Central Electricity Authority (Measures relating to Safety and Electric Supply), Regulations 2010

Clearance from buildings of lines of voltage and service lines not exceeding 650 Volts.- (1) 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.

(2) Where an overhead line of voltage not exceeding 650 V passes above or adjacent to or terminates on any building, the following minimum clearances from any accessible point, on the basis of maximum sag, shall be observed, namely:-

(i) for any flat roof, open balcony, varandah roof and lean-to-roof-

(a) when the line passes above the building a vertical clearance of 2.5 metres from the highest point, and

(b) when the line passes adjacent to the building a horizontal clearance of 1.2 metres from the nearest point, and

(ii) for pitched roof-

(a) when the line passes above the building a vertical clearance of 2.5 metres immediately under the line, and

(b) when the line passes adjacent to the building a horizontal clearance of 1.2 metres.

Central Electricity Authority (Measures relating to Safety and Electric Supply), Regulations 2010

Clearances from buildings of lines of voltage exceeding 650 V.- (1) 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.

(2) Where an overhead line of voltage exceeding 650 V passes above or adjacent to any building or part of a building it shall have on the basis of maximum sag a vertical clearance above the highest part of the building immediately under such line, of not less than-

(i) for lines of voltages exceeding 650 Volts upto and including 33,000 Volts	- 3.7 metres
(ii)for lines of voltages exceeding 33 kV	- 3.7 metres plus 0.30 metre for every additional 33,000 Volts or part thereof.

Central Electricity Authority (Measures relating to Safety and Electric Supply), Regulations 2010

(4) For High Voltage Direct Current (HVDC) systems, vertical clearance and horizontal clearance, on the basis of maximum deflection due to wind pressure, from buildings shall be maintained as below:

Sl.No	DC Voltage (kV)	Vertical Clearance (mtrs.)	Horizontal Clearance (mtrs.)
1.	100 kV	4.6	2.9
2.	200 kV	5.8	4.1
3.	300 kV	7.0	5.3
4.	400 kV	7.9	6.2
5.	500 kV	9.1	7.4
6.	600 kV	10.3	8.6
7.	800 kV	12.4	10.7

Central Electricity Authority (Measures relating to Safety and Electric Supply), Regulations 2010

(3) The horizontal clearance between the nearest conductor and any part of such building shall, on the basis of maximum deflection due to wind pressure, be not less than-

(i)	for lines of voltages exceeding 650 V upto and including 11,000 Volts	-	1.2 metres
(ii)	for lines of voltages exceeding 11,000 V and up to and including 33,000 V	-	2.0 metres
(iii)	for lines of voltages exceeding 33 kV	-	2.0 metres plus 0.3 metre fore every additional 33kV or part thereof.

Need to recalculate the RoW width for different voltage levels

- 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.
- Need to explore possibility of reduction in RoW 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

Appendix-V

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	400	13.3	67	66.32	67	NIL	56.41	54	10-13 m
	Zebra	250	6.10		58.08	58	9 m	48.17	46	19-21 m
2	765 kV S/C	400	14.8	64	63.35	64	NIL	54.05	54	10 m
	Bersimis	250	6.8		54.1	55	9 - 10m	44.8	45	9 m
3	400 kV D/C	400	13.3	46	44.01	46	0 - 2 m	37.63	38	8 m
	Moose	250	6.1		35.77	38	8-10 m	29.39	30	16 m
4	220 kV D/C	350	10.6	35	34.41	32	0.5 - 3m			
	Zebra	200	4.3		27.12	25	8-10 m			
5	132 kV D/c	320	7.8	27	26.31	25	0.5 - 2m			
	Panther	200	3.6		21.42	20	5.5 -7 m			
6	66 kV D/C	250	5.11	18	18.37		NIL			
	WOLF	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
2. Smt. Jyoti Arora, Joint Secretary (Trans)
3. Shri Ghanshyam Prasad, Director (Trans)

Central Electricity Authority (CEA)

4. Shri Goutam Roy, Chief Electrical Inspector
   Phone: 8376817933/Email: goutamroy.715@gmail.com
5. Shri S.K.RayMohapatra, Chief Engineer
   Mobile: 9818527857/Email: skmohapatra@rediffmail.com
6. Shri Awdhesh Kumar Yadav, Director
   Phone: 26732318/Email: awd.cea@gmail.com
7. Shri Upendra Kumar
   Email: upendra0309@gmail.com

Power Grid Corporation of India Limited (PGCIL)

8. Shri R.P.Sasmal, Dir (P&OP)
9. Shri AK Vyas, AGM
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STATE SECTOR

Govt. of Karnataka/ KPTCL

10. Shri Deepak T.C., Resident engineer
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Government of Uttar Pradesh/UPPTCL, Lucknow

11. Shri Ravi Prakash Dubey, CE (TW)
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12. Shri Yatendra Kumar, SE (Trans)
    Mobile No: 8130599601

Government of Kerala/KSEBL

13. Shri P. Rajan, Chief Engineer
    Mobile: 9496012377

Government of Haryana/HVPNL

14. Shri MK Vats, SE- Faridabad
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Govt. of Maharashtra/ MSETCL

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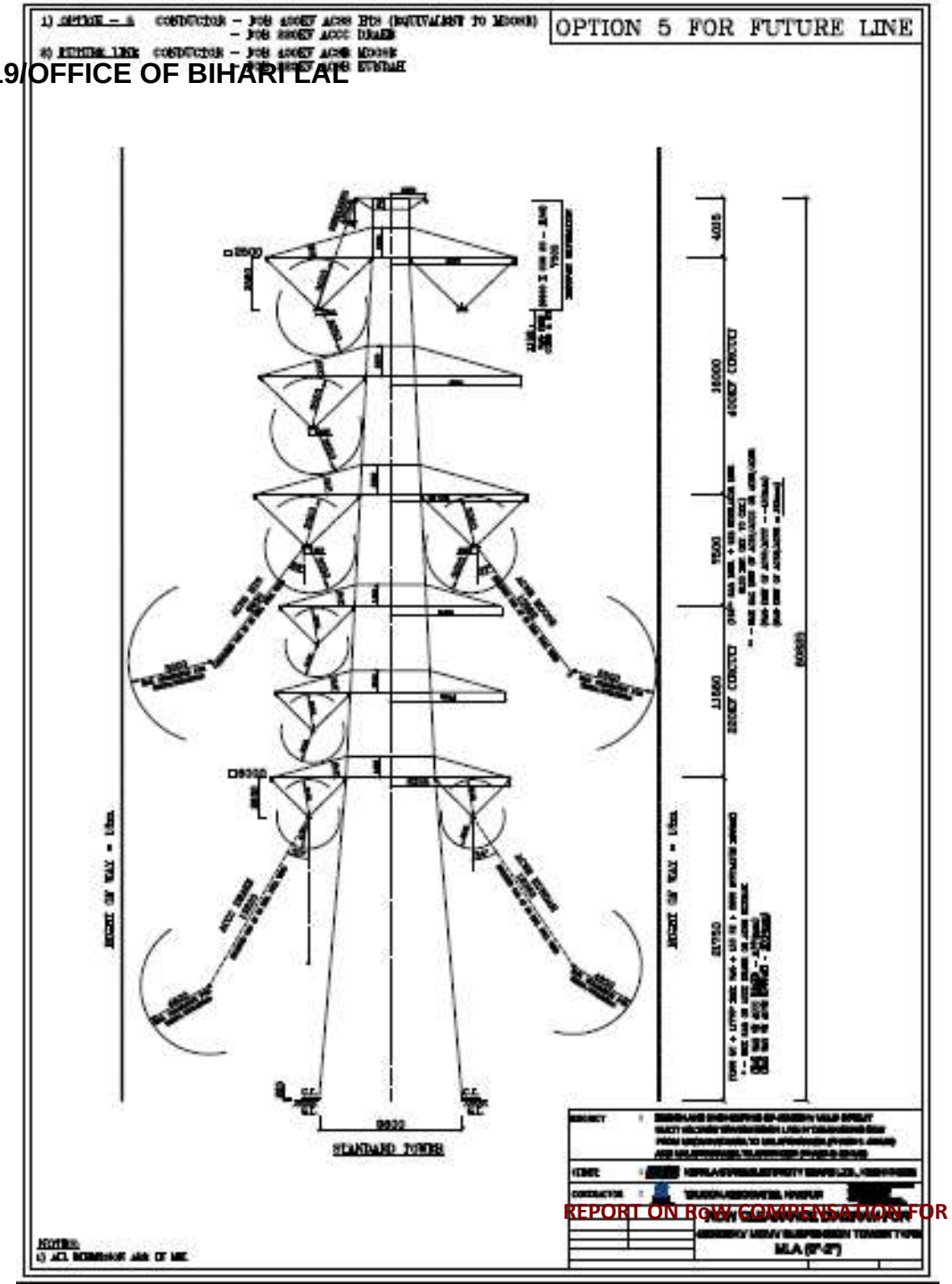
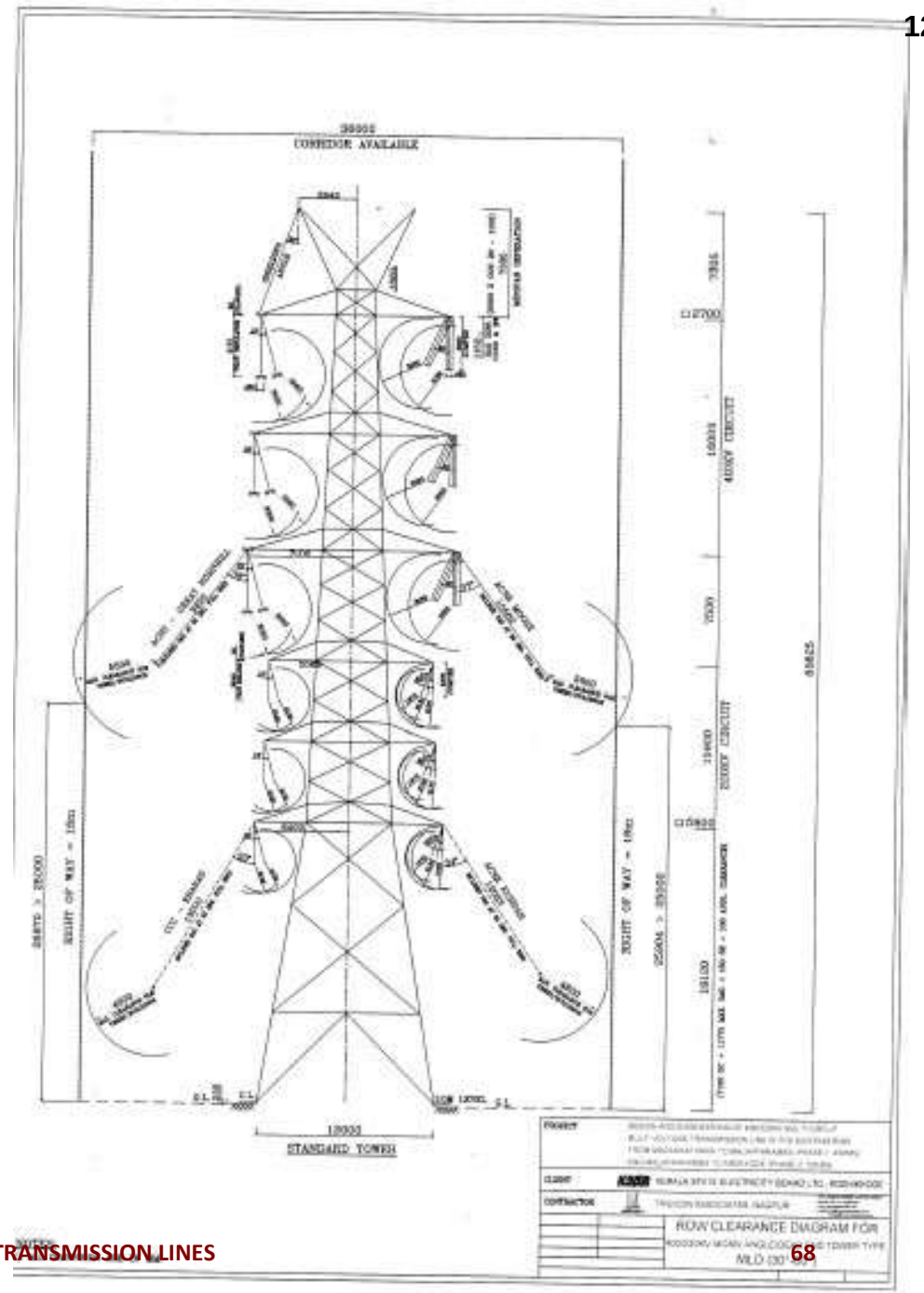
Annex ii

POSSIBILITIES OF REDUCTION OF TRANSMISSION CORRIDOR WIDTH

FACTORS CONTRIBUTING TO ROW

S.no	Factors contributing to the RoW width	Options available for optimization of RoW
1.	Configuration of the Tower	a) Use of different voltage levels on Multi circuit tower i.e multicircuit-multi voltage towers (eg. KSEB designed towers) b) Use of Narrow Base Multi circuit Tower c) Use of towers with insulated cross arms
2.	(a) Live Metal Clearance (b) Length of bottom cross arm from centre of tower	(a) Clearances are to be maintained as per safety norms. (b) Reduction in tower body width around bottom cross arm level
3.	Horizontal safety Clearances	Safety norms cannot be compromised.
4.	Swing and Sag	a) Reduction in span b) Use of V Suspension String c) Use of Tension tower


OPTION 5 FOR FUTURE LINE
STANDARD TOWER


CORRIDOR AVAILABLE
STANDARD TOWER
ROW CLEARANCE DIAGRAM FOR

POWERGRID CALCULATIONS

				RIGHT OF WAY (m)	
S.No.	CIRCUIT & CONDUCTOR	TOWER CONFIGURATION	SPAN (m)	I-STRING	V-STRING
1	765kV D/C HEXA ZEBRA	VERTICAL	400	67	54
			250	58	46
2	765kV S/C QUAD BERSIMIS	DELTA	400	64	54
			250	55	45
		VERTICAL	400	64	54
			250	55	45
3	400kV D/C TWIN & QUAD MOOSE	VERTICAL	400	46	38
			250	38	30
4	220kV D/C ZEBRA	VERTICAL	350	32	-
			200	25	-
5	132kV D/C PANTHER	VERTICAL	320	25	-
			200	20	-

STERLITE CALCULATIONS

SUMMARY					
S.NO.	CIRCUIT & CONDUCTOR	TOWER CONFIGURATION	SPAN (m)	RIGHT OF WAY (m)	
				I- STRING	V- STRING
1	765 KV D/C ZEBRA (HEXA)	VERTICAL	400	66.32	56.41
			250	58.08	48.17
2	765 KV S/C BERSIMIS (QUAD)	VERTICAL	400	63.35	54.05
			250	54.10	44.80
3	400 KV D/C MOOSE (TWIN & QUAD)	VERTICAL	400	44.01	37.63
			250	35.77	29.39
4	220 KV D/C ZEBRA	VERTICAL	350	34.41	-
			200	27.12	-
5	132 KV D/C PANTHER	VERTICAL	320	26.31	-
			200	21.42	-
6	66 KV D/C WOLF	VERTICAL	250	18.37	-
			200	16.59	-

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
2	765 kV S/C Bersimis	400	14.8	64	63.35	64	NIL	54.05	54	10 m
3	400 kV D/C Moose	400	13.3	46	44.01	46	0 - 2 m	37.63	38	8 m
4	220 kV D/C Zebra	350	10.6	35	34.41	32	0.5 - 3m			
5	132 kV D/c Panther	320	7.8	27	26.31	25	0.5 - 2m			
6	66 kV D/C WOLF	250	5.11	18	18.37		NIL			

COMPARISON of CALCULATIONS

					RIGHT OF WAY (M)					
					I - STRING			V-STRING		
S.NO.	Circuit & Conductor	Reduced 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	250	6.10	67	58.08	58	9 m	48.17	46	19-21 m
2	765 kV S/C Bersimis	250	6.8	64	54.1	55	9 - 10 m	44.8	45	9 m
3	400 kV D/C Moose	250	6.1	46	35.77	38	8-10 m	29.39	30	16 m
4	220 kV D/C Zebra	200	4.35	35	27.12	25	8-10 m			
5	132 kV D/c Panther	200	3.63	27	21.42	20	5.5 - 7m			
6	66 kV D/C WOLF	200	3.56	18	16.59		1.4 m			

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

COMPARISON of CALCULATIONS

S.NO.	Circuit & Conductor	SPAN (m)	Sag (m)	Exist. RoW (m)	RIGHT OF WAY (M)					
					I - STRING			V-STRING		
					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					

Result of phase to phase and phase to earth test on covered conductors by CPRI

Name of the Conductor	Applied Voltage in kV rms	Distance between phases in mm	Distance phase to ground in mm	Duration in minutes
33 kV	21	75	75	5
66 kV	42	300	300	5
132 kV	84	500	500	5

Comparison of ROW 33kV line with bare conductor and Covered conductor

Voltage	Span	cross arm length(A)	Horizental clearance(B)	max sag	insulator length	cross arm to conductor vertical distance	swing angle	Horizental Swing (C)	ROW=2*(A+B+C)
33 KV(Bare)	100	2.00	2.00	3.50	0.73	4.23	55	3.47	14.93
Covered Conductor									
33 KV	100	0.2	1.80	1.00	0.20	1.20	45	0.85	5.70
33 KV	100	0.2	1.80	1.00	0.20	1.20	35	0.69	5.37

Comparison of ROW 66 kV line with bare conductor and Covered Conductor

Voltage	Span	crossarm length (A)	Horizontal clearance (B)	max sag	insulator length	cross arm to conductor vertical distance	swing angle	Horizontal Swing (C)	ROW=2*(A+B+C)
Bare Conductor									
66 kV	150	2.13	2.30	4.50	1.10	5.60	55	4.59	18.03
COVERED CONDUCTOR									
66 kV(Broad Base)	150	1.05	2.30	2.00	0.50	2.50	45	1.77	10.23
66 kV(Broad Base)	150	1.05	2.30	2.00	0.50	2.50	35	1.43	9.56
66 kV(Pole Type)	150	0.62	2.30	2.00	0.50	2.50	45	1.77	9.36
66 kV(Narrow Base with single side cross arm)	**150**	**1.85**	**2.30**	**1.54**	**1.00**	**2.54**	**45**	**1.80**	**2*2.3+2*1.8=8.20**
66 kV(Narrow Base with single side cross arm)	150	0.90	2.30	1.54	0.50	2.04	45	1.44	2x2.3+2x1.44=7.4

Comparison of ROW 132kV line with bare conductor and Covered conductor

Voltage	Span	crossarm length (A)	Horizental clearance(B)	max sag	insulator length	cross arm to conductor vertical distance	swing angle	Horizental Swing (C)	ROW=2*(A+B+C)
132 KV(Bare)	200	3.50	2.91	6.86	1.81	8.67	55	7.10	27.02
COVERED CONDUCTOR									
132 KV	200	2.00	2.91	3.00	2.00	5.00	45	3.53	16.89
132 KV	200	2.00	2.91	3.00	2.00	5.00	35	2.86	15.55

REDUCTION IN RoW

SL.NO.	URBAN AREAS/ POPULATED AREAS / FOREST AREAS	NORMAL AREA WITHOUT CONSTRAINTS
	RoW REDUCTION NEEDS TO BE FOCUSSED THROUGH MEASURES LIKE	OPTIMUM USE OF CORRIDOR NEEDS TO BE FOCUSSED THROUGH MEASURES LIKE
(a)	MULTI CIRCUIT –MULTI VOLTAGE WITH LOWER VOLTAGE IN BOTTOM TIER	MULTI-CIRCUIT TOWERS / MULTI CIRCUIT-MULTI VOLTAGE TOWERS AND USE OF HTLS CONDUCTOR TO INCREASE MW POWER FLOW PER METER OF RoW
(b)	REDUCTION IN SPAN	CABLE / GIL TO BE USED EXCLUSIVELY BASED ON TECHNO-ECONOMIC CONSIDERATION
(c)	RAISING TOWER HEIGHT IN FOREST AREA TO REDUCE TREE CUTTING USE OF TENSION TOWER	
(d)	ONE SIDE STRINGING OF LATTICE TOWER / MONOPOLE STRUCTURE	
(e)	COVERED CONDUCTOR FOR 66kV AND BELOW	
(f)	UNDER GROUND CABLE / GIL [GIL EXCLUSIVELY FOR HIGH POWER TRANSMISSION AND WHERE MULTI CABLE PER PHASE IS REQUIRED]	
(g)	COMPACT TOWER WITH INSULATED CROSS ARM	
(h)	EXPLORING POSSIBILITY OF USE OF VSC BASED HVDC WITH UNDER GROUND CABLE	

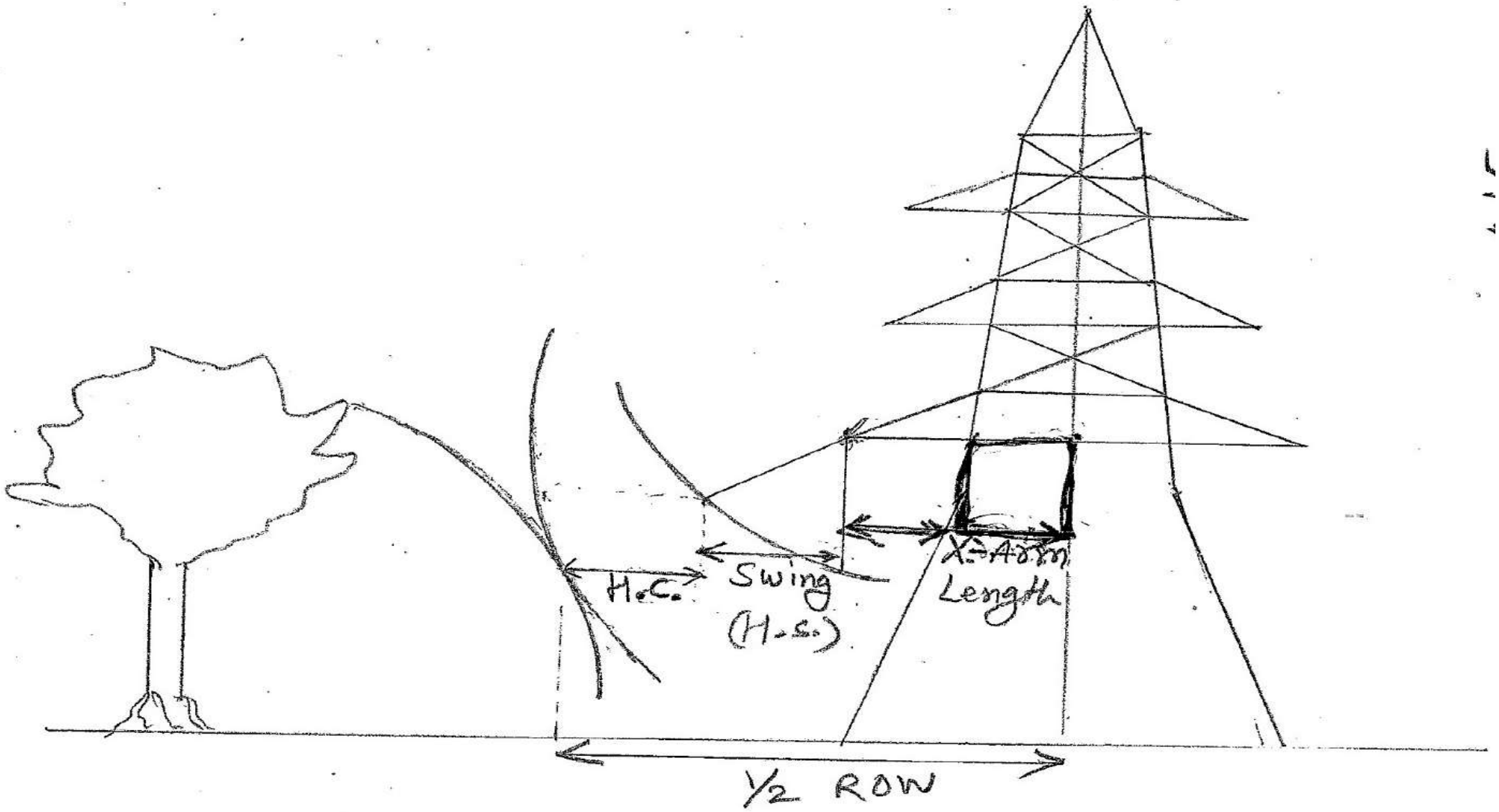
THANK YOU
FOR
YOUR ATTENTION

KSEB DESIGN

TYPICAL COMPARISON OF VARIOUS TOWERS AND THE TOWER DIMENSIONS FOR ROW						
Item/Details	Circuit	Phase	Total Minimum RoW required	Remarks	Approximate Height of cross arm	Tower Height Including Peak
Newly designed 400kV MCMV Tower suspension-MLA	400kV	Top	33.42	<36 Mtrs	56.83	61 Mtrs
	400kV	Middle	33.42	<36 Mtrs	48.83	
	400kV	Bottom	33.42	<36 Mtrs	40.83	
	220kV	Top	32.66	<36 Mtrs	33.33	
	220kV	Middle	32.66	<36 Mtrs	27.54	
	220kV	Bottom	32.66	<36 Mtrs	21.75	
Newly designed 400kV MCMV Tower Tension 60 deg-MLD	400kV	Top	35.6	<36 Mtrs	53.52	60Mtrs
	400kV	Middle	35.6	<36 Mtrs	45.52	
	400kV	Bottom	35.60	<36 Mtrs	37.52	
	220kV	Top	33.66	<35 Mtrs	30.02	
	220kV	Middle	33.66	<35 Mtrs	24.57	
	220kV	Bottom	33.66	<35 Mtrs	19.12	

Voltage level (kV)	Length of Bottom Cross arm from centre of tower (m)			Length of Insulator string (m)		
	Adani	Sterlite	PGCIL	Adani	Sterlite	PGCIL
66kV D/C	-	2.135	-	-	1.255	-
132kV D/C	3.66	3.51	3.9	2.5	1.955	2.3
220 kV D/C	4.95	4.95	4.6	3.2	2.64	2.5
400 kV D/C	7.15	6.75	7.5	3.97	3.75	4.0
765 kV (S/C)	12	10.05/9.5	10.5	7.2	7.15	7.1
765kV D/C	12.501	12.25	12.5	7.4	7.5	7.6

Basic Diagram for Calculation of Right of Way (ROW)



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)

Central Electricity Authority (CEA)

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Annex-2

4th Meeting of COMMITTEE FOR FINALISATION OF COMPENSATION IN REGARD TO RIGHT OF WAY (RoW) FOR TRANSMISSION LINES IN URBAN AREAS

CENTRAL ELECTRICITY AUTHORITY

(MINISTRY OF POWER)

08.12.2016

- In third meeting of the Committee held on 02.11.2016, it was decided that 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.

- Chief Engineer (PSP&PA-I), CEA had taken meeting on 25.11.2016 to discuss in detail the inputs provided by PGCIL and representatives from Kerala on the proposed matrix.

- It was proposed that the entire Route of transmission line could be divided into following three Sections:
  - Normal route
  - Forest area
  - Urban area / Approach section near Substation

- Different span lengths are proposed for forest areas, urban area / approach section near Substation.

- Two approaches has been suggested
  - ❖ Specifying RoW and base width of tower for different voltage level for calculation of compensation
  - ❖ Specifying only the clearance requirement including swing of conductor and giving opportunity for optimizing the design of tower.

- Based on inputs from PGCIL and KSEB, a matrix has been prepared for
  (a) Different spans
  (b) Different insulator string configuration
  (c) Conventional ACSR conductor used at different voltage levels

- V-type / Y-type / I-type insulator string configuration are used for suspension towers.

- It was reported that V string configuration of insulators has some maintenance issues. Hence the use of V string insulators may be restricted to areas with constraints.

- The V/Y type configuration is exclusively used for entire length of the HVDC lines to meet high creepage distance requirement.

- It is proposed to use Suspension towers with V-string or Tension towers in urban and forest area to reduce RoW.

- **Even if reduction in RoW is achieved by optimizing the tower design, Compensation has to be paid for specified RoW for different voltage levels**

- **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)**

Option available for optimization and Optimum utilization of RoW including Urban / Forest areas

Sl. No11	Description
1	Reduction in Span length
2	Use of Tension towers
3	Reduction in foot print of tower base [Monopole, Narrow base]
4	Use of Multi-circuit towers
5	Use of Muti-circuit & Multi-voltage towers to reduce RoW
6	Upgrading of the existing line or urating with high Ampacity conductor (HT/HTS) in the existing corridor
7	Use of Monopole / lattice structure with one side stringing
8	Use of XLPE cable / GITL

Option available for optimization and Optimum utilization of RoW including Urban / Forest areas

Sl. No11	Description
9	Use of multi-circuit / multi-voltage with extended towers to save trees (without cutting of trees) maintaining required safety clearance over the trees [as done in case of Jaldapara Reserve forest area by PGCIL]
10	Use of compact tower with insulated cross arm
11	Possibility of use of VSC based HVDC can be explored
12	Use of covered conductors upto 66kV level
13	Planning of intra-state transmission network should take into account the optimum utilization of existing corridor and the nearest connectivity with Inter-State Transmission system (ISTS)

Proposed ROW for various Voltage level of Transmission line

308134/2019/OFFICE OF BIHARI LAL

Summary

RIGHT OF WAY CALCULATION PLAIN/FOREST & URBAN

Voltage level	Configuration	Conductor type	Terrain	Ruling Span	String Type	Horizontal distance of Conductor attachment point from centre of tower In M	Width of right of way in M		Tentative Horizontal distance of Conductor attachment point from centre of tower In M	Approx. Width of right of way in M	AS per the current standards IS5613/CBIP in Mtrs	Proposed RoW value for compensation	Reduction in RoW	Proposed base width of tower for Compensation
A		B		C		X	R=2(D+H)+2X		X	R				
765kV D/C	Vertical	ACSR ZEBRA	Plain	400	"I" String	X	42	2X	12.5	67	67	67	0	25
					"V" String	X	33.2	2X	10.5	54				
					Tension		33.2	2X	14.5	62				
			Forest	300	"I" String	X	36	2X	12.5	61				
					"V" String	X	27	2X	10.5	48	67	56	11	25
					Tension		27	2X	14.5	56				
			Urban	250	"I" String	X	34	2X	12.5	59				
					"V" String	X	25	2X	10.5	46	67	54	13	25
					Tension		25	2X	14.5	54				
765kV S/C	Vertical /Delta	ACSR BERSIMIS	Plain	400	"I" String	X	43.2	2X	10.5	64	64	64	0	19
					"V" String	X	35	2X	9.5	54				
					Tension		35	2X	13	61				
			Forest	300	"I" String	X	36.6	2X	10.5	58				
					"V" String	X	28.4	2X	9.5	47	64	54	10	19
					Tension		28.4	2X	13	54				
			Urban	250	"I" String	X	34	2X	10.5	55				
					"V" String	X	25.8	2X	9.5	45	64	52	12	19
					Tension		25.8	2X	13	52				
765kV S/C	Horizontal	ACSR BERSIMIS	Plain	400	"I" String	X	43.2	2X	15.6	74	85	74	11	15
					"V" String	X	35	2X	14.4	64				
					Tension		35	2X	18.2	71				
			Forest	300	"I" String	X	36.6	2X	15.6	68				
					"V" String	X	28.4	2X	14.4	57	85	65	20	15
					Tension		28.4	2X	18.2	65				
			Urban	250	"I" String	X	34	2X	15.6	65				
					"V" String	X	25.8	2X	14.4	55	85	62	23	15
					Tension		25.8	2X	18.2	62				