP was also not in favour of such construction as it would be very difficult to stop such illegal constructions in rural areas. PGCIL was suggested to look in to the possibilities of increasing the height of tower to accommodate such small size houses under the transmission lines.

11. After detailed deliberations on various issues, following was decided:

    - To further explore any other technological options available for reduction of RoW based on worldwide practices and the cost implication.

- PGCIL to provide international practices for addressing the RoW issue in urban / populated / forest areas.
- To explore the possibility of framing detailed guidelines to incorporate RoW consideration at micro planning stage and to explore various options for optimum utilization of the existing RoW as far as possible right at planning stage
- To explore the possibility of dividing the route of transmission line into few broad categories such as normal route, Route through Reserved forest area and Route through Urban areas/Populated area and notifying different RoW for different category suggesting specific technical measures for urban / populated areas / forest areas.

Meeting ended with a vote of thanks to Chair.

F.No. 3/4/2016-Trans

Date/time of the meeting: 30.09.2016 at 3.00 pm
Venue: Ministry of Power, Conference Room
Shram Shakti Bhawan, New Delhi-110001

Sub: Second meeting of the committee for finalization of compensation in regard to Right of Way (RoW) for transmission line falling in urban areas.

List of Participants

Ministry of Power

1. Ms. Shalini Prasad, Additional Secretary - In the chair
2. Smt. Jyoti Arora, Joint Secretary (Trans)
3. Shri Ghanshyam Prasad, Director (Trans)

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15. Shri Yatendra Kumar, SE (Trans)

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Minutes of the third meeting of the committee for finalization of compensation in regard to Right of Way (RoW) for transmission line falling in urban areas taken by Ms. Shalini Prasad, Additional SecretaryMinistry of Power (MoP) on 2.11.2016

List of participants is placed at **Annex-I.**

2. Additional Secretary, MoP welcomed the participants and asked Chief Engineer (PSE&TD), CEA to go ahead with the presentation.

3. Chief Engineer (PSE&TD), CEA made a brief presentation (Enclosed at **Annex-II**) apprising the members of the committee about calculations received from PGCIL, M/s Sterlite and Adani. The comparison of reduction in RoW based on reduced span, use of I/V string was presented highlighting that reduction in span can bring down the RoW by about 8-10m at 400kV level and use of V-string can reduce the RoW further. The comparative statement is as follows:

COMPARISON of CALCULATIONS

					RIGHT OF WAY (M)					
					I - STRING			V-STRING		
S.NO.	Circuit & Conductor	SPAN (m)	Sag (m)	Exist. RoW (m)	Sterlite	PGCIL	Reduction w.r.t exist.	Sterlite	PGCIL	Reduction w.r.t exist.
1	765 kV D/C Zebra	400	13.3	67	66.32	67	NIL	56.41	54	10-13 m
		250	6.10		58.08	58	9 m	48.17	46	19-21 m
2	765 kV S/C Bersimis	400	14.8	64	63.35	64	NIL	54.05	54	10 m
		250	6.8		54.1	55	9 - 10m	44.8	45	9 m
3	400 kV D/C Moose	400	13.3	46	44.01	46	0 - 2 m	37.63	38	8 m
		250	6.1		35.77	38	8-10 m	29.39	30	16 m
4	220 kV D/C Zebra	350	10.6	35	34.41	32	0.5 - 3m			
		200	4.3		27.12	25	8-10 m			
5	132 kV D/c Panther	320	7.8	27	26.31	25	0.5 - 2m			
		200	3.6		21.42	20	5.5 -7 m			
6	66 kV D/C WOLF	250	5.11	18	18.37		NIL			
		200	3.56		16.59					

Note: The requirement of Electric field at edge of RoW at 2m height needs to be ensured as 5kV/m

4. CE (PSE&TD), CEA informed that the reduction in span would increase the cost of line due to increase in number of towers.For example, the no. of towers per km will increase from 2.5 to 4 per km at 400kV level i.e increase by about 60%. He further suggested that use of V-string insulators may be restricted to areas where RoW constraint is severe.

5. Joint Secretary (Trans), MoP stated that calculation of RoW do not cover use of V-string at 220kV, 132kV and 66kV. The calculation of RoW for above voltage levels with V-string configuration should also be provided by PGCIL.

6. CE(CEI), CEA informed about the request of Himachal Pradesh Electricity Utility and KPTL for reduction of RoW at 33kV and 66kV/132kV level respectively. He also informed that number of cases of death of elephants due to electrocution is a matter of concern for MOEF. He further emphasized the use of covered conductor in such areas. There could be reduction in RoW by about 50% as the required horizontal clearance can be reduced substantially by using covered conductor. CEA is considering the use of conductor at 33kV, 66kV and 132kV level for protecting animals in forest areas and reduction of RoW in Urban areas. He suggested that multiple options for reduction of RoW should be considered and option/ methodology to be used may be left to utilities to decide depending upon the conditions/area/constraints.

7. CE(PSE&TD), CEA highlighted that the current practice of RoW being followed in India for the transmission lines is more or less similar to worldwide practice as per input of PGCIL. Hence, the need for reduction in RoW is essential in urban areas/ populated areas and forest areas and it may not be desirable in areas without constraint. Adoption of available technologies and other methods involving reduction in span, multicircuit/ multicicuit-multivoltage towers, use of insulated cross arm, raising of tower height, use of VSC based HVDC transmission line, and underground cable/ Gas Insulated Lines etc. may be considered in such areas. The reduction in RoW needs to be checked for electric field norms at edge of RoW. PGCIL supplemented that except Korea, where very tall towers are being used at 765kV level to limit RoW to about 37m.The practices of other counties are more or less similar to that of India.

8. Representative from Kerala stated that RoW need not be specified in the regulation because it depends on multiple parameters. It would be preferable to mention the minimum clearance to be maintained instead of the minimum RoW. He further stated that the RoW, presently being used, is based on old tower design and with new technologies/ methodologies available now, it may not be required to maintain same RoW. CE(PSE&TD), CEA stated that it is desirable to define the RoW requirement for each and every voltage level. If voltage wise RoW is not specified then the process will become complex, non-uniform across the country and it will be difficult to calculate compensation.

9. Director (Operations), PGCIL suggested that the construction of single circuit tower should not be allowed anymore and each line may be divided into three/ four sections like approach section near substation, forest area, urban areas/ populated area and areas without constraint.

10. Representative from Maharashtra said that the measurement of RoW from the centre of the tower may be replaced by measurement from the live wire position. Utilities may be given free hand for reduction of the RoW by reduction of span, modifying the tower design, type of tower, and type of conductor etc.

11. Additional Secretary, MoP suggested that a committee comprising of representatives CEA, PGCIL,Kerala and Maharashtra may be constituted to calculate and create a matrix considering all factors influencing the RoW (span, conductor, I/V string, swing angle) for a particular wind zone clearly bringing out the RoW requirements for different combinations. .

12. Joint Secretary (Trans)desired that the state utilities should plan for separate corridor for transmission line for green field projects. Additional Secretary, MoP stated that the matter needs to be discussed with Chief Town planner or other concerned authorities, who are involved in town planning.

13. After detailed deliberations on various issues, following decisions were taken:

13.1 A committee comprising of representatives from CEA, PGCIL, Maharashtra and Kerala will calculate and create matrix for RoW requirements considering all factors influencing the RoW (span, conductor, I/V string, swing angle) for one wind zone, say wind zone 4.

13.2 Chief Town planners or other concerned authorities, who are involved in town planning, would be invited in the next meeting to discuss the provisions of RoW for laying of transmission lines.

13.3 The next meeting to be held in last week of November for reviewing the calculation submitted by the committee.

13.4 The state utilities shall come out with suggestions regarding methodology for calculation of compensation

14. The meeting concluded with thanks to the Chair.

Annex-I

Date/time of the meeting: 2.11.2016 at 11.30 am
Venue: Ministry of Power, Conference Room
Shram Shakti Bhawan, New Delhi-110001

Sub: Third meeting of the committee for finalization of compensation in regard to Right of Way (RoW) for transmission line falling in urban areas.

List of Participants

Ministry of Power

1. Ms. Shalini Prasad, Additional Secretary - In the chair
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3. Shri Ghanshyam Prasad, Director (Trans)

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Annex-II

CEA PPT.pptx

Appendix-VI

Minutes of the 4th meeting of the Committee chaired by Ms. Shalini Prasad, Additional Secretary, Ministry of Power (MoP) on 08-12-2016 for finalization of compensation in regard to Right of Way (RoW) for Transmission line falling in urban areas

List of Participants is at **Annex – 1**.

2. Additional Secretary, MoP welcomed the participants and Chief Engineer (PSP&PA-I), CEA highlighted about the discussions held with PGCIL and KSEB on 25.11.2016 and asked CE (PSE&TD) to make a brief presentation.

3. Chief Engineer (PSE&TD), CEA made a brief presentation (Enclosed as **Annex-2**) apprising the members of the committee about calculations. He informed that as decided in the last meeting, based on the inputs from PGCIL and Kerala, matrix for RoW width has been prepared considering various factors influencing the RoW (span, conductor, I/V string, swing angle) for wind Zone 4. As discussed in last meeting, it was proposed to divide the route of transmission lines (66kV and above voltage level) into three sections/ categories namely Normal route without constraint, Forest area and Urban area/populated areas/ approach section near substation. He further informed that the RoW matrix provides the values for following two conditions:

(i) Specifying RoW and base width of tower for different voltage level for calculation of compensation
(ii) Specifying the safety clearance requirement including swing of conductor and giving opportunity for optimizing the design of tower.

4. The representative from Karnataka stated that if the compensation is to be provided for the maximum value of RoW, then there will be no incentive for the utilities to optimise design of tower requiring lesser RoW or use better conductors to reduce the RoW. He argued that compensation should be provided for the actual RoW of transmission line. CE(PSE&TD), CEA informed that it is not desirable to calculate RoW requirement based on individual span for the purpose of compensation payment as it will be extremely difficult and practically impossible to calculate compensation on case to case basis. The process will be very complex, non-uniform across the country and it may lead to increase in legal disputes.

5. CE(PSP&PA-I), CEA stated that a number of times, representations have been received from Small Hydro Power developers for the reduction of RoW at 33 kV level. He also informed that number of cases of death of elephants in forest areas due to electrocution has been reported and it has become a matter of

concern for M/o Environment &Forests. The use of covered conductor, pole type structure etc. in forest areas need to studied. He proposed to extend the scope of the work for finalizing the RoW requirement for 33kV system for which a small committee may be constituted.

6. Director (O), PGCIL suggested to mandate the use of only multi circuit and multi voltage towers in the approach section of the substations upto a certain distance to reduce the RoW requirement. Director (PSP&PA-I), CEA added that length of this approach section depends upon the location of substation, which depends on many factors like availability of land, cost of land and expected load etc. He also pointed out that the onus is on the state utilities to connect ISTS to their load centres, but the location of substation (under ISTS) is generally identified by the developer/transmission utilities. Director(O), PGCIL said that generally the location of EHV substations are away from the cities and the use of multi circuit/ multi-circuit & multi voltage towers at the approach section of the substations should be mandated. CE(PSE&TD), CEA informed that the provision has been made in the draft CEA (Technical Standard for construction of Electric Plants & Electric Line) Regulations.

7. Chairperson enquired about the methodologies being followed by state utilities to calculate the compensation to be paid to the owner of the land/ affected party and whether the annuity based method is more suitable than the current practice of onetime compensation payment. Representative from Kerala informed that they are providing annuity in both urban as well as rural areas. Representative from Karnataka said that they are providing 100% compensation for land use for tower footing and 75% of land cost for RoW value in urban areas and 50 % of land cost of RoW in rural areas. Joint Secretary (Trans), MoP said that the provision of 85% of compensation for the tower footing was kept with intention that 100 % compensation is equivalent to acquisition of the land. Representative from Haryana stated that when the number of line crossing increases, the land owners do not like to spare their land even after offering the compensation. Representative from Kerala stated that annuity based compensation is preferred as it provides a source of regular income to the owner and the land has some resale value. Joint Secretary, MoP said that a choice can be given to the owner to choose between an annuity based compensation or onetime payment of compensation amount.

8. Joint secretary (Trans), MoP stated that the land under the transmission lines is used by owners for cultivation/ other activities in the rural areas and this is not possible in the urban areas. It is better to use monopole structure in the urban areas. This will reduce the footprint and land requirement. Director(O), PGCIL, informed that use of monopole may increase the cost of the line by about 20% as the pole type towers are three times costlier than the lattice towers. But, it will

reduce the compensation cost. Joint Secretary (Trans), MoP stated that pole type towers should be made mandatory for transmission lines up to 400 kV in the urban areas. Chief Engineer(PSE&TD), CEA highlighted that it is difficult to transport & erect monopole structure in densely populated areas/ urban areas as in many cases the approach to site may not be accessible, difficult to transport heavy structural parts of pole and to use heavy cranes for erection of poles. Representative from Kerala also agreed with his view and informed that KSEB is facing similar difficulties in using the pole structure in urban areas, although the requirement of monopole structure is maximum in such areas.

9. Chairperson said that demand for compensation will reduce if the owners are allowed to perform their activities below the transmission lines. As in Japan, towers with sufficiently increased heights can be used to allow the land owners to use their land. In such cases, the amount of compensation to be paid can be determined vis-a-vis the activities allowed under the transmission line.

10. Joint secretary (Trans), MoP said that for Greenfield projects, clear demarcation of RoW should be done. Additional Secretary, MoP added that while planning a new transmission line, in place of shortest route, a more optimised route should be chosen avoiding the possible hindrances in land acquisition for example new line should be planned along the rail corridor, road etc., if feasible.

11. After detailed deliberations on various issues, following decisions were taken:

(i) A sub-committee comprising of representatives from CEA, Punjab, Uttarakhand, Himachal Pradesh and TATA Power and few others would deliberate and finaliseRoW requirements for 33 kV transmission lines.
(ii) Deliberations to be held with Chief Town planners or other concerned authority, who are involved in town planning, to discuss about dedicated corridor for laying of transmission lines for Greenfield projects.
(iii) CEA to consider framing of guidelines stipulating use of monopole structure / multi-circuit / multi-circuit & multi-voltage towers in urban areas and in approach section near substation. The use of such structures can be considered by Utilities for other areas based on economics.
(iv) CEA and PGCIL to prepare a Draft Report concluding the decisions taken by the Committee.
(v) The issue regarding compensation methodology would be discussed further by MoP with state utilities.

12. The meeting concluded with thanks to the Chair.

Annex-1

Date/time of the meeting: 8.12.2016 at 3.00 pm
Venue: Ministry of Power, Conference Room
Shram Shakti Bhawan, New Delhi-110001

Subject: 4th meeting for finalization of compensation in regard to ROW for transmission lines in urban areas.

List of Participants

Ministry of Power

1. Ms. Shalini Prasad, Additional Secretary (SP) - In the Chair
2. Smt. Jyoti Arora, Joint Secretary (Trans)
3. Shri Bihari Lal, Under Secretary (Trans)

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Annex-2


4th RoW ppt.rar

Minutes of the 5th meeting of the Committee Chaired by Ms. Shalini Prasad, Additional Secretary, Ministry of Power (MoP) on 08-02-2017 for finalization of compensation in regard to Right of Way (RoW) for Transmission line falling in urban areas.

List of Participants is at **Annex – 1**.

2. Additional Secretary, MoP welcomed the participants and emphasised on the need to expeditiously finalise the report of the Committee.

3. On deliberation with the representative of the Town & Country Planning Organisation, it was decided that Ministry of Power (MoP) will write to Ministry of Urban Development to take up the issue of providing a dedicated corridor for the interstate and intra-state transmission lines and space for establishment of substations in all green field and brown field projects at the planning stage itself with State Governments/ State Urban development authorities. In this regard, State Governments/ State Urban development authorities may consult with State Transmission Utility/ CTU.

4. CEA informed that the owners of the land coming under the RoW are prohibited from any construction activity under the transmission line due to safety reasons. Since the main use of the land in the rural areas is for the purpose of agriculture, the land under RoW can still be used for the agriculture purpose. However, in urban areas, the value of land under RoW diminishes rapidly. Therefore, in the notified urban areas, the compensation of the land coming under the RoW should have an additional component in the form of non-usability allowance to be paid to the owners. The value of non-usability allowance is proposed to be at 15% of the land value for the width of RoW corridor. This non-usability allowance is in addition to the 15% compensation already agreed towards the diminution of the land value falling in the RoW of the transmission line. The payment of non-usability allowance is subject to the condition that no construction activities would be permitted in the RoW area.

5. Representative from PGCIL stated that the increase in compensation of urban areas may raise the issue of dispute between rural and urban population and ministry being biased against the rural areas.

6. Representative from Karnataka stated that the landowners in urban areas may also be allowed construction up to a certain height coming under the RoW of transmission lines and for providing the requisite safety clearances, height of towers may be increased. The same practice is used in many foreign countries

such as Japan etc. He added that if construction activities are allowed under RoW, utilities may face lesser problem in acquiring RoW from landowners and chances of litigation may also get reduced. Non-residential activities like godowns, cold storage etc. may be permitted under the transmission lines. Chief Engineer (PSE&TD, CEA) stated that the construction activities under the RoW should not be allowed in urban areas because in case of a tower failure/ snapping of conductor the lives of persons living under Row would be in danger. Moreover, in current scenario, even when no construction is allowed, there are instances of unauthorized constructions under the RoW. If construction activities are permitted under RoW, then there is a possibility that unauthorized construction may increase manifold thus endangering lives of persons living under the RoW. Representative from PGCIL stated that allowing construction activities under the RoW would increase the height of tower thereby increasing the cost of transmission line considerably. The transmission line with extended tower may become costlier than the current method adopted by utilities i.e. to pay the compensation.

7. Director (PSP&A-I), CEA stated that if construction activities are allowed under the RoW of the transmission line, then transmission utilities may face difficulty in carrying out the O&M activities as accessibility to the transmission line would become difficult.

8. Additional Secretary, MoP stated that allowing the non- residential activities can be looked as a solution to the problem and state governments may be asked to make an advisory body for regulating the same. This will also help in conversion of residential building to commercial building. Chief Engineer (PSE&TD, CEA) stated that present safety regulations of CEA do not allow any type of construction activities under RoW of the Transmission line. Further, Chief Engineer (Electrical Inspectorate, CEA) need to be consulted for allowing non-residential activities under the RoW of transmission line.

9. Representative from PGCIL stated that the land use of the city changes with time and a new master plan generally comes in 5 years. The amount to be paid as non-usability allowance may be kept limited to the notified urban area. Additional Secretary, MoP stated that this allowance shall be paid only in cases where no further construction activity is allowed in the RoW land.

10. Regarding the sub-committee constituted for determining RoW requirements at 33 kV voltage level, CEA informed that the first meeting of the sub-committee was held on 02.02.2017 wherein it was decided that a format would be circulated by CEA to all the members of the committee. The format would include various conductors, different span, line configurations etc at 33 kV level for calculation of RoW. Based on the calculations submitted by the members RoW matrix for 33 kV voltage level, would be prepared by CEA and the same would be

finalized in the second meeting of the sub-committee. The format has already been circulated by CEA and inputs from the members are awaited.

11. After further discussions, following decisions were taken:

(i) Additional compensation in the form of non-usability allowance of 15% of the land value for the width of RoW corridor would be applicable in the notified urban areas. No construction activity of any kind would be permitted under the RoW of the transmission line.

(ii) The RoW for 33 kV transmission lines as finalized by sub-committee for the purpose would be included in the draft report of the Committee on RoW compensation for urban areas and the same would be circulated to members of the committee for their comments.

(iii) After receipt of the comments from the members of the committee, the final report of the committee would be issued.

(iv) Chief Electrical Inspectorate, CEA would initiate/ circulate a discussion paper allowing construction activity under the RoW of the transmission line.

12. The meeting concluded with thanks to the Chair.

Annex-1

No. 3/4/2016-Trans

Date/ time of the meeting: 8.2.2017 at 3.30 pm
Venue: Ministry of Power, Conference Room
Shram Shakti Bhawan, New Delhi-110001

List of Participants

Ministry of Power

16. Ms. Shalini Prasad, Additional Secretary (SP) - In the Chair
17. Smt. Jyoti Arora, Joint Secretary (Trans)
18. Shri Irfan Ahmad, Director (Trans)

Central Electricity Authority (CEA)

19. Shri Ravinder Gupta, Chief Engineer,
    Mobile: 9968286184, Email: ravindergupta_cea@rediffmail.com
20. Shri S.K. Ray Mohapatra, Chief Engineer,
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21. Shri Awadesh Yadav, Director (PSPA-I)
    Phone : 011-26732318/Mob:9868664087/Email : awd.cea@gmail.com
22. Shri Mohit Mudgal, Assistant Director–I
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Power Grid Corporation Of India Limited (PGCIL)

23. Shri Atul Trivedi, E.D.,
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Govt. of Uttar Pradesh/UPPTCL

26. Shri Ravi Prakash Dubey, Chief Engineer (Transmission West),
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27. Shri Yatendra Kumar, SE (Trans), Gzb.
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Govt. of Haryana/HVPN

28. Shri Rajesh Sharma, XEN,
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Govt. of Kerala/KSEBL

29. Smt. Vijayakumari. P, Director (Trans. & SO)
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30. Smt. Sheela M Daniel, Resident Engineer,
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Govt. of Maharashtra/MAHATRANSCO

31. Shri Charuta Be ndre, Superintending Engineer,
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Govt. of Karnataka/KPTCL

32. Shri P. Ravi Kumar, Secretary,
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33. Shri Deepak T.C. Resident Engineer,
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TCPO, MOUD

34. Shri Monis Khan,
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35. Shri S. Sompalle,
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Appendix VIII

Report of the Committee for finalization of Right of Way (RoW) for 33 kV Transmission lines

5. Background

1.5 The matter of Right of Way for laying of transmission lines in the country was deliberated during the Power Ministers' Conference on 9-10 April 2015 at Guwahati and a committee under the Chairmanship of Special Secretary, Ministry of Power was constituted to analyse the issues related to Right of Way for laying of transmission lines in the country and to suggest a uniform methodology for payment of compensation on this account. The committee comprised of Chairperson, CEA, Principal Secretary (Energy) of M.P., U.P, Maharashtra, Karnataka, Kerala, Jt. Secretary (Trans), MoP, CMD/Dir (Projects), POWERGRID and Chief Engineer (SP&PA), CEA as convener and Member Secretary.

1.6 The Committee met three times (20.04.2015, 30.04.2015 and 1.06.2015) before finalizing its recommendations. The committee finalized its recommendations for payment of compensation towards damages in regard to Right of Way for transmission lines, which was issued via MoP OM No. 3/7/2015-Trans dated 15th October, 2015. The guidelines are applicable only for transmission lines of 66 kV and above voltage level. The guidelines recommended compensation for 85% of the land value for tower footing and 15% of the land value for RoW of the line. The above guidelines were communicated by the Ministry of Power to Chief Secretaries of all the States with the request to take suitable decision regarding adoption of the guidelines considering that acquisition of land is a state subject.

1.7 Further, to analyze the issues related to RoW for laying of transmission lines in the urban areas of the country and to suggest a methodology for payment of compensation on this account, a committee under the chairmanship of Ms. Shalini Prasad, Additional Secretary, Ministry of Power with members from CEA, Principal Secretary (Energy) of M.P., U.P, Maharashtra, Karnataka, Kerala, POWERGRID has been constituted. The terms of reference of the committee, inter alia, includes "Review/Analysis of existing procedures for compensation"

1.8 Four meetings of the committee were held in MoP on 30.8.2016, 30.9.2016, 2.11.2016 and 8.12.2016. In the 4th meeting of the committee, the representations received from Small Hydro Power developers for reduction of RoW at 33 kV voltage level and the incidents of death of elephants in forest areas due to electrocution was highlighted and accordingly, it was decided to constitute a sub-committee to look into the issue of RoW requirement for 33 kV transmission lines.

6. Constitution and term of reference of the committee for RoW for 33 kV

2.1 MoP vide its OM dated 20.1.2017 (copy enclosed at **Annexure-I**) constituted the committee under the chairmanship of Chief Engineer, PSPA-I, CEA alongwith representatives from CEA, Punjab, Uttarakhand, Himachal Pradesh, TATA Power and other stakeholders. The MoP order also provided for invitation to representatives from small Hydro developer / other utilities. Subsequently, MoP vide its letter dated 13-02-2017 included Chief Engineer CEI, CEA as a member of the committee.

2.2 To deliberate and finalise the Right of Way (RoW) requirements for lines at 33 kV level.

3 Deliberations of the committee of RoW requirement for 33 kV transmission lines

3.1 1st meeting of the committee was held on 2.2.2107 at CEA, New Delhi, wherein all the committee members and representatives from Himalayan Power Producers Association (on behalf of Small Hydro developers) participated.

3.2 In the meeting, it was decided that CEA will circulate a matrix listing down the combination of type of conductors, tower configuration, design span and type of insulator to all the members of the committee for calculating RoW for 33 kV transmission line.

3.3 The minutes of the 1st meeting is enclosed at **Annexure-1I.**

3.4 Subsequently, MoP convened a meeting on 8.2.2017, wherein CEA was requested to circulate the draft report **for finalisation of compensation in regard to Right of Way (RoW) for transmission lines in urban areas** after including the recommendations of the committee constituted for finalization of RoW for 33kV voltage level.

3.5 The 2nd meeting of the committee was held on 24.03.2107 at CEA, New Delhi, wherein, the RoW requirement for 33 kV voltage level was finalised. The minutes of the 2nd meeting of the committee is enclosed at Annexure-III.

The minutes of meeting is enclosed at **Annexure-III**

4 Recommendations of the Committee.

i) The RoW width for (a) 33kV overhead transmission lines for different types of structures, commonly used ACSR conductor (with maximum operating temperature of 85 degree) & normal design span and (b) for 33kV lines with covered conductor mounted on pole type structure shall be as indicated below.

33 kV RoW requirement for various configuration

Conductor	Structure Type	Design Span (in m)	String Type	**RoW recommended (in m)**
Commonly used ACSR Bare conductor	Lattice type/ Steel Monopole	250	"I" String/Suspension	15 meter
			Tension	
		150	"I" String/Suspension	12 meter
			Tension	
	(Concrete Pole/Rail pole/H pole/ Single steel pole)	100	Pin Insulator	9 meter
		60	Pin Insulator	8 meter
Covered	Pole	100		6 meter

ii) The CEA Safety Regulations, 2010 are under revision, wherein it has been proposed that in case of transmission lines of 33 kV and below voltage level passing through National Parks, Wildlife Sanctuaries and Wildlife Corridors, underground cables or overhead insulated (covered) conductors shall only be used to prevent accidental death of animals due to electrocution. The RoW width of 6m recommended for 33kV transmission lines with covered conductors mounted on Pole type structure would be further looked into, if required, as and when amendments in Safety regulations, 2010 will come into effect.

iii) These recommendations would form part of the main report of the Committee finalizing compensation in regard to Right of Way for transmission line falling in urban areas.

iv) The possibility of reduction in minimum safe horizontal clearance of 2m, and reduction in the RoW width for 33kV lines with covered conductors mounted on Pole type structure would be deliberated further while bringing out the revision of (Measures relating to Safety and Electric Supply) Regulations.

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Annexure-I

No. 3/4/2016-Trans
Government of India
Ministry of Power
Shram Shakti Bhawan, Rafi Marg, New Delhi- 110001

Dated, 20th January, 2017

OFFICE MEMORANDUM

Subject:- Constitution of the Committee to deliberate and finalise Right of Way (RoW) requirements for transmission lines at 33 kV level.

The undersigned is directed to state that during the fourth meeting of the committee regarding finalization of compensation in regard to RoW for transmission lines falling in urban areas, held on 8.12.2016 under theChairpersonship of Ms. Shalini Prasad, Additional Secretary, Ministry of Power, it has *inter alia* been decided to constitute a Committee comprising representatives from CEA, Govt. of Punjab/ Uttarakhand/ Himachal Pradesh/ Tata Power etc., to deliberate and finalise Right of Way (RoW) requirements for transmission lines at 33 kV level.

2. Accordingly, a Committee is hereby constituted with the following composition:-

1 Chief Engineer, PSP&PA-I, CEA - Chairperson
2 Chief Engineer, DPD, CEA
3 Chief Engineer, PSETD, CEA
4 Representative of Govt. of Punjab
5 Representative of Govt. of Uttarakhand
6 Representative of Govt. of Himachal Pradesh
7 Representative of Tata Power

3. The Committee, if required, may invite representatives from Small Hydro Power developers/ other utilities to its meeting(s).

4. The Committee shall submit its report in the next meeting of the Urban RoW Committee, which is scheduled for 3.2.2017 at 3.00 pm.

(Bihari Lal)
Under Secretary to the Govt. of India
Tele: 011-23325242
Email: transdesk-mop@nic.in

To,

1 Member (PS), Central Electricity Authority
2 Principal Secretary/ Secretary (Energy), Govt. of Punjab
3 Principal Secretary/ Secretary (Energy), Govt. of Uttarakhand
4 Principal Secretary/ Secretary (Energy), Govt. of Himachal Pradesh
5 Chief Engineer, PSP&PA-I, CEA, New Delhi.
6 Chief Engineer, DPD, CEA
7 Chief Engineer, PSETD, CEA
8 MD, Tata Power, Mumbai

No. 3/4/2016-Trans
Government of India
Ministry of Power
Shram Shakti Bhawan, Rafi Marg, New Delhi- 110001

Dated, 13th February, 2017

OFFICE MEMORANDUM

Subject:- Constitution of the Committee to deliberate and finalise Right of Way (RoW) requirements for transmission lines at 33 kV level.

In continuation of this Ministry's O.M. of even No. dated 20.01.2017, the undersigned is directed to say that Chief Engineer, CEI(CEA) will also be part of the Committee to deliberate and finalise Right of Way (RoW) requirements for transmission lines at 33 kV level.

2. All other terms and conditions of the said OM remain un-changed.

(Bihari Lal)
Under Secretary to the Govt. of India
Tele: 011-23325242
Email: transdesk-mop@nic.in

To,

1 Member (PS), Central Electricity Authority
2 Principal Secretary/ Secretary (Energy), Govt. of Punjab
3 Principal Secretary/ Secretary (Energy), Govt. of Uttarakhand
4 Principal Secretary/ Secretary (Energy), Govt. of Himachal Pradesh
5 Chief Engineer, PSP&PA-I, CEA, New Delhi.
6 Chief Engineer, DPD, CEA
7 Chief Engineer, PSETD, CEA
8 Chief Engineer, CEI, CEA
9 MD, Tata Power, Mumbai

Annexure-II

Minutes of the meeting of the committee to deliberate and finalize RoW requirements for transmission lines at 33kV held on 2.2.2017 at CEA

List of Participants is at Annex-I

1. Chief Engineer (PSPA-I) welcomed the participants and stated that in the 4th meeting of the Committee to finalize compensation in regard to Right of Way for transmission line falling in urban areas held at MoP on 8.12.2016, it was, interalia, decided to constitute a sub-committee, which would deliberate and finalise RoW requirements for 33 kV transmission lines. Accordingly, MoP vide its OM. dated 20.1.2017 has constituted the committee comprising of representatives from CEA, Punjab, Uttarakhand, Himachal Pradesh, TATA Power and other stakeholders. The MoP order also provides for invitation to representatives from small Hydro developer/ other utilities. Therefore, Himalayan Power Producers Association and Electrical Inspectorate division, CEA have been invited to the meeting and they are co-opted as committee members.

2. The representative of Himalaya Power Producers Association stated that Pole type tower structure is the preferred and common choice for 33 kV transmission lines, in which, the conductor is firmly fixed with Pin insulators. Even at the dead end, Disc Insulators firmly holds the conductor, therefore the swing of conductor is almost zero for 33 kV transmission lines. He stated that the RoW requirement of 15 m for 33 kV S/c transmission lines as per present MOEF guideline/ IS has been derived considering the swing of conductor in suspension insulator on lattice type tower structure, which is rare in hilly/ forest areas. He further stated that there are two types of configurations common on pole type structure i.e. Delta Configuration and Horizontal configuration and maximum RoW is required for horizontal configuration. As per IS 5613, conductor to conductor clearance required is 1.5 m and minimum phase to ground clearance of 0.33 m on both sides. Therefore, the RoW requirement for 33kV line (on pole structure) works out to be 6.66m, taking into consideration horizontal clearance of 1.83m as against RoW of 15m specified for 33kV. He further stated that for small hydro power developers, RoW compensation cost is substantial and effects the viability of the project.

3. The representative of Punjab stated that instead of Lattice type tower structure, Pole type towers are preferable for 33 kV in urban and forest areas. He further stated that where additional strength is required on account of wind pressure/additional height requirements, rail pole or cemented pole could be used. The RoW corridor of 15 m with Lattice type tower structure for 33kV is not in common use. He further stated that instead of freezing the RoW width, the same may be left open to the implementing agency as the RoW would vary depending on the type of structure used.

4. Director (EI) stated that the safety Regulations are under revision wherein the use of covered conductor/underground cable in wildlife/bird sanctuary, forest areas for 33 kV and below voltage level is being made mandatory to avoid accidental death of animals due to electrocution. Covered conductor would also reduce the RoW width substantially.

5. The representative of Uttarakhand stated that covered conductors are similar to Aerial Bunch Cables (ABC). With ABC, they are facing problems like insulation failure, leakage current etc. These issues needs to be considered while making the use of covered conductors mandatory upto 33 kV level in forest areas. He further stated that in hilly terrain, where poles are located on hill top, no cutting of trees is involved, still the forest authorities are claiming RoW compensation. In such cases, there should be no RoW compensation.

6. The representative of Tata Power stated that the horizontal clearance of 2m as per present regulation is very much on the higher side. At 11kV, horizontal clearance of 1.2 m is used and this 1.2 m also includes the phase to ground clearance of 0.33m. The horizontal clearance is basically safe distance to avoid accidental human contact with live wires. Therefore, the horizontal clearance of 1.2 m is also adequate for 33kV. To this additional clearance of 0.33 m may be added for the worst case, in that case also horizontal clearance for 33kV works out be 1.53m as against 2m.

7. It was seen that horizontal clearance mentioned in IS 5613 for 33 kV level is 1.83m whereas in the CEA Safety Regulations it is mentioned as 2m. Director (EI), CEA clarified that the clearance values in IS 5613 as well as CEA Safety Regulation has been taken from Indian Electricity Rules, 1956. The Electricity Rules, 1956 specifies horizontal clearance of 2m for 33kV level. He further stated that clearances are basically for human safety and to avoid accidental contact of human being with live conductor.

8. Representative of TATA Power was requested to carry out the calculations for electric fields at various distances as we move away from the live conductor for 33kV level. Tata Power agreed to carry out the studies.

9. Chief Engineer (PSETD) stated that ROW requirement works out to about 15m for span length of about 250m (with ACSR Dog conductor), which is normally considered for 33kV line with lattice structure. He further highlighted that although the developer is free to optimize the width of RoW by optimizing the width of tower base etc, a uniform fixed RoW should be defined for compensation purpose. He stated that in the manner the RoW matrix is being developed for voltage level of 66 kV and above, the same may be replicated for 33 kV voltage level. He apprised the participants that for 66 kV and above voltage level, the matrix that is being developed is defining the RoW for three different routes i.e. Urban/Populated area; Forest Area and Unrestricted area with different spans, tower configurations and conductor.

10. After detailed deliberations in the meeting, it was decided that CEA will forward the matrix listing down the combination of type of conductors, tower configuration, design span and type of insulator and members will have to furnish the RoW calculations for different configuration within a week. The matrix prototype is attached as **Annexure II**. The matter would be further deliberated in the next meeting after receipt of RoW calculation matrix and other relevant information from members of various utilities.

Annexure-I

List of participants of the meeting held on 02.02.2017 to deliberate and finalize Right of Way (RoW) requirements for transmission lines at 33 kV level

Sl. No.	Name Shri/Smt	Designation
I.	**CEA**	
1.	Ravinder Gupta	- Chief Engineer (PSP&PA)
2.	S. K. Ray Mohapatra	- Chief Engineer (PSETD)
3.	Ghanshyam Prasad	- Chief Engineer (DP&D)
4.	Awdhesh Kumar Yadav	- Director (PSP&PA-I)
5.	Upender Kumar	- Director (CEI)
6.	Manjari Chaturvedi	- Dy. Director (PSP&PA)
7.	Kavita Jha	- Dy. Director (PSETD)
8.	Priyam Srivastava	- Assistant Director
9.	Vikas Sachan	- Assistant Director
10.	Nitin Deswal	- Assistant Director
11.	Mohit Mudgal	- Assistant Director
II.	**Tata Power Delhi**	
12.	H.C. Sharma	- Head (Project)
III.	**PSPCL**	
13.	Sanjeev Gupta	- Dy CETL(Dsg.)
IV.	**HPSEBL**	
14.	R.K. Sharma	- Director
V.	**Uttarakhand Power Corporation Limited (UPCL)**	
15.	Er. P.C. Pandey	- Chief Engineer
VII.	**Himalaya Power Producers Association**	
16.	Pawan Kohli	-President
17.	Er. C.J. Rai	- Chief Engineer

Annexure - II

Table

Conductor type	Configuration	structure type (Lattice type/ Concrete Pole/Monopole/Rail pole/Double pole/ Single steel pole)	Design Span (in m)	String Type	Horizontal clearance (in m)	Insulator Length (Considered for Swing) (in m)	Max Sag at 85 Deg.C (in m)	Horizontal displacement from Conductor attachment point due to swing (in m)		Maximum Horizontal distance of Conductor attachment point from centre of tower /Pole (in m)	Width of right of way (in m)
B			C		D	E	F	H=(E+F)*Sin35	I=(E+F)*Sin60	X	R=2(D+H)+2X
ACSR DOG		Lattice type/ Steel Monopole	250	"I" String/Suspension	2.0						
				Tension	2.0	0					
			150	"I" String/Suspension	2.0						
				Tension	2.0	0					
		(Concrete Pole/Rail pole/H pole/ Single steel pole)	100	Pin Insulator	2.0	0					
			60	Pin Insulator	2.0	0					
ACSR Wolf		Lattice type/ Steel Monopole	250	"I" String/Suspension	2.0						
				Tension	2.0	0					
			150	"I" String/Suspension	2.0						
				Tension	2.0	0					
		(Concrete Pole/Rail pole/H pole/ Single steel pole)	100	Pin Insulator	2.0	0					
			60	Pin Insulator	2.0	0					

X= Internal deflection+ Live metal clearance + Tower barrel width (at bottom cross arm level)

NOTE: **Inputs desired from the members:**

1). Length of insulators (considered for swing)

2) Schematic showing the dimensions along with height of conductor attachment point indicating the ground clearance may be furnished.

3) Tower barrel width dimensions

Annexure-III

Minutes of the 2nd meeting of the committee to deliberate and finalize RoW requirements for transmission lines at 33kV held on 24.03.2017 at CEA

List of Participants is at **Annexure-I**

11. Chief Engineer (PSPA-I) welcomed the participants and stated that as decided in the first meeting of the Committee, CEA circulated the matrix for various combination of conductors, type of structure / pole configuration, design span to the members of the Committee, requesting for submission of Right of Way (RoW) calculations. He stated that the RoW calculations received from the members including the calculation of PSE&TD Division of CEA for RoW requirement for 33 kV voltage level is enclosed at **Annexure II**. He stated that the RoW calculation has been done assuming swing of conductor as 35 degrees & 60 degree, sag corresponding to maximum conductor operating temperature of 85° C and minimum horizontal clearance of 2 m on both sides as mandated in IS 5613. The variation in the RoW calculation furnished by the members is primarily because of the value of sag considered in calculations. The calculations of Himachal Pradesh and CEA are closely matching. He suggested that as the probability of occurrence of high wind at the maximum operating temperature of conductor (85° C) is very low , in order to optimize the RoW requirement we should consider the swing of conductor as 35 degree only. All the members present agreed to the suggestion.

12. The representative of Himalaya Power Producers Association stated that for uninhabited areas in hilly terrain, deriving the RoW width for 33 kV transmission lines with bare conductor, considering the horizontal clearance of 2 m as mandated by IS 5613 is very much on higher side. He requested to use the horizontal clearance of 0.33 m on either sides in calculation of RoW width for transmission lines passing through such uninhabitable areas such as hill slopes and valley.

13. Director, DPD, CEA said that as per IS 5613, the ROW takes into account the safety clearances as well as movement of vehicle for transportation of material during construction and maintenance of the lines. It may be kept in mind while reducing the ROW with reference to the values given in IS 5613.

14. Chief Engineer (CEI), CEA stated that CEA (Measures relating to Safety and Electric Supply) Regulations, 2010 are under revision, wherein it has been proposed that in case of transmission lines of 33 kV and below voltage level passing through National Parks, Wildlife Sanctuaries and Wildlife Corridors, underground cables or overhead insulated (covered) conductors shall only be used to prevent accidental death of animals due to electrocution. The use of covered conductors for 33 kV and below voltage level is also being considered in habitable areas. He stated that in the absence of electric field calculations at various distances from the center line of the tower / pole, it is difficult to reduce the horizontal clearance of 2m, which has been considered for more than six decades, for 33 kV transmission lines as mentioned in CEA Safety Regulations, 2010. However, there is scope for reduction in the horizontal clearance with covered conductors, which would be finalized as and when safety Regulation gets revised.

15. The representative of Himalaya Power Producers Association stated that mandating the use of covered conductors for 33 kV and below transmission lines

passing through wildlife/bird sanctuary is indeed required. However, mandating the same for transmission lines passing through hilly terrain and valleys (where minimum tree cutting is required) is not necessary. He requested that choice of conductor (bare or covered) should be left to the utility / developer. He added that a line may be passing through forest, non-habitable and habitable area, therefore, RoW should be defined separately for habitable, forest areas and non-habitable areas.

16. Chief Engineer (CEI), CEA stated that this exercise of optimizing the RoW is for the purpose of compensation only and we cannot specify different RoW for different section of the line. Therefore, RoW requirement should be uniform for the entire route of the transmission line. CE (PSETD), CEA said that different RoW for different section of the line might pose problem in deciding the compensation amount. He also advocated for indicating RoW width for compensation purpose.

17. Director, CEA stated that in the 1st meeting of the Committee, TATA Power was requested to carry out the calculations for electric fields at various distances within the RoW. The field calculation is yet to be submitted by TATA power. Himachal Pradesh has submitted the electric field calculations along with the RoW calculations. Director (EI), CEA stated that if the calculations for the electric field strength at varying distances from the centre line of tower / pole upto the edge of RoW is furnished by Tata Power and other power utilities, then the possibility of reduction in horizontal clearance, which has been considered as 2 m in arriving at the RoW requirement for 33 kV voltage level, would be explored / deliberated further.

18. On a query from CE(EI), CEA regarding the prevalent practice (for clearing the RoW) for laying of 33 kV transmission lines in forest area, representative of Himalaya Power Producers Association and Uttarakhand stated that for laying of the line, the vegetation / trees within RoW are pruned to maintain minimum electrical safety clearance, however, the compensation is paid for the full RoW width of 15 m for 33 kV.

19. Chief Engineer, PSETD stated that the matrix being proposed by CEA for RoW width takes into account different types of structure, commonly used ACSR conductor at 33kV level, normal design span, swing of conductor as 35 degree, minimum horizontal safety clearance of 2m. The RoW requirement can be further reduced to 6m by using covered conductor.

20. After detailed deliberations, the committee recommended the following:

    (i) The ROW width for (a) 33kV overhead transmission lines for different types of structures, commonly used ACSR conductor (with maximum operating temperature of 85 degree) & normal design span and (b) for 33kV lines with covered conductor mounted on pole type structure shall be as indicated below.

33 kV RoW requirement for various configuration

Conductor	Structure Type	Design Span (in m)	String Type	**RoW recommended (in m)**
Commonly used ACSR Bare conductor	Lattice type/ Steel Monopole	250	"I" String/Suspension	15 meter
			Tension	
		150	"I" String/Suspension	12 meter
			Tension	
	(Concrete Pole/Rail pole/H pole/ Single steel pole)	100	Pin Insulator	9 meter
		60	Pin Insulator	8 meter
Covered	Pole	100		6 meter

(ii) The CEA Safety Regulations, 2010 are under revision, wherein it has been proposed that in case of transmission lines of 33 kV and below voltage level passing through National Parks, Wildlife Sanctuaries and Wildlife Corridors, underground cables or overhead insulated (covered) conductors shall only be used to prevent accidental death of animals due to electrocution. The RoW width of 6m recommended for 33kV transmission lines with covered conductors mounted on Pole type structure would be further looked into, if required, as and when amendments in Safety regulations, 2010 will come into effect.

(iii) These recommendations would form part of the main report of the Committee finalizing compensation in regard to Right of Way for transmission line falling in urban areas.

(iv) The possibility of reduction in minimum safe horizontal clearance of 2m, and reduction in the RoW width for 33kV lines with covered conductors mounted on Pole type structure would be deliberated further while bringing out the revision of (Measures relating to Safety and Electric Supply) Regulations.

Meeting ended with thanks to the chair.

Annexure-I

List of participants in the 2nd meeting of the committee to deliberate and finalize RoW requirements for transmission lines at 33kV held on 24.03.2017 at CEA

Sl. No.	Name Shri/Smt	Designation
I.	**CEA**	
1.	Ravinder Gupta	- Chief Engineer (PSP&A-I)
2.	Goutam Roy	- Chief Engineer (CEI)
3.	S.K. Ray Mohapatra	- Chief Engineer (PSETD)
4.	Ghanshyam Prasad	- Chief Engineer (DP&D)
5.	Awdhesh Kumar Yadav	- Director
6.	Vivek Goel	- Director
7.	Upendra Kumar	- Director
8.	Manjari Chaturvedi	- Dy. Director
9.	Shiva Suman	- Dy. Director
10.	C.N. Devarajan	- Dy. Director
11.	Priyam Srivatava	- Assistant Director
12.	Jitesh Srivas	- Assistant Director
13.	Vijay Pal	- Sr. Consultant
II.	**HPPA , SHIMLA**	
14.	Powan Koli	-Vice President
15.	C.J. Rai	-Secy. General
III.	**HPSEB Ltd. , Hamirpur**	
16.	Lukesh Kumar	- Sr. Executive Engineer
17.	Pritam Chand	- SE (Design)
IV.	**TPDDL**	
18.	Kapil Kumar	- AGM (PE)
V.	**Uttarakhand Power Corp.**	
19.	P.C. Pandey	- Chief Engineer

Table 1

Conductor type	Configuration	Structure type (Lattice type/ Concrete Pole/Monopole/Rail pole/Double pole/ Single steel pole)	Design Span (in m)	String Type	Horizontal clearance (in m)	Insulator Length (Considered for Swing) (in m)	Max Sag at [illegible] Deg.C (in m)	Max Swing angle in Deg	Horizontal displacement from Conductor attachment point due to swing (in m)		Maximum horizontal distance of Conductor attachment point from centre of tower/Pole (in m)	Width of right of way (in m)			Width of right of way (in m) (with [illegible]° swing)	Width of right of way (in m) (with [illegible]° swing)	UK: Approx. Width of right of way (in m)	HPPA: Approx. Width of right of way (in m)	HP: Approx. Width of right of way (in m)	HP: Electric field with horizontal configuration (in kV/m)		HP: Electric field with Delta Configuration (in kV/m)
B			C		D	E	F	G	[illegible]	[illegible]	A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				At edge of ROW	At 0.[illegible] m from conductor	
												(with [illegible]° swing)	(with [illegible]° swing)									
ACSR DOG		Lattice type/ Steel Monopole	250	"V" String/Suspension	2.0	0.75	5.61		5.65	5.50	3.30	15.01	11.39	[illegible]	15.89	15.41	11.05		16.10/13.07***	0.15	5.36	0.99
				Tension	2.0	0	5.61		5.21	4.68	3.30	15.71	10.43	[illegible]	14.49	16.11	10.66		15.96/11.40***	0.16	5.36	1.01
			150	"V" String/Suspension	2.0	0.75	2.45		1.96	2.05	3.30	9.86	7.86	[illegible]	13.36	14.36	10.56		10.20/8.79***	0.12	5.36	1.30
				Tension	2.0	0	2.45		1.51	2.28	3.30	8.56	7.03	[illegible]	11.43	13.06	9.86		10.02/8.0***	0.11	5.36	1.29
	Horizontal	(Concrete Pole/Rail pole/H pole/ Single steel pole)	100	Pin insulator	2.0	0	1.50		0.86	1.50	1.01	4.60	5.71	[illegible]	6.60	6.70	4.065/6.60	5.56	6.70	0.86	5.36	
			60	Pin insulator	2.0	0	0.77		0.44	0.66	1.01	5.59	4.46	[illegible]	7.06	6.43	4.005/6.43	4.52	7.40	0.96	5.36	
	Delta	(Concrete Pole/Rail pole/H pole/ Single steel pole)	100	Pin insulator	2.0	0	1.50		0.86	1.50	0.78	4.60	5.71	[illegible]	7.26	6.16	4.065/6.60	5.56	7.33			1.46
			60	Pin insulator	2.0	0	0.77		0.44	0.66	0.78	5.59	4.46	[illegible]	6.44	4.96	4.005/6.43	4.52	6.98			1.96
ACSR Wolf		Lattice type/ Steel Monopole	250	"V" String/Suspension	2.0	0.75	6.96		5.27	6.96	3.30	15.86	10.03	[illegible]	14.95	16.26	10.05		15.59/11.40***	0.18	5.99	1.19
				Tension	2.0	0	6.96		3.86	6.50	3.30	12.78	6.88	[illegible]	14.28	10.96	10.83		13.06/11.17***	0.19	5.99	1.22
												6.66	6.60	[illegible]								
			150	"V" String/Suspension	2.0	0.75	2.253		1.73	2.60	3.30	6.26	7.44	[illegible]	11.46	13.60	10.26		9.87/8.95***	0.16	5.99	1.83
				Tension	2.0	0	2.26		1.26	1.86	3.30	7.86	4.58	[illegible]	10.06	11.50	9.76		9.08/8.06***	0.16	5.99	1.83
	Horizontal	(Concrete Pole/Rail pole/H pole/ Single steel pole)	100	Pin insulator	2.0	0	1.25		0.71	1.07	1.01	6.15	5.41	[illegible]	6.51	6.25	4.005/6.65	6.66	6.55	0.95	5.99	
			60	Pin insulator	2.0	0	0.58		0.55	0.53	1.01	5.66	4.66	[illegible]	7.26	6.10	6.77	6.3	7.69	0.63	5.99	
	Delta	(Concrete Pole/Rail pole/H pole/ Single steel pole)	100	Pin insulator	2.0	0	1.25		0.71	1.07	0.78	6.15	5.41	[illegible]	6.07	7.00	4.005/6.65	6.66	6.61			1.71
			60	Pin insulator	2.0	0	0.58		0.55	0.53	0.78	5.66	4.66	[illegible]	6.23	6.56	6.77	6.3	6.17			1.82

*** higher value is calculated using value of K=1.325 & lower value is calculated using value of K=0.765

Appendix IX

Minutes of the 6th meeting of the Committee Chaired by Ms. Shalini Prasad, Additional Secretary, Ministry of Power (MoP) on 09-05-2017 for finalization of compensation in regard to Right of Way (RoW) for Transmission line falling in urban areas

List of Participants is at **Annex – I**.

1. Additional Secretary, MoP welcomed the participants. She stated that the recommendations made in the Draft Report for finalization of compensation in regard to Right of Way (RoW) for Transmission line falling in urban areas were already circulated with the meeting notice and is to be discussed with the Members of the Committee.

2. Representative of MoUD stated that their guidelines already includes the provision of sub-stations and space to be left for transmission lines. On going through the guidelines, the Committee members observed that the provisions made in the guidelines are basically the mandatory safety clearances required for transmission lines at various voltage levels which has to be followed by all utilities. However, the requirement/recommendation of the Committee is that while town planning separate corridors for laying of transmission lines should be clearly identified in consultation with the State Transmission Utilities.The same has been recommended at item No. 5.7 (viii) of the Report.

3. The recommendations of the Committee was discussed item-wise and Members of the Committee were in agreement on the Draft Report except for minor changes.

4. Additional Secretary, MoP requested the Committee members to send their additional comments, if any, within a week so that the final report could be released.

5. The meeting concluded with thanks to chair

Annex-1
No. 3/4/2016-Trans

Date/ time of the meeting: 9.5.2017 at 3 pm
Venue: Ministry of Power, Conference Room
Shram Shakti Bhawan, New Delhi-110001

List of Participants

Ministry of Power

1. Ms. Shalini Prasad, Additional Secretary (SP) - In the Chair
2. Shri Irfan Ahmad, Director (Trans)

Ministry of Urban Development

3. Shri Mohd. Monis Khan, Town & Country Planner,
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Central Electricity Authority (CEA)

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5. Shri S.K. Ray Mohapatra, Chief Engineer,
   Mobile: 9818527857, Email: skmohapatra@rediffmail.com
6. Shri Awadesh Yadav, Director (PSPA-I)
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7. Shri Upendra Kumar, Director CEI,
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8. Shri M. Srikanth Reddy, Assistant Director,
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9. Shri P.K. Sangwan, Assistant Director,
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Power Grid Corporation Of India Limited (PGCIL)

10. Shri A. K. Sinha, ED,
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Govt. of Haryana/ HVPNL

12. Shri Gulshan Nagpal, SE,
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Govt. of Uttar Pradesh/ UPPTCL

13. Shri Yatendra Kumar, SE (T), Ghaziabad,
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14. Shri Mohd. Ishaq, SE,
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Govt. of Karnataka

15. Shri A.K Tiwari, Resident Commissioner,
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Govt. of Kerala/ KSEBL

16. Smt. Vijayakumari. P, Director
    Mobile: 9446008444, Email: mtkseb@ksebnet.com
17. Smt. Sheela M Daniel, Resident Engineer,
    Mobile: 9599096599, 011-23381964, Email: ksebdelhi@gmail.com

Govt. of Maharashtra/ MAHATRANSCO

18. Shri Yogesh Pach Pande, SE (Maha Transco),
    Mobile: 9920103000, Telefax: 022-26595265, Email: yogeshpachpande@gmail.com

Appendix X

13 MAY 2014
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F. No. 7-25/ 2012-FC
Government of India
Ministry of Environment and Forests
(FC Division)

Paryavaran Bhawan,
CGO Complex, Lodhi Road,
New Delhi - 110 510
Dated: 5th May, 2014

To

The Principal Secretary (Forests),
All State /Union Territory Governments

Sub: Guidelines for diversion of forest land for non-forest purposes under the Forest (Conservation) Act, 1980- Guidelines for laying transmission lines through forest areas - *reg*.

Sir,

I am directed to say that the Hon'ble National Green Tribunal in their Order dated 7th March 2012 in the Appeal No. 10 of 2012 in the matter of Janajagaritii Samiti (Regd.) versus Union of India and Others directed this Ministry to take steps and notify the detailed fresh guidelines for laying transmission lines through forest area, incorporating necessary changes to mitigate the difficulties which arise during granting forest clearance.

Accordingly, this Ministry in consultation with the Central Electricity Authority formulated revised guidelines for laying transmission lines through forest areas. **A copy of the same is enclosed.**

Yours faithfully,

Encl.: As above.

(H.C. Chaudhary)
Assistant Inspector General of Forests

Copy along with a copy of the said guidelines to:-

1. Prime Minister's Office (*Kind attn.:* Shri Santosh D. Vaidya, Director).
2. Secretary, Ministry of Power, Government of India, Shram Shakti Bhawan, New Delhi.
3. Principal Chief Conservator of Forests, all State/UT Governments.
4. Nodal Officer, the Forest (Conservation) Act, 1980, all State/UT Governments.
5. All Regional Offices, Ministry of Environment & Forests (MoEF), Government of India (GoI).
6. Joint Secretary in-charge, Impact Assessment Division, MoEF, GoI
7. All Assistant Inspector General of Forests/ Director in the Forest Conservation Division, MoEF, GoI.

GUIDELINES FOR LAYING TRANSMISSION LINES THROUGH FOREST AREAS

1. Where routing of transmission lines through the forest areas cannot be avoided, these should be aligned in such a way that it involves the least amount of tree cutting

2. As far as possible, the route alignment through forest areas should not have any line deviation.

3. (i) The width of right of way for the transmission lines on forest land shall be as follows:

Transmission Voltage	Width of Right of Way (Meter)
11kV	7
33 kV	15
66 kV	18
110 kV	22
132 kV	27
220 kV	35
400 kV S/C	46
400 kV D/C	46
+/- 500 kV HVDC	52
765 kV S/C (with delta configuration)	64
765 kV D/C	67
+/- 800 kV HVDC	69
1200 kV	89

(ii) In forest areas, only vertical delta configuration of 400 kV S/C and delta configuration of 765 kV S/C shall be permitted.

4. (i) Below each conductor or conductor bundle, following width clearance would be permitted for stringing purpose:

Transmission line with conductor bundle	Width clearance below each conductor or conductor bundle (meter)
Upto 400kV twin bundle	3

400 kV triple bundle	5
400 kV /+/- 500 kV HVDC /765 kV Quadruple bundle	7
+/- 800 kV HVDC / 765 kV hexagonal bundle	10

(ii) The trees on such strips would have to be felled but after stringing work is completed, natural regeneration will be allowed to come up. Felling/ pollarding/ pruning of trees will be done with the permission of the local forest officer wherever necessary to maintain the electrical clearance. One outer strip shall be left clear to permit maintenance of the transmission line.

(iii) During construction of transmission line, pollarding/ pruning of trees located outside the above width of the strips, whose branches/ parts infringe with conductor stringing, shall be permitted to the extent necessary, as may be decided by local forest officer.

(iv) Pruning of trees for taking construction/stringing equipments through existing approach/access routes in forest areas shall also be permitted to the extent necessary, as may be decided by local forest officer. Construction of new approach/access route will however, require prior approval under the Act..

(v) In the remaining width of right of way trees will be felled or lopped to the extent required, for preventing electrical hazards by maintaining the following:

Transmission Voltage	Minimum clearance between conductor and trees (Meters)
11 kV	2.6
33 kV	2.8
66 kV	3.4
110 kV	3.7
132 kV	4.0
220 kV	4.6
400 kV	5.5
+/- 500 kV HVDC	7.4
765 kV	9.0
+/- 800 kV HVDC	10.6
1200 kV	13.0

(vi) The maximum sag and swing of the conductors are to be kept in view while

working out the minimum clearance mentioned as above.

(vii) To avoid any hazard, felling/cutting/pruning of those trees which because of their height /location may fall on conductors shall also be permitted, as may be decided by local forest office.

(viii) In the case of transmission lines to be constructed in hilly areas, where adequate clearance is already available, trees will not be cut except those minimum required to be cut for stringing of conductors.

(ix) In case of transmission lines passing through National Parks, Wildlife Sanctuaries and Wildlife Corridors, insulated conductors shall only be used to prevent electrocution of animals.

5. Where the forest growth consists of coconut groves or similar tall trees, widths of right of way greater than those indicated at Sl. No.3 may be permitted in consultation with CEA.

*****

Appendix XI

TABLE-2

RIGHT OF WAY CALCULATION FOR NORMAL ROUTE, FOREST AREA, URBAN AREA / POPULATED AREA / APPROACH SECTION NEAR SUBSTATION

Voltage level (kV)	Configuration	Conductor type	Terrain	Design Span (in m)	String Type	Horizontal clearance (in m) (2.0m+0.3 M for every additional 33 kV or part thereof (in m)	Insulator Length (Considered for Swing) (in m)	Max Sag at 85 Deg. C (in m)	Horizontal displacement from Conductor attachment point due to swing (in m)	**Width of right of way (in m)**	Maximum Horizontal distance of Conductor attachment point from centre of tower (in m)	**Approx. Width of right of way (in m)**	Electric field at edge of ROW (in kV/m)
A		**B**		**C**		**D**	**E**	**F**	**H=(E+F)*Sin 35**	**R=2(D+H)+2X**	**X**	**R**	
765kV D/C	Vertical	ACSR ZEBRA	Normal Route	400	"I" String	9.0	7.6	13.3	12.0	**42+2X**	12.5	**67**	1.9
					"V" String	9.0	0	13.3	7.6	**33.2+2X**	10.5	**54**	2.7
					Tension	9.0	0	13.3	7.6	**33.2+2X**	14.5	**62**	
			Forest	300	"I" String	9.0	7.6	8.2	9.1	**36+2X**	12.5	**61**	2.9
					"V" String	9.0	0	8.2	4.7	**27+2X**	10.5	**48**	3.7

					Tension	9.0	0	8.2	4.7	**27+2X**	14.5	**56**	
			Urban area / populated area / approach section near substation	250	"I" String	9.0	7.6	6.1	7.9	**34+2X**	12.5	**59**	3.2
					"V" String	9.0	0	6.1	3.5	**25+2X**	10.5	**46**	4.2
					Tension	9.0	0	6.1	3.5	**25+2X**	14.5	**54**	
765kV S/C	Vertical /Delta	ACSR BERSIMIS	Plain	400	"I" String	9.0	7.1	14.8	12.6	**43.2+2X**	10.5	**64**	2.5
					"V" String	9.0	0	14.8	8.5	**35+2X**	9.5	**54**	3.2
					Tension	9.0	0	14.8	8.5	**35+2X**	13	**61**	
			Forest	300	"I" String	9.0	7.1	9.1	9.3	**36.6+2X**	10.5	**58**	3
					"V" String	9.0	0	9.1	5.2	**28.4+2X**	9.5	**47**	4.1
					Tension	9.0	0	9.1	5.2	**28.4+2X**	13	**54**	
			Urban	250	"I" String	9.0	7.1	6.8	8.0	**34+2X**	10.5	**55**	3.3
					"V" String	9.0	0	6.8	3.9	**25.8+2X**	9.5	**45**	4.5

					Tension	9.0	0	6.8	3.9	**25.8+2X**	13	**52**	

765kV S/C	Horizontal	ACSR BERSIMIS	Plain	400	"I" String	9.0	7.1	14.8	12.6	**43.2+2X**	15.6	**74**	3
					"V" String	9.0	0	14.8	8.5	**35+2X**	14.4	**64**	3.9
					Tension	9.0	0	14.8	8.5	**35+2X**	18.2	**71**	
			Forest	300	"I" String	9.0	7.1	9.1	9.3	**36.6+2X**	15.6	**68**	3.8
					"V" String	9.0	0	9.1	5.2	**28.4+2X**	14.4	**57**	5.1
					Tension	9.0	0	9.1	5.2	**28.4+2X**	18.2	**65**	
			Urban	250	"I" String	9.0	7.1	6.8	8.0	**34+2X**	15.6	**65**	4.2
					"V" String	9.0	0	6.8	3.9	**25.8+2X**	14.4	**55**	**5.5**
					Tension	9.0	0	6.8	3.9	**25.8+2X**	18.2	**62**	
±800kV HVDC	Horizontal	ACSR Lapwing	Plain/Forest/ Urban	400	"Y" String	10.6	5.3	14.9	11.6	**44.4+2X**	12.3	69	5.1
±500kV HVDC	Horizontal	ACSR Lapwing	Plain/Forest/ Urban	400	"V" String	7.4	0	14.9	8.5	**31.8+2X**	8.2	48	4.9
400kV D/C & S/C	Vertical	ACSR MOOSE	Plain	400	"I" String	5.6	4.0	13.3	9.9	**31+2X**	7.5	**46**	0.8
					"V" String	5.6	0	13.3	7.6	**26.4+2X**	6.0	**38**	1.1
					Tension	5.6	0	13.3	7.6	**26.4+2X**	9.7	**46**	
			Forest	300	"I" String	5.6	4.0	8.2	7.0	**25.2+2X**	7.5	**40**	1.5

					"V" String	5.6	0	8.2	4.7	**20.6+2X**	6.0	**33**	1.7
					Tension	5.6	0	8.2	4.7	**20.6+2X**	9.7	**40**	
			Urban	250	"I" String	5.6	4.0	6.1	5.8	**22.8+2X**	7.5	**38**	1.9
					"V" String	5.6	0	6.1	3.5	**18.2+2X**	6.0	**30**	2.3
					Tension	5.6	0	6.1	3.5	**18.2+2X**	9.7	**38**	
400kV S/C	Horizontal	ACSR MOOSE	Plain	400	"I" String	5.6	4.0	13.3	9.9	**31+2X**	10.9	**53**	2.3
					"V" String	5.6	0	13.3	7.6	**26.4+2X**	9.1	**45**	2.8
					Tension	5.6	0	13.3	7.6	**26.4+2X**	13.5	**53**	
			Forest	300	"I" String	5.6	4.0	8.2	7.0	**25.2+2X**	10.9	**47**	3.2
					"V" String	5.6	0	8.2	4.7	**20.6+2X**	9.1	**39**	4.6
					Tension	5.6	0	8.2	4.7	**20.6+2X**	13.5	**48**	
			Urban	250	"I" String	5.6	4.0	6.1	5.8	**22.8+2X**	10.9	**45**	3.6
					"V" String	5.6	0	6.1	3.5	**18.2+2X**	9.1	**36**	4.8
					Tension	5.6	0	6.1	3.5	**18.2+2X**	13.5	**45**	
1200kV	Horizontal	ACSR Moose	Plain/Forest/ Urban	400	"V" String	13.0	0	13.3	7.6	**41.2+2X**	24	89	5.3
220kV D/C	Vertical	ACSR ZEBRA	Plain	350	"I" String	3.8	2.5	10.6	7.5	**22.6+2X**	4.6	**32**	0.4
					"V" String	3.8	0	10.6	6.1	**19.8+2X**	4	**28**	
					Tension	3.8	0	10.6	6.1	**19.8+2X**	5.7	**31**	
			Forest	300	"I" String	3.8	2.5	8.2	6.1	**19.8+2X**	4.6	**29**	
					"V" String	3.8	0	8.2	4.7	**17+2X**	4	**25**	

					Tension	3.8	0	8.2	4.7	**17+2X**	5.7	**28**	
			Urban	200	"I" String	3.8	2.5	4.3	3.9	**15.4+2X**	4.6	**25**	1.1
					"V" String	3.8	0	4.3	2.5	**12.6+2X**	4	**21**	
					Tension	3.8	0	4.3	2.5	**12.6+2X**	5.7	**24**	
132kV D/C / 110 kV D/C	Vertical	ACSR PANTHER	Plain	320	"I" String	2.9	2.3	7.5	5.6	**17+2X**	3.9	**25**	0.5
					"V" String	2.9	0	7.5	4.3	**14.4+2X**	3.5	**21**	
					Tension	2.9	0	7.5	4.3	**14.4+2X**	5.3	**25**	
			Forest	200	"I" String	2.9	2.3	3.6	3.4	**12.6+2X**	3.9	**20**	
					"V" String	2.9	0	3.6	2.1	**10+2X**	3.5	**17**	
					Tension	2.9	0	3.6	2.1	**10+2X**	5.3	**21**	
			Urban	150	"I" String	2.9	2.3	2.3	2.6	**11+2X**	3.9	**19**	0.9
					"V" String	2.9	0	2.3	1.3	**8.4+2X**	3.5	**15**	
					Tension	2.9	0	2.3	1.3	**8.4+2X**	5.3	19	

66kV	Vertical	ACSR PANTHER	Plain	250	"I" String	2.3	1.9	5.0	4.0	**12.5+2X**	2.5	**18**	
					"V" String	2.3	0	5.0	2.9	**10.4+2X**	2.5	**15**	
					Tension	2.3	0	5.0	2.9	**10.4+2X**	3.5	**17**	
			Forest	150	"I" String	2.3	1.9	2.3	2.4	**9.4+2X**	2.5	**14**	
					"V" String	2.3	0	2.3	1.3	**7.3+2X**	2.5	**12**	
					Tension	2.3	0	2.3	1.3	**7.3+2X**	3.5	**14**	
			Urban	100	"I" String	2.3	1.9	1.3	1.8	**8.3+2X**	2.5	13	
					"V" String	2.3	0	1.3	0.7	**6.1+2X**	2.5	11	

					Tension	2.3	0	1.3	0.7	**6.1+2X**	3.5	13	
66kV		ACSR DOG	Plain	250	"I" String	2.3	1.9	6.3	4.7	**14+2X**	2.5	19	
					"V" String	2.3	0	6.3	3.6	**11.8+2X**	2.5	17	
					Tension	2.3	0	6.3	3.6	**11.8+2X**	3.5	19	
			Forest	150	"I" String	2.3	1.9	2.9	2.8	**10.2+2X**	2.5	15	
					"V" String	2.3	0	2.9	1.7	**8+2X**	2.5	13	
					Tension	2.3	0	2.9	1.7	**8+2X**	3.5	15	
			Urban	100	"I" String	2.3	1.9	1.7	2.1	**8.8+2X**	2.5	14	
					"V" String	2.3	0	1.7	1.0	**6.6+2X**	2.5	12	
					Tension	2.3	0	1.7	1.0	**6.6+2X**	3.5	14	

Note: Swing angle (in degrees)= 35

Table-3 (summarized)

RIGHT OF WAY CALCULATION FOR NORMAL ROUTE, FOREST AREA, URBAN AREA / POPULATED AREA / APPROACH SECTION NEAR SUBSTATION

Voltage level	*Configuration*	*Conductor type*	*Terrain*	*Ruling Span*	*String Type*	***RoW width (As per the current Practice (in m)***	***Revised RoW width in m (for compensation purpose)***
765kV D/C	Vertical	ACSR ZEBRA	Normal route without constraint	400	"I" String	**67**	**67**
					"V" String		
					Tension		
			Forest	300	"V" String	**67**	**56**
					Tension		
			Urban area / populated area / approach section near substation	250	"V" String	**67**	**54**
					Tension		
765kV S/C	Vertical /Delta	ACSR BERSIMIS	Normal route without constraint	400	"I" String	**64**	**64**
					"V" String		
					Tension		
			Forest	300	"V" String	**64**	**54**
					Tension		

Voltage level	*Configuration*	*Conductor type*	*Terrain*	*Ruling Span*	*String Type*	***RoW width (As per the current Practice (in m)***	***Revised RoW width in m (for compensation purpose)***
			Urban area / populated area / approach section near substation	250	"V" String	**64**	**52**
					Tension		
765kV S/C	Horizontal	ACSR BERSIMIS	Normal route without constraint	400	"I" String	**85**	**74**
					"V" String		
					Tension		
			Forest	300	"V" String	**85**	**65**
					Tension		
			Urban area / populated area / approach section near substation	250	"V" String	**85**	**62**
					Tension		
±800kV HVDC	Horizontal	ACSR Lapwing	Normal route without constraint/Forest/ Urban	400	"Y" String	69	69
±500kV HVDC	Horizontal	ACSR Lapwing	Normal route without constraint/Forest/ Urban	400	"V" String	52	52
400kV D/C	Vertical	ACSR MOOSE	Normal route without constraint	400	"I" String	**46**	**46**
					"V" String		
					Tension		

Voltage level	Configuration	Conductor type		Ruling Span	String Type	**RoW width (As per the current Practice (in m)**	**Revised RoW width in m (for compensation purpose)**
			Forest	300	"V" String	**46**	**40**
					Tension		
			Urban area / populated area / approach section near substation	250	"V" String	**46**	**38**
					Tension		
400kV S/C	Horizontal/ Vertical	ACSR MOOSE	Normal route without constraint	400	"I" String	**52**	**52**
					"V" String		
					Tension		
			Forest	300	"V" String	**52**	**47**
					Tension		
			Urban area / populated area / approach section near substation	250	"V" String	**52**	**44**
					Tension		
1200kV	Horizontal	ACSR Moose	Normal route without constraint/Forest/ Urban	400	"V" String	89	89
220kV D/C	Vertical	ACSR ZEBRA	Normal route without constraint	350	"I" String	**35**	**32**
					"V" String		
					Tension		

Voltage level	*Configuration*	*Conductor type*	*Terrain*	*Ruling Span*	*String Type*	***RoW width (As per the current Practice (in m)***	***Revised RoW width in m (for compensation purpose)***
			Forest	300	"V" String	**35**	**28**
					Tension		
			Urban area / populated area / approach section near substation	200	"V" String	**35**	**24**
					Tension		
132kV D/C / 110 kV D/C	Vertical	ACSR PANTHER	Normal route without constraint	320	"I" String	**27**	**25**
					"V" String		
					Tension		
			Forest	200	"V" String	**27**	**21**
					Tension		
			Urban area / populated area / approach section near substation	150	"V" String	**27**	**19**
					Tension		
66kV	Vertical	ACSR PANTHER	Normal route without constraint	250	"I" String	**18**	**18**
					"V" String		
					Tension		
			Forest	150	"V" String	**18**	**14**
					Tension		

Voltage level	*Configuration*	*Conductor type*	*Terrain*	*Ruling Span*	*String Type*	***RoW width (As per the current Practice (in m)***	***Revised RoW width in m (for compensation purpose)***
			Urban area / populated area / approach section near substation	100	"V" String	18	**13**
					Tension		

Table 3 (detailed)

RIGHT OF WAY CALCULATION FOR NORMAL ROUTE, FOREST AREA, URBAN AREA / POPULATED AREA / APPROACH SECTION NEAR SUBSTATION

Voltage level	Configuration	Conductor type	Terrain	Ruling Span	String Type	**Width of right of way (in m)**		Maximum Horizontal distance of Conductor attachment point from centre of tower (in m)	**Approx. Width of right of way (in m)**	**RoW width (As per the current Practice (in m)**	**Revised RoW width in m (for compensation purpose)**	**Reduction in RoW**	****Indicative base width of normal tower at Concrete level (in m)**
(1)		**(2)**	**(3)**	**(4)**	**(5)**	**(6)**		**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
A		**B**		**C**		**R=2(D+H)+2**	**X**	**X**	**R**				
765kV D/C	Vertical	ACSR ZEBRA	Normal route without constraint	400	"I" String	**42+**	**2X**	12.5	**67**	**67**	**67**	**0**	**16 - 25**
					"V" String	**33.2+**	**2X**	10.5	**54**				
					Tension	**33.2+**	**2X**	14.5	**62**				
			Forest	300	"V" String	**27+**	**2X**	10.5	**48**	**67**	**56**	**11**	**16 - 25**
					Tension	**27+**	**2X**	14.5	**56**				
			Urban area / populated area / approach section near substation	250	"V" String	**25+**	**2X**	10.5	**46**	**67**	**54**	**13**	**16 - 25**
					Tension	**25+**	**2X**	14.5	**54**				

765kV S/C	Vertical /Delta	ACSR BERSIMIS	Normal route without constraint	400	"I" String	**43.2+**	**2X**	10.5	**64**	**64**	**64**	**0**	**13 - 19**
					"V" String	**35+**	**2X**	9.5	**54**				
					Tension	**35+**	**2X**	13	**61**				
			Forest	300	"V" String	**28.4+**	**2X**	9.5	**47**	**64**	**54**	**10**	**13 - 19**
					Tension	**28.4+**	**2X**	13	**54**				
			Urban area / populated area / approach section near substation	250	"V" String	**25.8+**	**2X**	9.5	**45**	**64**	**52**	**12**	**13 - 19**
					Tension	**25.8+**	**2X**	13	**52**				
765kV S/C	Horizontal	ACSR BERSIMIS	Normal route without constraint	400	"I" String	**43.2+**	**2X**	15.6	**74**	**85**	**74**	**11**	**12 - 15**
					"V" String	**35+**	**2X**	14.4	**64**				
					Tension	**35+**	**2X**	18.2	**71**				
			Forest	300	"V" String	**28.4+**	**2X**	14.4	**57**	**85**	**65**	**20**	**12 - 15**
					Tension	**28.4+**	**2X**	18.2	**65**				
			Urban area / populated area / approach section near substation	250	"V" String	**25.8+**	**2X**	14.4	**55**	**85**	**62**	**23**	**12 - 15**
					Tension	**25.8+**	**2X**	18.2	**62**				
±800kV HVDC	Horizontal	ACSR Lapwing	Normal route without	400	"Y" String	**44.4+**	**2X**	12.3	69	69	69	0	14 - 21

			constraint/ Forest/ Urban										
±500kV HVDC	Horizontal	ACSR Lapwing	Normal route without constraint/ Forest/ Urban	400	"V" String	**31.8+**	**2X**	8.2	--	52	52	4	12.5 - 16.5
400kV D/C	Vertical	ACSR MOOSE	Normal route without constraint	400	"I" String	**31+**	**2X**	7.5	**46**	**46**	**46**	**0**	**10-18**
					"V" String	**26.4+**	**2X**	6.0	**38**				
					Tension	**26.4+**	**2X**	9.7	**46**				
			Forest	300	"V" String	**20.6+**	**2X**	6.0	**33**	**46**	**40**	**6**	**10-18**
					Tension	**20.6+**	**2X**	9.7	**40**				
			Urban area / populated area / approach section near substation	250	"V" String	**18.2+**	**2X**	6.0	**30**	**46**	**38**	**8**	**10-18**
					Tension	**18.2+**	**2X**	9.7	**38**				
400kV S/C	Horizontal/ Vertical	ACSR MOOSE	Normal route without constraint	400	"I" String	**31+**	**2X**	10.5	**52**	**52**	**52**	**0**	**8-11**
					"V" String	**26.4+**	**2X**	9.1	**45**				
					Tension	**26.4+**	**2X**	13.0	**52**				
			Forest	300	"V" String	**20.6+**	**2X**	9.1	**39**	**52**	**47**	**5**	**8-11**
					Tension	**20.6+**	**2X**	13.0	**47**				

			Urban area / populated area / approach section near substation	250	"V" String	**18.2+**	**2X**	9.1	**36**	**52**	**44**	**8**	**8-11**
					Tension	**18.2+**	**2X**	13.0	**44**				
1200kV	Horizontal	ACSR Moose	Normal route without constraint/ Forest/ Urban	400	"V" String	**41.2+**	**2X**	24	89	89	89	0	16 - 18
220kV D/C	Vertical	ACSR ZEBRA	Normal route without constraint	350	"I" String	**22.6+**	**2X**	4.6	**32**	**35**	**32**	**3**	**6 - 12**
					"V" String	**19.8+**	**2X**	4	**28**				
					Tension	**19.8+**	**2X**	5.7	**31**				
			Forest	300	"V" String	**17+**	**2X**	4	**25**	**35**	**28**	**7**	**6 - 12**
					Tension	**17+**	**2X**	5.7	**28**				
			Urban area / populated area / approach section near substation	200	"V" String	**12.6+**	**2X**	4	**21**	**35**	**24**	**11**	**6 - 12**
					Tension	**12.6+**	**2X**	5.7	**24**				
132kV D/C /110 kV D/C	Vertical	ACSR PANTHER	Normal route without constraint	320	"I" String	**17+**	**2X**	3.9	**25**	**27**	**25**	**2**	**5 - 9**
					"V" String	**14.4+**	**2X**	3.5	**21**				
					Tension	**14.4+**	**2X**	5.3	**25**				

			Forest	200	"V" String	**10+**	**2X**	3.5	**17**	**27**	**21**	**6**	**5 - 9**
					Tension	**10+**	**2X**	5.3	**21**				
			Urban area / populated area / approach section near substation	150	"V" String	**8.4+**	**2X**	3.5	**15**	**27**	**19**	**8**	**5 - 9**
					Tension	**8.4+**	**2X**	5.3	19				
66kV	Vertical	ACSR PANTHER	Normal route without constraint	250	"I" String	**12.5+**	**2X**	2.5	**18**	**18**	**18**	**0**	**4 - 7**
					"V" String	**10.4+**	**2X**	2.5	**15**				
					Tension	**10.4+**	**2X**	3.5	**17**				
			Forest	150	"V" String	**7.3+**	**2X**	2.5	**12**	**18**	**14**	**4**	**4 - 7**
					Tension	**7.3+**	**2X**	3.5	**14**				``
			Urban area / populated area / approach section near substation	100	"V" String	**6.1+**	**2X**	2.5	11	18	**13**	**5**	**4 - 7**
					Tension	**6.1+**	**2X**	3.5	13				

Note: (1) For normal Route without constraint , RoW width= Maximum of RoW (corresponding to I-string configuration, V string configuration , tension insulator)

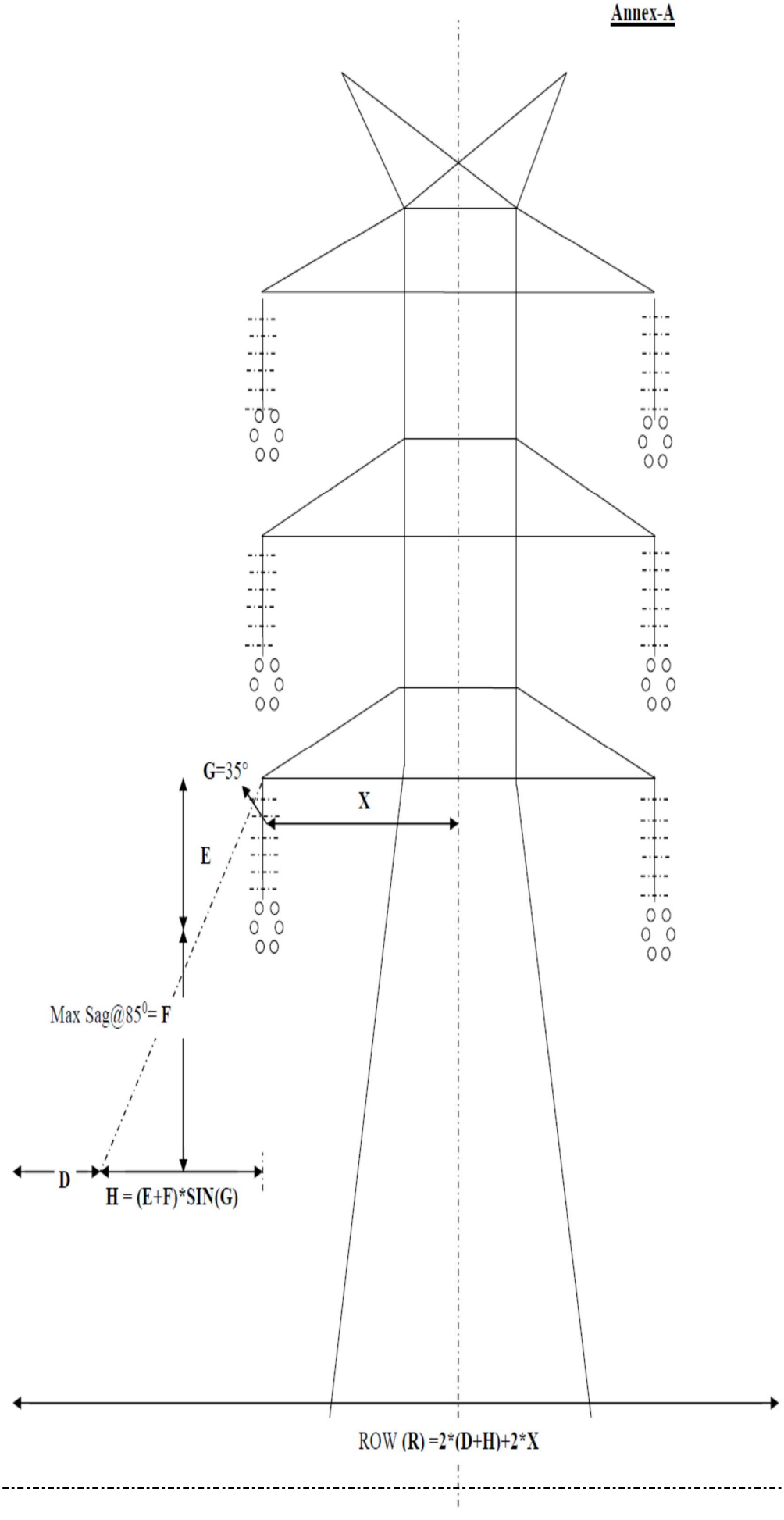
Note: (2) For urban area/ forest , RoW width= Maximum of RoW (corresponding to V string configuration , tension insulator)

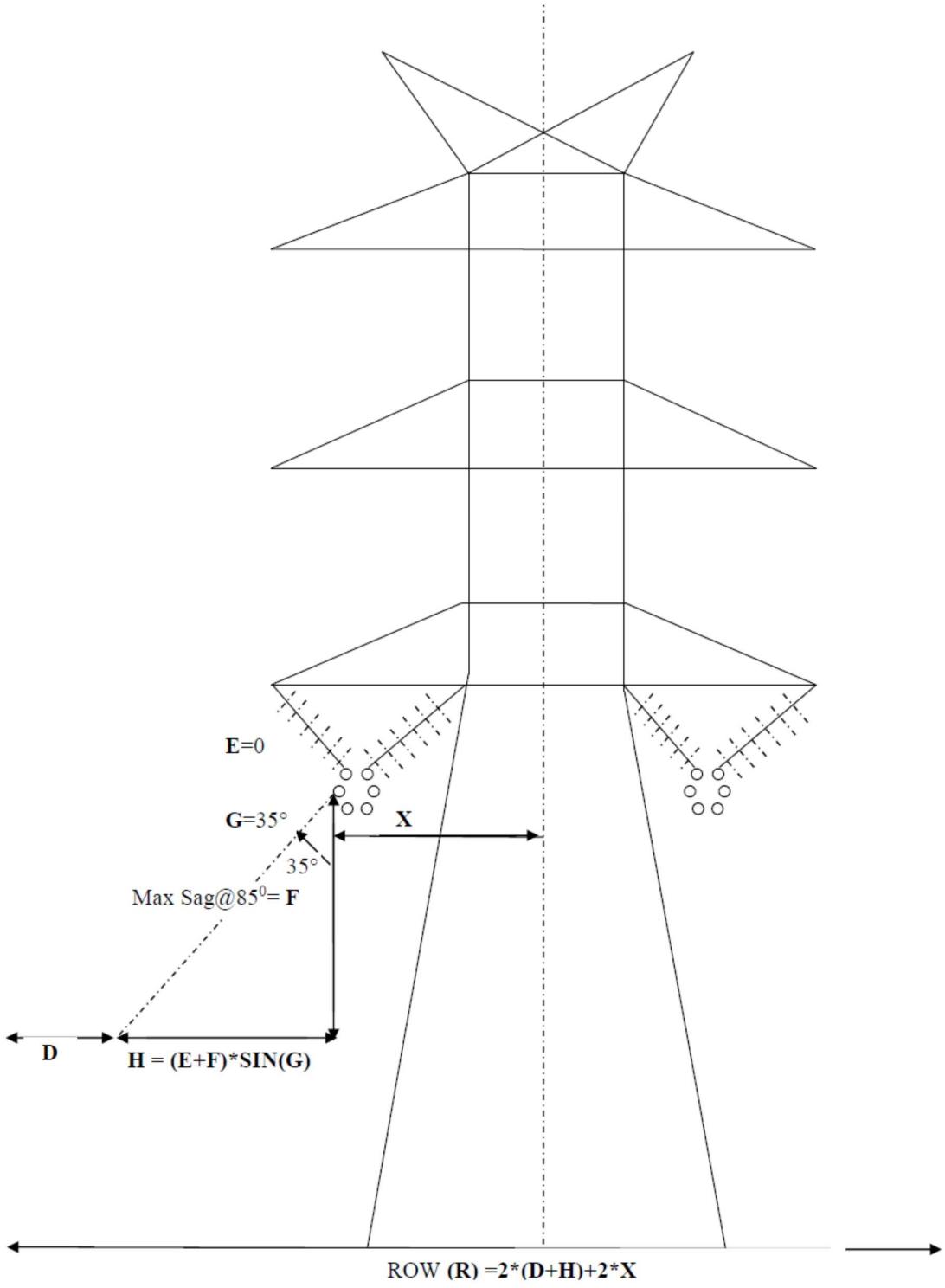
Note: (3) Typical 765kV D/C Tower diagram with "I" string & "V" string is attached at Annex. A

Note: (4) ** Lower values of base width corresponds to suspension tower / small angle towers and higher values corresponds to higher angle towers

Note: (5) For ±500 kV HVDC, ± 800 kV HVDC and 1200 kV HVAC lines, the reduction in RoW is not possible as it violates the minimum electrical field requirement at the edge of RoW (i.e 5kV/m at 1.8m height)

Annex-A




E=0
G=35°
X
35°
Max Sag@85^0= F
D
H = (E+F)*SIN(G)
ROW (R) =2*(D+H)+2*X