Republic of India
Madhya Pradesh Power Transmission Company Limited (MPPTCL)

Technical Assistance for Transmission System Strengthening Works in Madhya Pradesh

Final Report

October 2015

Japan International Cooperation Agency (JICA)

Tokyo Electric Power Company, Inc.

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Contents

Abbreviations

Abbreviation	Full Name
ACE	Additional Chief Engineer
ACSR	Aluminum Conductor Steel Reinforced
AS	Aluminum-Clad Steel Wire
ATS	Atomic Power Station
BHEL	Bharath Heavy Electrical Limited
CE	Chief Engineer
CEA	Central Electricity Authority of India
CRA	Commercial and Regulatory Affairs
CoD	Collect on Delivery
DCDS	Double Circuit Double String
DCSS	Double Circuit Single String
DMIC	Delhi-Mumbai Industrial Corridor
DPR	Detailed Project Report
DS	Disconnecting Switch
DVC	Damodar Valley Corporation
EC	Environmental Clearance
ED	Executive Director
EHT	Extra High Tension
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPC	Engineering, Procurement and Construction
ES	Earthing Switch
GCB	Gas Circuit Breaker
GIS	Gas Insulated Switchgear
GoI	Government of India
GSW	Galvanized Steel Wire
HSES	High Speed Earthing Switch
HTLS	High Temperature Low Sag (conductor)
HPS	Hydro Power Station
HRD	Human Resource Development
ICB	International Competitive Bidding
IEE	Initial Environmental Examination
IEEE	Institute of Electrical and Electronics Engineers
IKL	Isokeraunic Level
INR	Indian Rupee
IPP	Independent Power Producer
IPP	Indigenous Peoples Plan
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
JV	Joint Venture
LAA	Land Acquisition Act
LL-ACSR	Low Loss type ACSR (conductor)
M&I	Maintenance and Inspection

MPERC	Madhya Pradesh Electricity Regulatory Commission
MPPGCL	Madhya Pradesh Power Generating Company Limited
MPPTCL	Madhya Pradesh Power Transmission Company Limited
MPSEB	Madhya Pradesh State Electricity Board
MW	Megawatt
NGO	Non-Governmental Organizations
NPC	Nuclear Power Corporation of India Limited
NRRP-2007	National Rehabilitation and Resettlement Policy, 2007
NTPC	NTPC Limited (National Thermal Power Corporation Limited)
ODA	Official Development Assistance
O&M	Operation and Maintenance
OPTCL	Odisha Power Transmission Company Limited
OPGW	Optical Ground Wire
PGCIL	Power Grid Corporation of India Limited
PQ	Prequalification
PSAF	Power Systems Analysis Framework
PSS/E	Power System Simulator for Engineering
PC	Procurement and Construction
RAP	Resettlement Action Plan
RE	Renewable Energy
ROW	Right-of-Way
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
STPS	Super Thermal Power Station
SCADA	Supervisory Control and Data Acquisition
SE	Superintending Engineer
SLDC	State Load Dispatching Center
S/S	Substation
TANTRANSCO	Tamil Nadu Transmission Corporation Ltd.
T&C	Testing and Communication
T&D	Transmission and Distribution
TEPCO	Tokyo Electric Power Company, Inc.
T/L	Transmission Line
TPS	Thermal Power Station
UGS	Ultra-High Strength Galvanized Steel Wire

Chapter 1. Background and Necessity of Project

1.1. Introduction (Background)

In India, national energy consumption has continued to grow due to recent annual economic growth, becoming the 4th largest in the world at the end of 2012. Supply has not kept up with the demand growth, with a 3.6% shortage in energy (supply of 1,028,955GWh for demand of 1,067,085GWh), and a 4.7% shortage in capacity (generation capacity of 141,160MW for peak demand of 148,166MW) in FY2014-15. To counter these problems, in energy sector reforms after the New Electricity Act was introduced in the 12th Five year Plan (2012-2017), new power developments will be focused exclusively on supercritical technology after the 13th Five year Plan (2018-2023) and transmission and distribution network reinforcement and rural electrification will also be critical domestic issues.

Located in the central part of India, the State of Madhya Pradesh has the 2nd largest surface area (308,144km^2) and the 6th largest population (73 million) in India. The state constitutes part of the Delhi-Mumbai Industrial Corridor (DMIC), which is a mega-infrastructure project initiated by India and Japan, and has plans for industrial development in the future, including the development of a Special Economic Zone near Indore airport, a distribution center near Dewas and the industrial area of Pithampur. To achieve sustainable development in the state of Madhya Pradesh the electricity demand will continue to increase. In the state's power demand-supply balance in FY2014-15, there was a 0.5% shortage in energy, with a supply of 53,445GWh for a demand of 53,737GWh. To cope with the energy deficit, the government of Madhya Pradesh has signed contracts with Independent Power Producers (IPPs) to develop further power plants, and the generation capacity of the state will increase in the future. Since the increased power should flow not only into the urban areas, but also into the rural areas, transmission line system strengthening is essential for the entire state. To strengthen the power system, the Japan International Cooperation Agency (JICA) provided a loan, with a total project cost of 22,213 million yen and the loan amount of 18,475 million yen, for "the Madhya Pradesh Transmission System Modernisation Project" (JICA Phase I Project) in 2011. The JICA Phase I Project has been successfully implemented to improve the power system in Madhya Pradesh. Meanwhile, to cope with the increasing power demand in the future, the Madhya Pradesh Power Transmission Company Limited (MPPTCL) prepared a Detailed Project Report (DPR) for "Transmission System Strengthening Works in Madhya Pradesh" (Project) for expected financial cooperation from the Japanese government, concerning transmission system development with new technologies like Low Loss type ACSR (LL-ACSR) conductor, High Temperature Low Sag (HTLS) conductor, and Gas Insulated Switchgear (GIS), to stabilize and reduce losses in the

power transmission system. Some further refinement of the Project is necessary.

Table 1-1 Demand Forecast in 18th Electricity Power Survey

Unit: MW

State/Uts	FY2011-12	FY2016-17	FY2021-22	FY2026-27	FY2031-32
Delhi	4,770	6,398	9,024	12,681	17,246
Haryana	6,376	10,273	14,244	20,103	27,202
Himachal Pradesh	1,335	1,900	2,589	3,424	4,476
Jammu & Kashmir	1,802	2,687	4,217	5,996	8,302
Punjab	8,363	12,342	14,552	18,352	23,144
Rajasthan	8,097	13,886	19,692	28,828	40,284
Uttar Pradesh	12,021	23,081	36,061	53,690	73,708
Uttarakhand	1,656	2,189	2,901	3,911	5,222
Chandigarh	336	426	559	732	948
Northern Region	**37,265**	**60,934**	**86,461**	**121,979**	**164,236**
Goa	530	815	1,192	1,658	2,216
Gujarat	11,556	19,091	26,973	38,691	53,301
Chhattisgarh	3,155	4,687	6,599	9,090	12,116
Madhya Pradesh	**8,897**	**13,904**	**18,802**	**27,519**	**38,088**
Maharashtra	18,398	28,645	39,622	54,982	74,528
D. & N. Haveli	640	944	1,297	1,733	2,294
Daman & Diu	308	441	605	818	1,082
Western Region	**39,351**	**62,015**	**86,054**	**120,620**	**163,222**
Andhra Pradesh	14,122	22,445	33,194	51,601	74,818
Karnataka	8,545	13,010	18,403	25,396	34,720
Kerala	3,489	4,669	6,093	8,150	10,903
Tamil Nadu	12,271	20,816	29,975	43,044	59,127
Pudducherry	497	630	782	787	940
Southern Region	**36,175**	**57,221**	**82,199**	**118,764**	**165,336**
Bihar	2,226	5,018	9,306	16,239	23,411
Jharkhand	3,201	4,616	6,341	8,780	11,930
Odisha	3,964	5,672	6,749	8,712	11,280
West Bengal	7,454	11,793	17,703	26,027	36,187
Sikkim	106	144	176	245	341
Eastern Region	**15,122**	**24,303**	**35,928**	**53,053**	**72,874**
Assam	1,257	1,817	2,534	3,613	5,033
Manipur	171	346	497	869	1,212
Meghalaya	361	445	596	828	1,112
Nagaland	130	185	271	403	554
Tripura	239	340	472	674	913
Arunachal	88	135	177	266	365
Mizoram	160	285	352	521	723
North Eastern	**2,021**	**2,966**	**4,056**	**6,169**	**8,450**
Andaman	51	67	89	125	172
Lakshadweep	7	11	18	23	30
India	**124,995**	**199,540**	**283,470**	**400,705**	**541,823**

(Source: 18th Electricity Power Survey by CEA)

1.2. Purpose of the Project

The purpose of the Project is to strengthen MPPTCL's transmission lines and substations to cope with the increasing demand for electricity in the state of Madhya Pradesh. It is conducive to the capacity increase and the stability of the power transmission system.

1.3. Outline of the Study

The following table shows the outline of the Study.

Table 1-2 Summary of the Study

Objective	Based on the introduction of new technologies for loss reduction and an efficient system in Madhya Pradesh, the purpose of the study is to provide technical assistance for improvement of the Project, including a review of the DPR with new technologies and environmental effects.
Scope	1. Review and update of MPPTCL's power system development plan 2. Review and update of the DPR 3. Study on introduction of new technologies 4. Assistance with environmental and social considerations 5. Review of implementation scheme
Period	July 2015 to October 2015 (two visits to India)
Study Area	Madhya Pradesh state, India
Counterpart	Madhya Pradesh Power Transmission Company Limited (MPPTCL)

1.4. Outline of the Power Sector in Madhya Pradesh

The power sector in Madhya Pradesh was originally operated by the vertically-integrated Madhya Pradesh State Electricity Board (MPSEB) as per other states in India. To improve its power supply efficiency and to meet the growing power demand, the Madhya Pradesh VidyutSudhar Adhiniyam, 2000, was enacted in 2000 and enforced in 2001, along almost the same timeline as the other states in India. This unbundled the power utilities and separated generation from power transmission and distribution in order to encourage market mechanisms in the power sector. Under the act, Madhya Pradesh Electricity Regulatory Commission (MPERC) was established and started operation from 2001 as a regulatory authority to monitor and control power utilities and to promote competitiveness in the power sector. At the same time, Madhya Pradesh Power Generating Company Limited (MPPGCL) as a generation company, MPPTCL as a transmission company, and three area-wise distribution companies were established in 2002 (see Figure 1-1) MPPTCL owns and operates the transmission system of voltage levels over 132kV, while

distribution companies are under 33kV system[1]. Afterward, Madhya Pradesh Power Management Company Limited (former Madhya Pradesh Power Trading Company Limited) with the functions of bulk purchase of electricity from generating companies and supply of electricity in bulk to the three distribution companies were established in 2006.

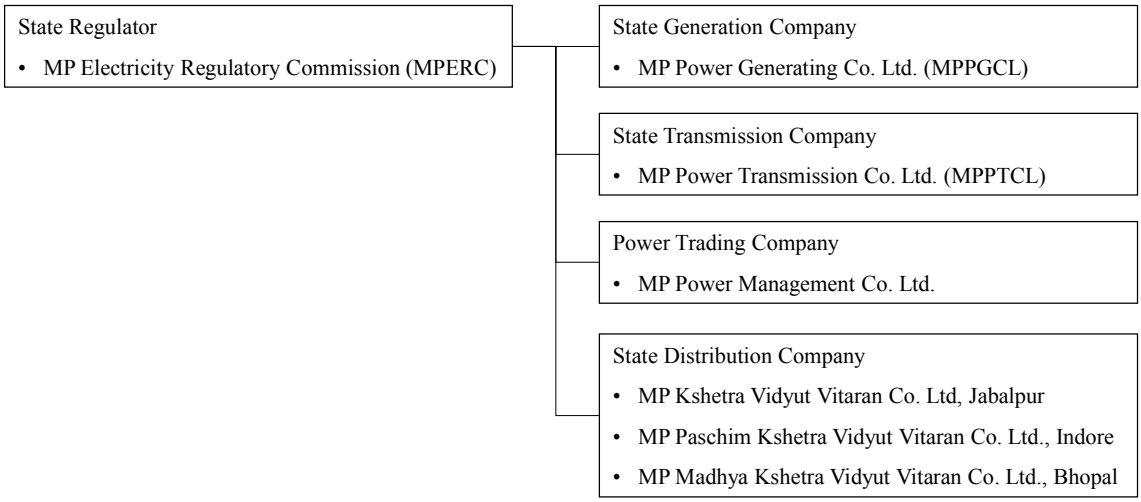

Figure 1-1 Power Sector Structure in Madhya Pradesh

1.4.1. Mission and Strategy of MPPTCL

MPPTCL's first priority is to provide stable electricity to customers as a transmission company operating a transmission business in Madhya Pradesh. Amid the increase in electricity demand in Madhya Pradesh, MPPTCL has plans to develop the power transmission system in order to supply stable electricity under the regulations of MPERC.

In recent years, new technologies have been introduced to improve their management efficiency and to enable them to grow as a transmission company. These include a SCADA system[2] to monitor and operate substations remotely and a demand management system connected to the State Load Dispatch Center (SLDC).[3]

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[1] MPPTCL owns and operates transmission lines and substations basically over the 132kV voltage level, which also includes 33kV distribution line feeders in 220kV/33kV or 132kV/33kV substations and some minor 66kV equipment.

[2] A system to monitor and control all MPPTCL's substations remotely. Three Control Centers are established in Jabalpur, Bhopal and Indore. The project has been executed by Dongfang Electronics Company Ltd. as a Turnkey since September 2013. At the time of September 2015, part of the system is in operation.

[3] A system for automatic load shedding in case of the possibility of system collapse from supply and demand unbalance. The project has been executed by Dongfang Electronics Company Ltd. as a Turnkey since March 2015.

1.4.2. Power Demand and Supply Balance in Madhya Pradesh

Table 1-3 shows the capacity of power generation in Madhya Pradesh, and Table 1-4 presents the peak power demand. According to the two tables, year-wise generation capacity sufficiently surpasses the corresponding year-wise peak power demand throughout the planned year. This means that the power development plan is suitable for the state and its high annual power demand increase, 7% on average. Actual power demand and supply balance, however, seems not to be sufficient. For example, according to the CEA's Monthly Power Supply Report[4], there was the power deficit of 38MW, 0.4%, with the peak demand of 9,755MW and the supply of 9,717MW in the period between April 2014 and March 2015. It was supposedly caused by the fuel supply trouble to the thermal plants and the deterioration of generation capacity/efficiency in the old power plants

The generation capacity for Madhya Pradesh was 15,190MW at the end of FY 2014-15, for which a breakdown is given in Table 1-5. The future development plan for power plants is shown in Table 1-6. According to Table 1-6, three power plants with a total capacity of 630MW are to be operated in 2015-16 by IPP, and Madhya Pradesh Power Generation Company Limited (MPPGCL), National Thermal Power Company (NTPC) and Nuclear Power Company of India (NPC) are to develop plants with the total capacity of 8,000 MW for the longer term. Therefore, the capacity expansion of the transmission system is also required in the state.

Table 1-3 Power Supply Capacity in Madhya Pradesh

FY	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
The State of MP [MW]	5,237	5,237	5,237	5,831	7,085	7,085	7,085	7,085
Central Sector [MW]	3,231	3,231	3,565	4,684	4,684	5,344	6,763	8,108
Others (IPPs, JVs, DVC, RE) [MW]	6,722	7,655	7,655	7,655	7,886	7,886	7,886	7,886
Total Capacity [MW]	15,190	16,123	16,457	18,170	19,655	20,315	21,734	23,079
Increase Rate by Year [%]	-	6.1	2.1	10.4	8.2	3.4	7.0	6.2

Note: The figures for FY 2015-16 and later are projections

(Source: MP Power Management Co. Ltd.)

[4] http://cea.nic.in/monthlypowersupply.html

Table 1-4 Peak Power Demand Forecasts by Distribution Companies in Madhya Pradesh

FY	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
East Discom [MW]	3,140	3,418	3,672	3,980	4,270	4,592	4,891
Central Discom [MW]	3,344	3,641	3,910	4,239	4,548	4,890	5,209
West Discom [MW]	4,029	4,386	4,710	5,106	5,478	5,890	6,275
Total Demand [MW]	10,513	11,445	12,293	13,326	14,297	15,372	16,375
Increase Rate by Year [%]	-	8.9	7.4	8.4	7.3	7.5	6.5

(Source: MPPTCL)

Table 1-5 Power Generation Capacity for Madhya Pradesh

Unit: MW

Category		No.	Name of Project	Installed Capacity	State Share (2015 March)
The State of MP					
	MPPGCL Thermal	1	Amarkantak TPS Ph-I	2x30 (50)	0
		2	Amarkantak TPS Ph-II	2x120	240
		3	Amarkantak TPS Ph-III	1x210	210
		4	Satpura TPS Ph-I	5x62.5	0
		5	Satpura TPS Ph-II	1x200+1x210	410
		6	Satpura TPS Ph-III	2x210	420
		7	Satpura TPS Ph-IV	2x250	500
		8	Sanjay Gandhi TPS Birsinghpur Ph-I	2x210	420
		9	Sanjay Gandhi TPS Birsinghpur Ph-II	2x210	420
		10	Sanjay Gandhi TPS Birsinghpur Ph-III	1x500	500
		11	Shri Singaji TPS Ph-I	2x600	1,200
			Sub Total		4,320
	MPPGCL Hydro	12	Rani Awanti Bai Sagar, Bargi HPS	2x45	90
		13	Bansagar HPS Ph - I (Tons)	3x105	315
		14	Bansagar HPS Ph - II (Silpara)	2x15	30
		15	Bansagar HPS Ph - III (Deolond)	3x20	60
		16	Bansagar HPS Ph - IV (Jhinna)	2x10	20
		17	Birsinghpur HPS	1x20	20
		18	Madikheda HPS	3x20	60
		19	Rajghat HPS (MP Share 50%, rest UP) (Situated in MP)	3x15	23
		20	Gandhi sagar HPS (MP share 50%, rest Rajasthan) (Situated in MP)	5x23	58
		21	Ranapratap Sagar HPS (MP Share 50%, rest Rajasthan) (Situated in Rajasthan)	4x43	86
		22	Jawahar Sagar HPS (MP Share 50%, rest Rajasthan) (Situated in Rajasthan)	3x33	50
		23	Pench HPS (MP Share 66.6%, rest Maharashtra) (Situated in Maharashtra)	2x80	107
			Sub total		917
	Sub Total (The State of MP)				5,237
Central Sector					
		24	NTPC Korba STPS	3x200+4x500	557
		25	NTPC Vindhyanchal STPS - I	6x210	443
		26	NTPC Vindhyanchal STPS - II	2x500	318
		27	NTPC Vindhyanchal STPS - III	2x500	245
		28	NTPC Vindhyanchal STPS - IV	2x500	284
		29	NTPC Sipat STPS Stage-I	3x660	337
		30	NTPC Sipat STPS Stage-II	2x500	187
		31	NTPC Mouda STPS Stage-I	2x500	184
		32	NTPC Kawas GPP (Gas)	4x106+2x116.1	140
		33	NTPC Gandhar GPP (Gas)	3x144.3+1x224.49	117
		34	NTPC Kahalgaon STPS Stage - II (ER)	3x500	74
		35	NPC Kakrapar APS (Atomic)	2x220	114
		36	NPC Tarapore APS (Atomic)	2x540	231
	Sub Total (Central Sector)				3,231
Others					
	IPPs	37	Torrent Power GPP, Gujrat (Gas)	3x382.5	100
		38	BLA Power TPS, Gadarwara	1x45	16
		39	Jaypee Bina Power TPS	2x250	350
		40	Lanco Amarkantak TPS, Raigarh	1x300	300
		41	Reliance UMPP, Sasan	6x660	1,485
		42	Essar Power STPS, Mahan, Singrauli	1x600	30
		43	Jaiprakash Power STPS, Nigri	2x660	495
			Sub total (IPPs)		2,776
	JV Hydro	44	NHDC Indira Sagar HPS	8x125	1,000
		45	NHDC Omkareshwar HPS	8x65	520
		46	Sardar Sarovar HPS (Share 57%) (Situated in Gujrat)	5x50 + 6x200	827
		47	NVDA Indira Sagar LBC HPS	3x5	15
		48	NVDA Bargi LBC HPS	2x5	10
		49	Rihand and Matatila HPS (Situated in UP)	6x50+3x10.2	55
			Sub total (JV Hydro)		2,427
	DVC	50	DVC Mejia TPS	4x210 + 2x250	200
		51	DVC Chandrapur TPS Unit 7 & 8	2x250	200
		52	DVC Durgapur TPS	2x500	100
			Sub total (DVC)		500
	Renewable Sources	53	Solar Plants		305
		54	Wind Plants		685
		55	Biogas/Biomass Plants		24
		56	Micro Hydel Plants		5
			Sub total (Renewable Sources)		1,020
	Sub Total (Others)				6,722
Total					15,190

(Source: MPPTCL)

Table 1-6 Upcoming Generation Projects in Madhya Pradesh

Category	Name of Project	CoD	Capacity (MW)	MP Share (MW)	Year wise Capacity Addition program (MW)						
					2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
The State of MP											
	MPPGCL - Shri Singaji Phase-2, Unit-1	Mar-2018	1x660	594			594				
	MPPGCL - Shri Singaji Phase-2, Unit-2	Sep-2018	1x660	594				594			
	MPPGCL - Replacement Unit of Satpura	Mar-2019	1x660	660				660			
	Sub-Total (MPPGCL)			1,848	0	0	594	1,254	0	0	0
Central Sector											
	NTPC Vindhyanchal STPS, Stage - 5, Unit-1	Apr-2016	1x500	128		128					
	NTPC Mouda STPS, Stage-2, Unit-1&2	Dec-2016	2x660	206		206					
	NTPC Lara STPS, Rajgarh (Unit 1 to 6)	Sep-2017	6x660	319			319				
	NTPC Gadarwara STPS, Unit-1	Sep-2017	1x800	400			400				
	NTPC Gadarwara STPS, Unit-2	Mar-2018	1x800	400			400				
	NTPC Barethi STPS, Chhatarpur, Unit-1&2	Dec-2019	2x660	660					660		
	NTPC Barethi STPS, Chhatarpur, Unit-3&4	Sep-2020	2x660	660						660	
	NTPC Barethi STPS, Chhatarpur, Unit-5&6	Dec-2021	2x660	660							660
	NTPC Solapur STPS, Unit-1&2	Mar-2021	2x660	304						304	
	NTPC Khargone STPS, Unit-1	Mar-2021	1x660	330						330	
	NTPC Khargone STPS, Unit-2	Sep-2021	1x660	330							330
	NTPC Dhruvan STPS, Gujrat, Unit-1,2&3	Sep-2021	3x660	230							230
	NTPC North Karanpura STPS, Unit-1	Dec-2018	1x660	66				66			
	NTPC North Karanpura STPS, Unit-2	Jun-2019	1x660	66					66		
	NTPC North Karanpura STPS, Unit-3	Dec-2019	1x660	67					67		
	NPC Kakrapar APS, Unit-3	Sep-2020	1x700	125						125	
	NPC Kakrapar APS, Unit-4	Sep-2021	1x700	125							125
	Sub-Total (Central Sector)			5,076	0	334	1,119	66	793	1,419	1,345
Others											
	MB Power STPS, Unit-1	May-2015	1x600	210	210						
	MB Power STPS, Unit-2	Dec-2015	1x600	210	210						
	Essar Power STPS, Unit 1 & 2		2x600	150							
	Jhabua Power STPS, Unit-1	Sep-2015	1x600	210	210						
	BLA Power TPS Unit-2		1x45	16							
	DB Power TPS, Unit-1		1x660	231							
	Sub-Total (IPPs)			1,027	630	0	0	0	0	0	0
Renewable Sources											
	Solar Plants	Jan-2016		130	130						
	Wind Plants	Jan-2016		236	236						
	Bio Mass/Bio gas Plants	Jan-2016		8	8						
	Sub-Total (Renewable)			374	374	0	0	0	0	0	0
Grand Total (Upcoming Projects)				8,324	1,004	334	1,713	1,320	793	1,419	1,345

(Source: MPPTCL)

An overview of transmission lines and substations owned by MPPTCL is given in Table 1-7. The table includes the equipment increase rate between 2002 and 2015 to ascertain the rate of system expansion. MPPTCL owns 30,686km (circuit length) of transmission lines and 294 substations as of June 2015. Between March 2002 and June 2015, there were increases of 75% in transmission lines, 109% in substations and 178% in substation capacity, where all MPPTCL's substations are Air Insulated Substation (AIS) and MPPTCL has not used Gas Insulated Switchgear (GIS) in the past.

Table 1-7 Summary of the Transmission Lines and Substations Owned by MPPTCL

Equipment	Unit	Amount of equipment (as of March 2002)	Amount of equipment (as of June 2015)	Increase rate from March 2002 to June 2015
400kV T/L	Circuit-km	1,706	3,074	80%
220kV T/L	Circuit-km	6,496	12,001	85%
132kV T/L	Circuit-km	9,229	15,549	68%
66kV T/L	Circuit-km	61	61	-
T/L Total	Circuit-km	17,493	30,686	75%
400kV S/S	No.	4	9	125%
	MVA	2,940	6,720	129%
220kV S/S	No.	26	64	146%
	MVA	6,610	18,630	182%
132kV S/S	No.	110	220	100%
	MVA	6,910	20,517	197%
66kV S/S	No.	1	1	-
	MVA	20	20	-
S/S Total	No.	141	294	109%
	MVA	16,480	45,887	178%
Number of Transformers in S/S	No.	356	718	102%

(Source: MPPTCL Overview)

1.4.3. Transmission and Distribution Losses in Madhya Pradesh

Table 1-8 shows the historical record of transmission and distribution losses in Madhya Pradesh. The latest record of the transmission loss rate, which is controlled by MPPTCL, was at a sufficiently low 3.0% in FY2014-15. On the other hand, the distribution loss rate was at a very high 24.1%. Generally, lower-voltage systems which are close to the demand side produce more electricity losses, including technical and commercial losses. The electricity loss is proportional to the square of the current. This means that an appropriate investment strategy is necessary to

keep the electricity loss low against increased power demand. As mentioned earlier, demand has been growing in Madhya Pradesh, which means the system requires appropriate investment in order to maintain low distribution losses.

Table 1-8 T&D Losses in Madhya Pradesh

Unit: %

FY	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Transmission Loss	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Distribution Loss	24.1	22.2	20.9	19.9	18.8	17.8	16.8	15.7
Average T&D Loss	27.1	25.2	24.0	23.0	22.0	21.0	20.0	19.0

Note: The figures for FY 2015-16 and later are projections

(Source: MP Power Management Co. Ltd.)

1.4.4. Power Quality (Substation Voltage)

As an indicator of the power quality in Madhya Pradesh, the substation busbar voltage and power frequency must be controlled within the specified values on Table 1-9 and Table 1-10 according to Electricity Grid Code (Revisions-I), 2015[5]. Based on the interviews with MPPTCL, the regulations are almost always adhered to in normal conditions except for system failures. However, considering the future demand increase, the operational voltage, especially in some 132kV substations which are close to the demand, is predicted to be close to the regulated -10%, and MPPTCL's planned target voltage of -9%, by normal voltage drop. MPPTCL has strengthened the 132kV systems in order not to stray from the voltage criteria.

Table 1-9 Operational Voltage Criteria in Madhya Pradesh

Nominal [kV]	% Limit of variation	Maximum [kV]	Minimum [kV]
400kV	+5% / -10%	420	360
220kV	+/- 10%	245	200
132kV	+/- 10%	145	120

(Source: Electricity Grid Code (Revision-I), 2005)

[5] In Table 1-10, the reason why the upper limit of target range is more than the lower ones, it is supposedly originated from the characteristics of Indian power system operation in the past, which power frequency usually ranged between 48.5Hz and 50.0Hz due to the supply capacity shortage.

Table 1-10 Power Frequency Criteria in Madhya Pradesh

Target Range		Statutory Acceptable Limit	
Upper Limit	**Lower Limit**	**Upper Limit**	**Lower Limit**
50.5 Hz (+1%)	49.0 Hz (-2%)	51.5 Hz (+3%)	48.5 Hz (-3%)

(Source: Electricity Grid Code (Revision-I), 2005)

1.4.5. System Reliability

Table 1-11 shows System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) for each distribution company in Madhya Pradesh state in FY 2013-14 according to the CEA report. SAIDIs and SAIFIs in Madhya Pradesh state are wide ranging, from around 152.17 to 60,800.52 minutes and 1.97 to 885.26 times respectively. It is found that regional differences in system reliability are large. Additionally, the system reliability level in Madhya Pradesh state is not necessarily high compared with the SAIDIs from a couple of minutes to about an hour in advanced countries and the SAIFIs from about 0.1 to 0.2 times in Tokyo Electric Power Company.

Table 1-11 System Reliability in Madhya Pradesh State

Distribution Company	SAIDI [Minutes]	SAIFI [No. of Incidents]
MP Paschim KVVCL, Indore		
Indore	359.49	12.87
Dhar	481.31	3.10
Khandwa	281.29	9.57
Burhanpur	770.16	24.80
Khargone	401.19	36.21
Badwani	1503.26	2.85
Jhabua	609.36	46.67
Ujjain	2497.23	32.89
Dewas	582.00	22.92
Shajapur	152.17	1.97
Ratlam	470.59	14.38
Mandsaur	2425.00	38.30
Neemuch	440.00	5.97
MP Poorv KVVCL, Jabalpur		
Boregaon	2072.00	110.00
Chanatoriya	3584.26	90.00
Chhatarpur	3048.21	198.30
Chindwada	3085.61	89.62

Distribution Company	SAIDI [Minutes]	SAIFI [No. of Incidents]
Damoh	7600.98	294.60
Jabalpur	23455.63	885.26
Katni	241.58	31.00
Rewa	1470.52	32.54
Sagar	2406.32	78.11
Satna	8143.38	234.61
Anooppur	9255.99	218.67
Balaghat	272.15	72.86
Narsingpur	6722.99	207.25
Panna	60800.52	777.50
Shahdol	5757.94	204.17
Seoni	4378.04	133.60
Sidhi	13143.08	244.25
Tikamgarh	10183.67	332.33
Umariya	4905.19	175.33
Waidhan	9818.15	285.08
MPMKVVCL, Bhopal		
Bhopal	2046.89	63.48
Sehore City	4017.44	171.33
Vidisha Town	6338.89	124.24
Betul City	9546.88	250.67
Rajgarh	4615.51	49.50
Hoshangabad	7055.13	287.22
Harda	6966.78	254.50
Raisen	704.90	102.67
Mandideep	-	-
Gwalior	3267.66	263.69
Datia	1598.29	59.54
Morena	27251.27	177.17
Bhind	6630.72	93.06
Guna	7787.11	306.38
Ashoknagar	8985.74	604.75
Shivpuri	16335.52	153.42
Sheopur	3441.51	24.57

(Source: Reliability Index of the Cities/Towns/Villages - DISCOM wise by CEA)

1.4.6. Transmission Charge System

The main revenue for MPPTCL is transmission charges from transmitting power generated in power plants to distribution companies in the State. MPERC approves the transmission charge annually and different charges are applied according to the length of the contract term, as shown in Table 1-12.

Table 1-12 Transmission Charges

No.	Particulars	FY 2013-14	FY 2014-15	FY 2015-16
1	Annual Fixed Cost [INR Crores]	1642.49	1724.99	1795.72
2	Transmission System Capacity [MW]	10530	13015	14540
3	Transmission Charges for Long Term Customers [INR Lacs/MW/Year]	15.60	13.25	12.35
4	Transmission Charges for Long Term Customers [INR/MW/Day]	4273.48	3631.19	3374.37
5	Short Term Rates (25% of above) [INR/MW/Day]	1068.36	907.80	843.59
6	Short Term Rates for 6 Hour Block [INR/MW]	267.09	226.95	210.90
7	Short Term Rates for more than 6 Hours to 12 Hours in one Block [INR/MW]	534.18	453.90	421.80
8	Short Term Rates for more than 12 Hours up to 24 Hours [INR/MW]	1068.37	907.80	843.59
9	Units Expected to be Transmitted in a Year [GWh]	56437	62543	69310
10	Short Term Open Access Rates (No.1/No.9*0.25) [INR/MWh]	72.76	68.95	64.77

(INR 1=JPY 1.94, July 2015 monthly average)

(Source: Transmission Multi-Year Tariff Order for FY2013-14 to FY2015-16, MPERC)

Chapter 2. Project Outline

2.1. Project Outline

The Project aims to install new 400kV, 220kV, and 132kV transmission lines and substations and to extend existing substations. For the transmission system development plan, MPPTCL officially establishes their five-year development plan every five years and MPERC approves it. The latest 12th Five-Year Business Plan, from April 2012 to March 2017, has been officially published and implemented. In addition, MPPTCL updates their development plans appropriately in response to changes in situations, such as demand forecast updates. The 33 subprojects in the Project are selected from the list in the latest development plan between FY2015-16 and to FY 2021-22.

Table 2-1 shows the subproject list for the Project. As new technologies for MPPTCL, Low Loss ACSR conductor for 190km (route length), 220kV transmission lines and GIS for a 220kV substation are included.

Table 2-1 List of 33 Subprojects

No.	Name	T/L [km, Route Length][*1]			S/S[*2]		
		400kV	220kV	132kV	S/S Name	Tr. Voltage	Tr. Capacity
1	LILO of Khandwa – Rajgarh	5			-	-	-
2	Super Corridor		LL 50	13	New Super Corridor (GIS)	220/132kV 132/33kV	160MVA×1 63MVA×1
4	Charging/Upgrading Chichli - Udaipura				Exist. Udaipura	220/132kV	160MVA×1
5	Chhatarpur – Tikamgarh		LL 110		-	-	-
6	LILO of Bina - Ganibasoda		10		Exist. Bina	400/220kV	315MVA×1
7	Rewa - Rewa UMSP – Sidhi		LL 30 60		-	-	-
9	Julwania –Pati (Silawad)			40	New Pati (Silawad)	132/33kV	50MVA×1
10	LILO of Mangliya - Indore SZ			3	New Mahalaxmi	132/33kV	63MVA×1
11	Julwania - Shahpura			65	New Shahpura	132/33kV	50MVA×1
12	Datia - Bhitarwr			40	New Bhitarwr	132/33kV	50MVA×1
13	Mugalia Chhap – Mahwadia			10	New Mahwadia	132/33kV	50MVA×1
15	Sidhi - Madwas			50	New Madwas	132/33kV	50MVA×1
16	Panagar - Dheemarkheda			65	New Dheemarkheda	132/33kV	50MVA×1
17	Prithivipur – Orchha			30	New Orchha	132/33kV	50MVA×1
18	Sirmour - Atraila			30	New Atraila	132/33kV	50MVA×1
19	Udaipura -Tendukheda			45	New Tendukhe	132/33kV	50MVA×1

					da		
20	Gohad - Gormi			25	New Gormi	132/33kV	50MVA×1
21	Narsinghgarh – Suthaliya			50	New Suthaliya	132/33kV	50MVA×1
22	LILO of Satna – Kymore			5	New Unchhera	132/33kV	50MVA×1
23	Sidhi - Sinhawal			50	New Sinhawal	132/33kV	50MVA×1
24	Rajgarh - Chachoda			61	New Chachoda	132/33kV	50MVA×1
25	Maneri - Mandla			80	-	-	-
26	Sukha (Jabalpur)				Exist. Sukha(Jabalpur)	220/33kV	50MVA×2
27	Hoshangabad				Exist. Hoshangabad	220/132kV	160MVA×1
28	Barwaha				Exist. Barwaha	220/132kV	160MVA×1
29	Betma				Exist. Betma	132/33kV	50MVA×1
30	Khirkiya				Exist. Khirkiya	132/33kV	50MVA×1
31	Amla				Exist. Amla	132/33kV	50MVA×1
32	Tejgarh				Exist. Tejgarh	132/33kV	50MVA×1
33	Satwas				Exist. Satwas	132/33kV	50MVA×1
34	Sitamau				Exist. Sitamau	132/33kV	50MVA×1
35	Baroda				Exist. Baroda	132/33kV	50MVA×1
36	Amrawadkhurd				Exist. Amrawadkhurd	132/33kV	50MVA×1
Total		Conv. 5	Conv. 70 **LL 190**	Conv. 662	New AIS 15 **New GIS 1** Exist. AIS 14		2,281MVA

Note *1: LL means Low Loss ACSR type conductor is applied

*2: GIS or AIS substation. New/Existing substations are specified. The Project includes transmission line feeder extensions and a shunt reactor installation in existing substations, but this is not specified in the above table.

*3: Red text denotes new technologies.

(Source: DPR)

2.2. Power System Planning and Analysis

Each transmission company in India uses a power system analysis tool selected by themselves, and MPPTCL has been using PSAF for power system planning and analysis. In order to standardize the software for easy data handling between PGCIL and transmission companies, PGCIL distributed PSS/E to each transmission company.

In this study, power system data was converted to PSS/E from PSAF, and the JICA Study Team evaluated this project using PSS/E. A study under peak 2018-19 was carried out in consideration of the required construction periods for each subproject in the Project after the ODA agreement.

CEA developed the Manual on Transmission Line Criteria (latest version, January 2013), and each transmission company defined each grid code applied in their states based on CEA's manual. The power system in Madhya Pradesh state is developed in accordance with the Madhya Pradesh Electricity Grid Code, dated August 2004. After the establishment of the state Grid Code, minor amendments were made 4 times in 2005, 2007 and 2008.
The following is a list of power system analysis done in the Project.

- Power Flow Analysis
- Fault Current Analysis

Transient stability analysis, which evaluates continuous synchronous operation of generators under abnormal conditions such as a transmission line tripping, is studied when a new generator is integrated into the grid and/or when the entire power system stability is assessed in consideration of faults in bulk transmission lines. This study does not simulate the transient stability analysis due to the following reasons. Since most of the subprojects in the Project are implemented to improve power supply reliability and quality in remote and/or rural areas, it produces only minor impacts on the power system stability. MPPTCL does not have data for the transient stability analysis. Therefore, a past technical report studied by the outsource consultant was referred to in order to evaluate the power system stability in this study. The consultant carried out the studies with a software different from PSAF, and MPPTCL didn't receive the dynamic data for the transient stability analysis.

2.2.1. Power Flow and Voltage Analysis

MPPTCL applies the N-1 system planning criteria in their transmission system planning, where no overloading is allowed under a single transmission facility failure such as transmission lines and transformers. The transmission system is planned accordingly; however, MPPTCL applies the increased transmission capacity of 10% against the normal rated capacity under N-1 contingencies for a short period of time due to the temporal use of irrigation pumps during winter. Table 2-2 shows the allowable system voltage levels based on the MPPTCL Grid Code.

Table 2-2 Allowable Voltage Levels

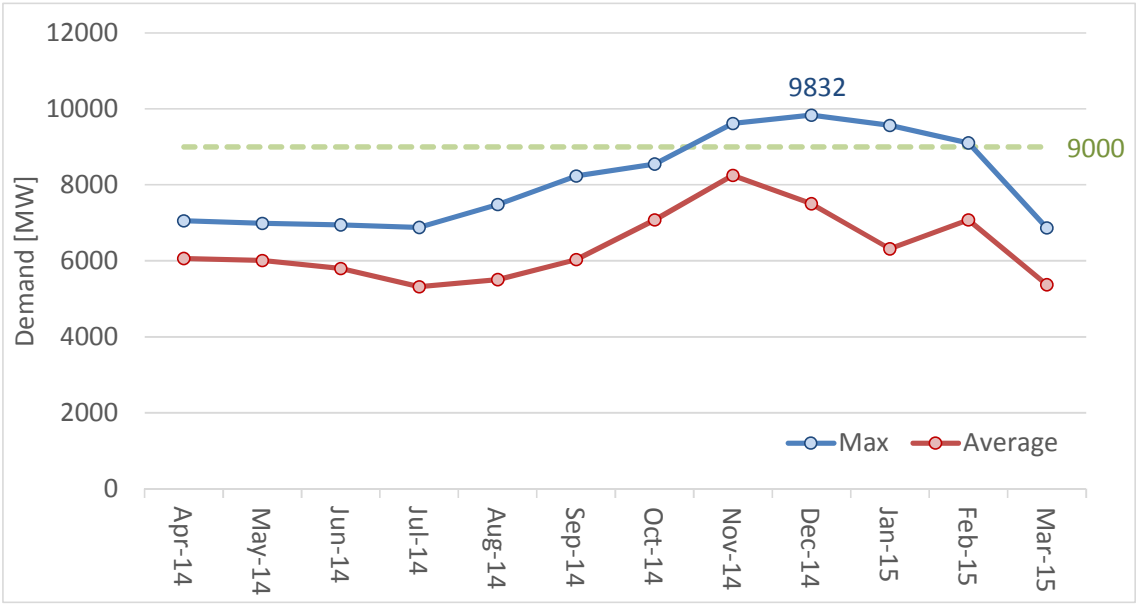
Nominal Voltage	Maximum [kV]	Minimum [kV]
400 kV	420 (+5.0%)	360 (-10.0%)
220 kV	245 (+11.0%)	200 (-9.1%)
132 kV	145 (+9.8%)	120 (-9.1%)

(Source: Madhya Pradesh Electricity Grid Code)

It is confirmed that there are no overloaded lines or transformers in the project under normal operating conditions (N-0). However, the criteria are not satisfied under several N-1 conditions. The peak demands were recorded during a couple of hours in the winter season for a couple of months due to irrigation pumping, as shown in Figure 2-1 and Figure 2-2. The duration in hours above 9,000 MW was 210 in 2014-15, as illustrated in Figure 2-3. According to past MPPTCL experiences, it is a very rare event to have overloaded transmission lines due to a transmission line fault, and it can be solved via load shifts and/or switching operations of the transmission system. Therefore, MPPTCL allows overloading of transmission lines even in planning even though it doesn't satisfy their criteria. MPPTCL uses a standardized transmission capacity for both summer and winter seasons. However, the daily maximum temperatures in winter are 10 to 15 °C lower compared with those in summer, and this contributes to an increase in the thermal capacity of transmission lines in the peak period (winter) by at least more than 20%.

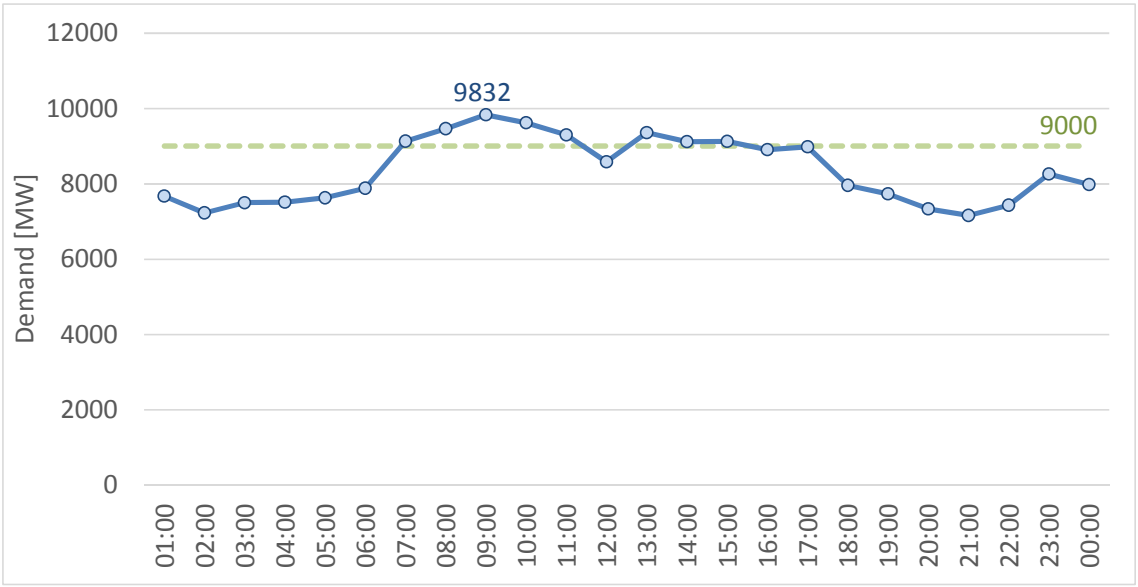
The JICA Study Team concluded that MPPTCL could properly manage these issues with operational countermeasures although the plan does not meet the planning criteria. The N-1 criteria are not satisfied in the projects listed in Table 2-3, because they are included in the Project to facilitate rural electrification and improve power quality in remote areas with a single circuit of radial network technique, and no large demand is expected in these areas. MPPTCL prioritizes the expansion of the system in other areas by reducing the investment cost for those transmission systems.

There are several substations which don't meet the voltage criteria, but reactive power equipment will be installed, if required, according to MPPTCL.



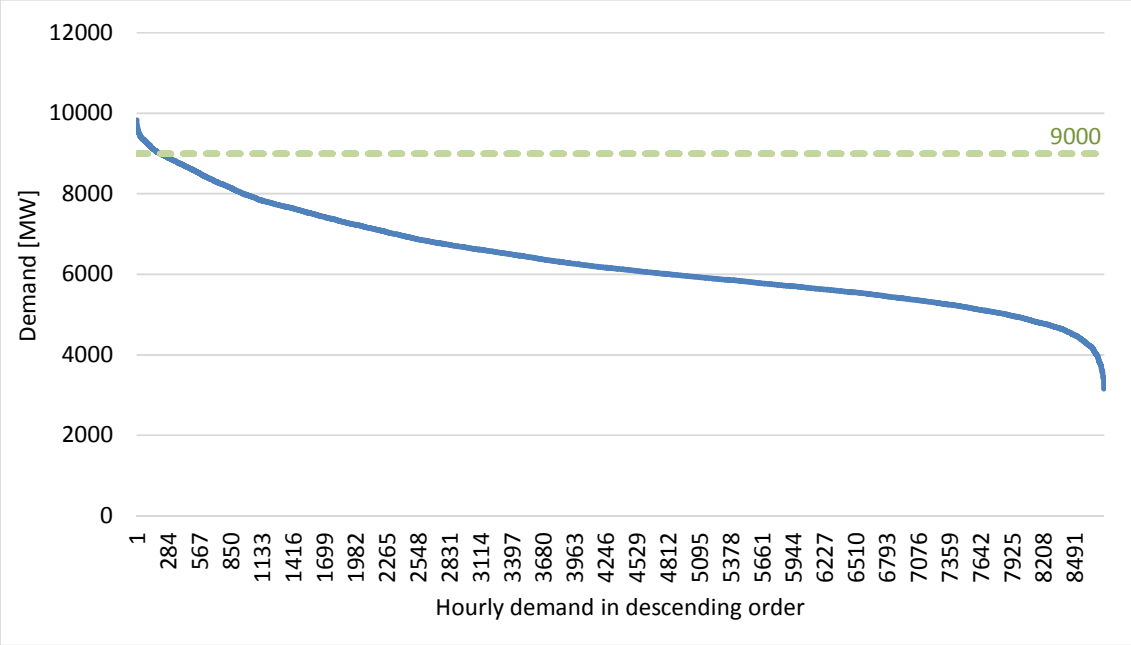
(Source: MPPTCL Date-wise Hourly Demand in MW)

Figure 2-1 Monthly Maximum and Average Demands in 2014-15



(Source: MPPTCL Date-wise Hourly Demand in MW)

Figure 2-2 Demand Curve for the Peak Recorded Day on 9th December 2014



(Source: MPPTCL Date-wise Hourly Demand in MW)

Figure 2-3 Duration Curve in 2014-15

Table 2-3 Subprojects of N-1 Criteria Violation

No.	Name	Source substation
9	Pati (Silawad)	DCSS line from Julwaniya substation
11	Shahpura	DCSS line from Julwaniya substation
12	Bhitarwr	DCSS line from Datiya substation
15	Madwas	DCSS line from Sidhi substation
16	Dheemarkheda	DCSS line from Panagar substation
17	Orchha	DCSS line from Prithvipur substation
18	Atraila	DCSS line from Sirmour substation
19	Tendukheda	DCSS line from Udaipura substation
20	Gormi	DCSS line from Gohad substation
21	Suthaliya	DCSS line from Narsinghgarh substation
24	Chachoda	DCSS line from Rajgarh substation

(Source: JICA Study Team)

According to DPR, the effects of each 400 kV and 220 kV subproject are outlined in Table 2-4.

Table 2-4 Effects of Each 400 kV and 220 kV Subproject

No	Project name	Effect / Impact
1	Cheggaon	System reliability improvement against N-2 of 400 kV transmission line connected to Shri Singaji thermal power station
2	Indore	Future demand increase in Indore area for new city development
4	Udaipura	Demand increase
5	Chhatarpur	Countermeasure for radial system operation under N-1 contingency
6	Bina	Countermeasure for N-1 contingency
7	Rewa UMSP	System development for Mega Solar Project by GoI

(Source: DPR)

In the Project, the subprojects in the 132 kV system are planned to improve 33 kV distribution system voltages at the remote ends and to reduce distribution losses by shortening the distribution lines and by decentralizing loads. The effects of 132 kV subprojects are shown in Table 2-5. The longest existing distribution line of 83 km (connected load 30.8 MVA) in subproject No. 23 will become 46 km (connected load 6.35 MVA) and, accordingly, the voltage dip will be improved from 44.5% to 9.0%. The maximum voltage dip of 46.6% in subproject No. 15 can be improved to 8.4% by constructing a new substation and shortening the line from 58 km to 11.3 km. Each subproject also contributes to the reduction of power losses as shown in Table 2-5.

Table 2-5 Effects of Subprojects in 132 kV System

No	Project name	Voltage improvement in distribution system (%)		Distribution loss (kWh/year)			
		W/o JICA	With JICA	W/o JICA	With JICA	Reduction	
9	Pati	20.0	4.3	5,367,312	873,271	4,494,041	84%
10	Maharaxmi	11.9	4.9	6,887,618	3,285,847	3,601,771	52%
11	Shahpura	32.2	6.1	11,738,610	2,208,160	9,530,450	81%
12	Bhirarwar	33.1	5.5	12,749,950	1,271,630	11,478,320	90%
13	Mahwadiya	12.9	3.7	5,856,434	1,431,103	4,425,331	76%
15	Madwas	46.6	8.4	17,144,717	2,114,191	15,030,526	88%
16	Dheemarkheda	19.8	4.9	10,510,734	2,065,154	8,445,580	80%
17	Orchha	26.6	9.0	16,788,844	4,668,418	12,120,427	72%
18	Atraila	15.4	5.4	5,377,443	1,904,763	3,472,680	65%
19	Tendukheda	19.5	8.4	12,073,888	5,016,632	7,057,256	58%
20	Gormi	16.7	2.9	6,647,273	777,134	5,870,139	88%
21	Suthaliya	24.6	8.7	13,979,813	2,969,934	11,009,879	79%
22	Unchhera	13.8	5.3	6,715,699	2,106,842	4,608,857	69%
23	Sinhawal	44.5	9.0	19,353,488	3,802,150	15,551,338	80%
24	Chachoda	17.8	5.9	7,231,058	2,639,012	4,592,046	64%

(Source: DPR)

The maximum power flows for the Project in each voltage level are shown in Table 2-6. It is confirmed that power flows in the Project are maintained within the rated capacity under both normal operating and N-1 conditions in 2018-19.

Table 2-6 Maximum Power Flows in 2017-18 in the Project

Voltage	Conductor Type	Rated capacity	Max. power flow in JICA project		
			Project No.	N-0	N-1
400 kV	Twin Moose	1010 MW	1	411.7	Below rating
220 kV	Single Zebra	245 MW	6	143.8	Below rating
132 kV	Single Panther	95 MW	3	34.8	Below rating

(Source: JICA Study Team)

2.2.2. Short Circuit Current Analysis

Faults on transmission lines are cleared by opening switchgears installed in substations. The short circuit currents must be below the rated current breaking capacity of the installed switchgear at each substation. The study calculates short circuit currents caused by a fault on a transmission line near a substation in the transmission system in Madhya Pradesh state. Table 2-7 shows maximum short circuit currents in the Project in 2018-19. It is confirmed that the short circuit currents are below the rated current breaking capacity as shown in the table.

Table 2-7 Maximum Short Circuit Currents in the Project in 2018-19

Voltage	Rated current breaking capacity [kA]	Project No.	Substation / Bus	Max. short circuit current in JICA Project [kA]
400 kV	40.0	1	Khandwa	29.9
220 kV	40.0	6	Bina	33.3
132 kV	31.0	2	Indore (J)	26.1

(Source: JICA Study Team)

It should be noted that the short circuit currents in several substations listed in Table 2-8, which are not in the Project, have short circuit current violations. They are located near power stations or they have many transmission line connections, and it is reasonable to have a large short circuit current. It is necessary to split buses or change system configuration to reduce the short circuit current in the future.

Table 2-8 List of Substations with Short Circuit Current Violations

Substation Name	Voltage [kV]	Short circuit current [kA]	
		Rating	Results
INDOR SZ	132	31.0	32.0
SATNA	400	40.0	41.3
VINDHYACHAL TPS	400	40.0	58.0
VINDHYACHAL PP	400	40.0	54.7
SASAN	400	40.0	53.1
VINDHYACHAL	400	40.0	53.3

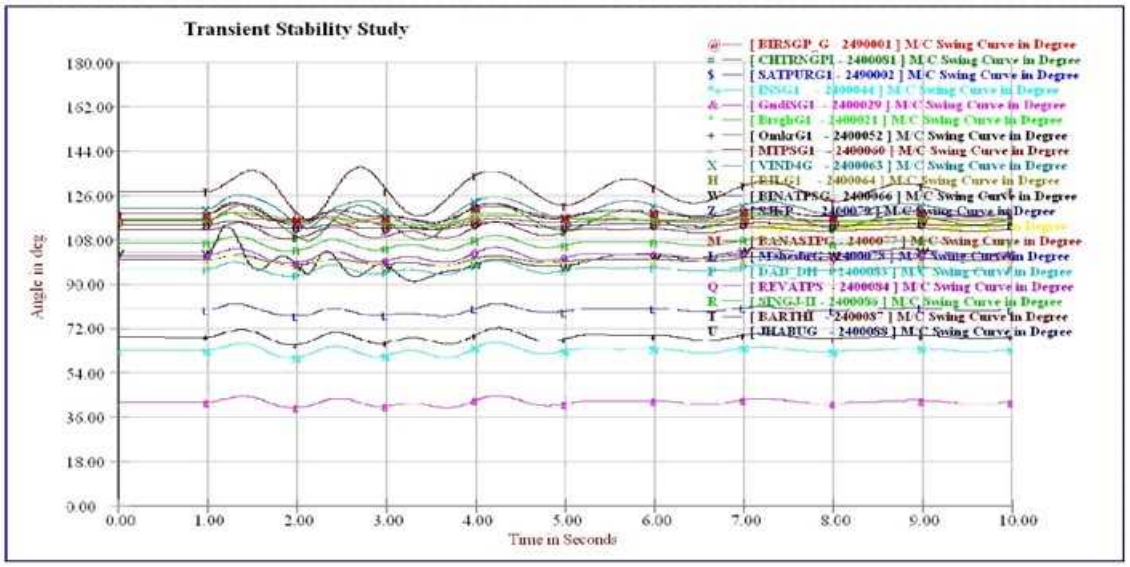
(Source: JICA Study Team)

2.2.3. Transient Stability Analysis

Generators can be tripped due to instability caused by a fault on a transmission line. This causes the loss of large generators in the system and it may lead to large-scale blackout.

The JICA Study Team could not carry out a transient stability analysis because MPPTCL does not have dynamic simulation data to be used in the study. The Project doesn't include installation of new power generations, but this is a project for transmission system reinforcement, and this generally improves the transient stability of the system. Also, because most of the subprojects are developments of new 132 kV transmission lines and substations electrically far away from generators, it can be said that the impact on the transient stability produced by a transmission fault in a 132 kV system is minute. The JICA Study Team concluded that the Project did not deteriorate the transient stability of the system taking the above into consideration.

In the technical report in 2011 studied by the outsource consultant from Power Research and Development Consultants Pvt. Ltd., it is reported that the Madhya Pradesh power system was stable under the power development plan at that time. Figure 2-4 illustrates the result of the transient stability analysis. After a fault clearance on the transmission line, phase angles of generators are recovered to the original phase angles before the event, and the system becomes stable.



(Source: MPPTCL / Report on Studies for formulation of proposal for evacuation of power from generating stations coming up in Madhya Pradesh and development of suitable interconnection with the transmission system being developed by PGCIL in Madhya Pradesh as well as to decide various electrical parameters of 2X660 MW Reva Thermal Power Project to be developed by M/s NHDC Ltd.)

Figure 2-4 Simulation Results of Transient Stability Analysis

(Unsuccessful Re-closure at 400 kV Line between Bina & Bhopal)

2.3. Transmission Lines

2.3.1. Climatic Conditions

Basic climatic conditions for the transmission line design in Madhya Pradesh are as below. The technical specifications of the transmission line facilities are based on the IS (Indian Standard) and international standards such as IEC (International Electrotechnical Commission), IEEE and so on.

Maximum ambient air temperature:	50	deg. C
Minimum temperature in shade:	1	deg. C
Maximum relative humidity:	95	%
Average daily ambient air temperature:	32	deg. C
IKL:	50	days/year
Average rainfall:	1,250	mm
Wind zone as per IS 802:	4	(47 m/s)
Seismic level (Horizontal acceleration):	0.3	G

2.3.2. Towers

The transmission line towers of MPPTCL are almost standardized to the same as other states in India and the self-supporting lattice type is used for all voltage levels. There are several types of towers such as tangent type, medium angle, heavy angle, gantry for extra high voltage transmission line crossings and river crossing type with required extension. The multi-circuit towers are also standardized and quadruple-circuit towers are used for 220 kV and 132 kV transmission lines but only double-circuit towers are used for 400 kV in MPPTCL.
Regarding the 400 kV transmission line, the equivalent design span length is defined as 400 m and the maximum and minimum span lengths are defined as 1,100 m and 100 m respectively.

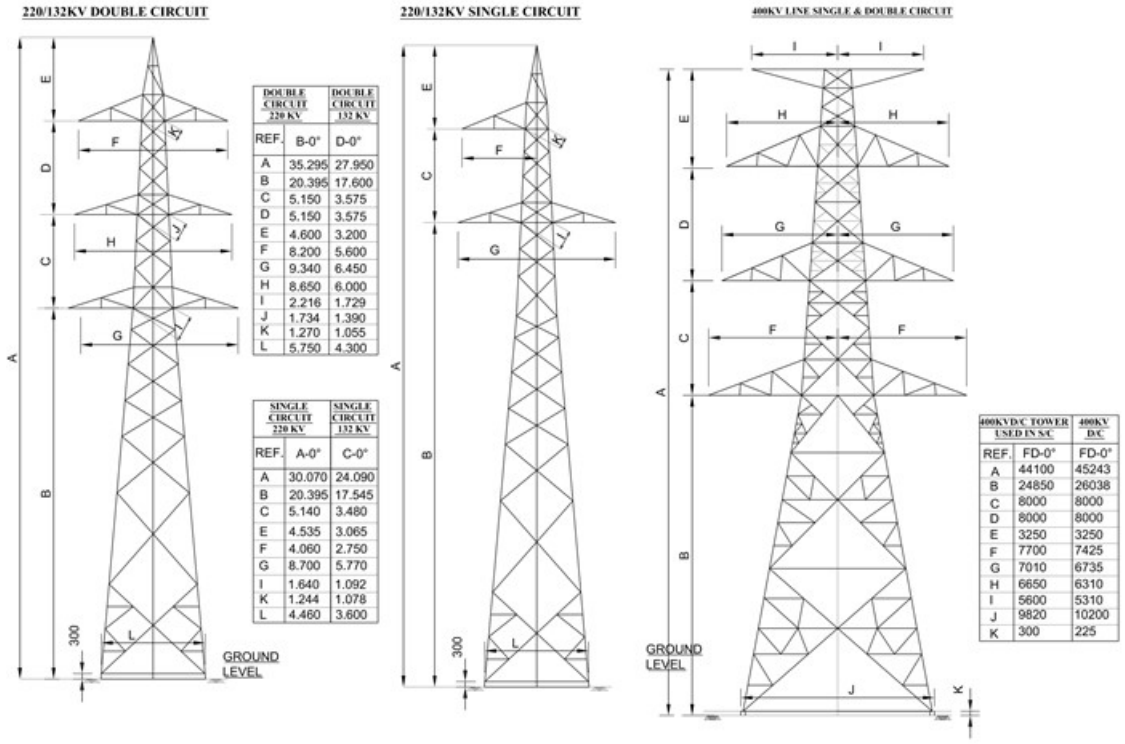
Figure 2-5 (left) 400 kV & (right) 132 kV Transmission Lines

Figure 2-6 220kV Transmission Line (Incoming Tower to the Jabalpur S/S)

The following figure shows the LILO system of the 132 kV transmission line. There are several sub-projects including the LILO transmission lines in the Project.

Figure 2-7 LILO System of the 132 kV Transmission Line

The standard tower configurations of MPPTCL are as below.



REF.	B-0°	D-0°
A	35.295	27.950
B	20.395	17.600
C	5.150	3.575
D	5.150	3.575
E	4.600	3.200
F	8.200	5.600
G	9.340	6.450
H	8.650	6.000
I	2.216	1.729
J	1.734	1.390
K	1.270	1.055
L	5.750	4.300

REF.	A-0°	C-0°
A	30.070	24.090
B	20.395	17.545
C	5.140	3.480
E	4.535	3.065
F	4.060	2.750
G	8.700	5.770
I	1.640	1.092
K	1.244	1.078
L	4.460	3.600

REF.	FD-0°	FD-0°
A	44100	45243
B	24850	26038
C	8000	8000
D	8000	8000
E	3250	3250
F	7700	7425
G	7010	6735
H	6650	6310
I	5600	5310
J	9820	10200
K	300	225

(Source: MPPTCL)

Figure 2-8 Standard Tower Configurations

2.3.3. Foundations

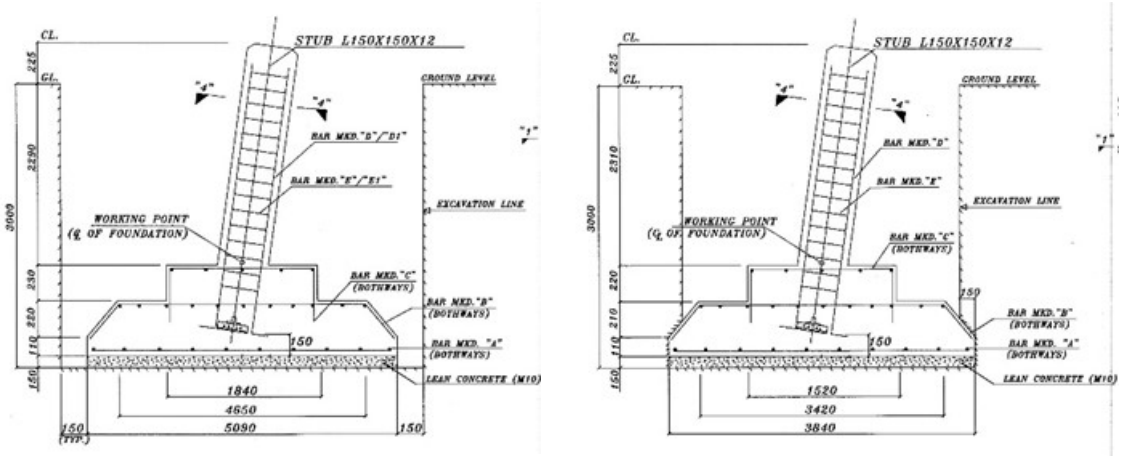
MPPTCL has their standard types of foundation drawings according to the soil condition, such as black cotton soil[6] or fissured rock soil, etc. and the foundations for the new transmission lines are designed based on them. All of the existing transmission line tower foundations are pad and chimney type and no pile foundation is used.

Generally, the central part of India including Madhya Pradesh is covered with black cotton soil. The ground surface gets dry and displays cracks during the dry season but it absorbs water, bloats and then becomes mud during the rainy season. Therefore, several meters (max. 5 m) of the stratum from the ground surface are unstable and cannot be assumed as a bearing layer, but it is expected that weather-unaffected weathering bedrock would be distributed in the lower part. According to MPPTCL, the Project includes neither wide river crossings, where pile foundations are required, nor submerged areas.

[6] Darkly-colored clayey soil.

Therefore, it is reasonable to assume that the transmission line tower foundations applied in the Project are the standard pad and chimney type, the same as the existing transmission lines of MPPTCL.

The figures below are example drawings of 132 & 400 kV transmission line tower foundations.

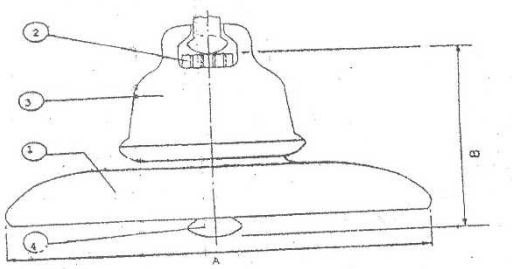


(Source: MPPTCL)

Figure 2-9 132 kV Foundation Drawings for BCW (left) and SFR (right)

2.3.4. Insulators

The suspension type porcelain insulator with ball and socket is used in MPPTCL and the polymer insulator as well. Both suspension and tension insulator string sets are either single or double, and 70 kN, 90 kN, 120 kN and 160 kN size insulators are applied based on the voltage and the string type.



Item	Description	Material
1	Shell	Porcelain
2	Security Clip	Phosphor Bronze/Stainless Steel
3	Cap	MCI
4	Ball Pin	Forged Steel

(Source: MPPTCL)

Figure 2-10 Standard Suspension Insulator

Figure 2-11 132kV Insulator String

2.3.5. Conductors

Standard conductors are defined for each voltage level as below. As for the earth wire, galvanized steel wire (GSW) is used and optical ground wire (OPGW) has been introduced in some parts.

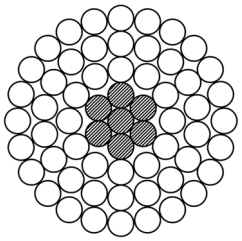
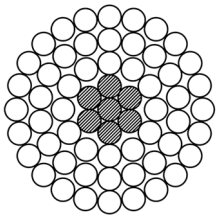
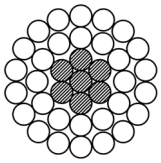
Table 2-9 Standard Conductors

Voltage	Conductor
400 kV	Twin ACSR Moose
220 kV	Single ACSR Zebra
132 kV	Single ACSR Panther

(Source: MPPTCL)

The technical specifications of the conductors are as below.

Table 2-10 Technical Specification of the Standard Conductors

		ACSR Moose	ACSR Zebra	ACSR Panther
Cross Sectional Area	AL	528.5 mm^2	428.9 mm^2	212.1 mm^2
	Steel	68.5 mm^2	55.59 mm^2	49.5 mm^2
	Total	597.0 mm^2	484.5 mm^2	261.6 mm^2
Conductor Diameter		31.77 mm	28.62 mm	21.00 mm
Conductor Weight		2,004 kg/km	1,621 kg/km	976 kg/km
D.C. Resistance at 20 deg. C		0.05552 ohm/km	0.06915 ohm/km	0.139 ohm/km
Min. Breaking Strength		161.2 kN	130.32 kN	89.67 kN
Modulus of Elasticity		0.703x106 kg/cm^2	69 GN/m^2	80 GN/m^2
Cross Sectional View				

(Source: Technical Specification for Supply of Materials and Construction of 400 kV, 220 kV and 132 kV Transmission Lines of MPPTCL)

2.3.6. Outline of the Transmission Line Routes

A large part of the Project sites through which the transmission lines pass are flat terrain such as cropland. The transmission lines of several sub-projects, including No. 17, contain river crossings whose span lengths are expected to be less than 1 km, but it is assumed that there will be no difficulty in construction of such transmission lines because of MPPTCL's work on previous projects.

The 132 kV Mangaliya – Maharaxmi transmission line in sub-project No. 10 is planned to be installed in a comparatively urban area in Indore; therefore, further route investigation and study must be done. But the present transmission line routes are the ones roughly drafted at the planning stage and MPPTCL will optimize each route considering the maintainability of those transmission lines and so on, as per their normal procedure, hereafter.

2.4. Substation

2.4.1. Design Policy

Table 2-11 shows the major substation equipment installed by the Project. MPPTCL's standards are applied for the substation design in the Project. The numbers of each piece of substation equipment are properly estimated from the substation single line diagrams shown in the DPR. The JICA Study Team confirmed that the designs of DPR are consistent with the drawings and standards.

Table 2-11 Main Substation Equipment for the Project

Sub-project No.	Substation	Substation Type	Transformers [Number and Capacity]	Number of Feeders Installed			Land Area [ha]
				400 kV	220 kV	132 kV	
1	Chhegaon	Exist. AIS	400kV 125MVAR×1 Reactor	2			–
2	Super Corridor	New GIS	220/132kV 160MVA×1 132/33kV 63MVA×1		2 	 2	3.27
	Pithampur	Exist. AIS			2		–
4	Udaipura	Exist. AIS	220/132kV 160MVA×1		2		–
	Chichli	Exist. AIS			2		–
5	Chhatarpur	Exist. AIS			1		–
	Tikamgarh	Exist. AIS			1		–
6	Bina	Exist. AIS	400/220kV 315MVA×1		2		–
7	Rewa	Exist. AIS			2		–
	Sidhi	Exist. AIS			2		–
	Rewa UMSP	Exist. AIS			4		–
9	Pati (Silawad)	New AIS	132/33kV 50MVA×1			1	4.00
	Julwaniya	Exist. AIS				1	–
10	Mahalaxmi	New AIS	132/33kV 63MVA×1			2	unknown
11	Shahpura	New AIS	132/33kV 50MVA×1			1	2.25
	Julwaniya	Exist. AIS				1	
12	Bhitarwr	New AIS	132/33kV 50MVA×1			1	2.25
	Datiya	Exist. AIS				1	
13	Mahwadia	New AIS	132/33kV 50MVA×1			2	5.00
	Mugaliya Chhap	Exist. AIS				2	
15	Madwas	New AIS	132/33kV 50MVA×1			1	3.30
	Sidhi	Exist. AIS				1	
16	Dheemarkheda	New AIS	132/33kV 50MVA×1			1	2.25
	Panagar	Exist. AIS				1	
17	Orchha	New AIS	132/33kV 50MVA×1			1	3.00
	Prithvipur	Exist. AIS				1	

18	Atraila Sirmour	New AIS Exist. AIS	132/33kV 50MVA×1			1 1	4.00
19	Tendukheda Udaipura	New AIS Exist. AIS	132/33kV 50MVA×1			1 1	3.82
20	Gormi Gohad	New AIS Exist. AIS	132/33kV 50MVA×1			1 1	2.25
21	Suthaliya Narsinghgarh	New AIS Exist. AIS	132/33kV 50MVA×1			1 1	3.28
22	Unchhera	New AIS	132/33kV 50MVA×1			2	6.25
23	Sinhawal Sidhi	New AIS Exist. AIS	132/33kV 50MVA×1			1 1	unknown
24	Chachoda Rajgarg(B)	New AIS Exist. AIS	132/33kV 50MVA×1			1 1	unknown
25	Maneri Mandla	Exist. AIS Exist. AIS				1 1	
26	Sukha (Jabalpur)	Exist. AIS	220/33kV 50MVA×2				
27	Hoshangabad	Exist. AIS	220/132kV 160MVA×1				
28	Barwaha	Exist. AIS	220/132kV 160MVA×1				
29	Betma	Exist. AIS	132/33kV 50MVA×1				
30	Khirkiya	Exist. AIS	132/33kV 50MVA×1				
31	Amla	Exist. AIS	132/33kV 50MVA×1				
32	Tejgarh	Exist. AIS	132/33kV 50MVA×1				
33	Satwas	Exist. AIS	132/33kV 50MVA×1				
34	Sitamau	Exist. AIS	132/33kV 50MVA×1				
35	Baroda	Exist. AIS	132/33kV 50MVA×1				
36	Amrawadkhurd	Exist. AIS	132/33kV 50MVA×1				
		New AIS 15 **New GIS 1** Exist. AIS 36	Total of Tr. Capacity: 2,281MVA	2	20	36	

(Source: DPR)

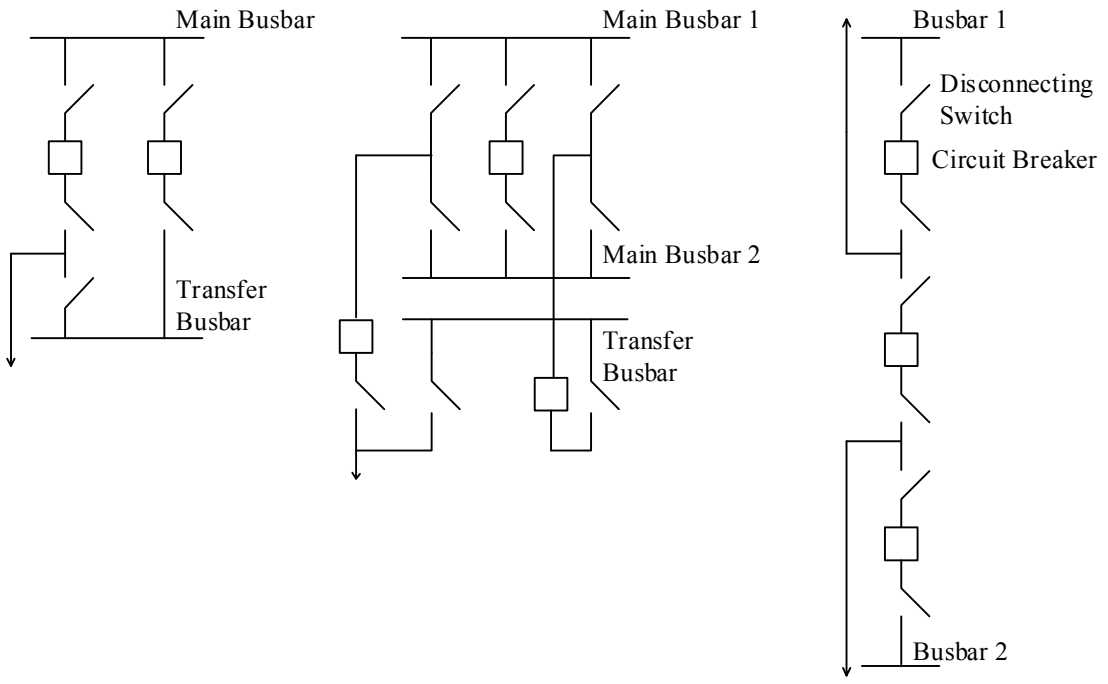
2.4.2. Substation Busbar Arrangement

As one of the basic factors of substation design, MPPTCL has adopted their standard busbar arrangements, presented in Table 2-12 and Figure 2-12, which can be selected based on the busbar voltage level. The arrangements are commonly used both in India and several other countries.

Table 2-12 Busbar Arrangement in MPPTCL

400kV Busbar	One and a half breaker (Double bus and transfer busbar*1)
220kV Busbar	Double bus and transfer busbar (Main and transfer busbar*1)
132kV and 33kV Busbar	Main and transfer busbar

Note: *1 as an exception in the case of land area restrictions



(a) Main and transfer bus (b) Double bus and transfer bus (d) One and a half breaker

Figure 2-12 Busbar Arrangement in MPPTCL

2.4.3. Substation Type (AIS/GIS)

The JICA Study Team confirmed MPPTCL's design policy for adopting GIS. GIS are adopted for subproject No.2, Super Corridor S/S, which is located in an urban area and has limited land area for additional equipment in the future, while other substations are developed as conventional AIS. Although GIS has some advantages in comparison with AIS, such as the smaller required land area and safer O&M work due to the enclosed energized part, GIS construction costs are generally more than double those of AIS. In Madhya Pradesh, land availability is not a problem except for limited urban areas, so MPPTCL's design policy of considering investment cost is rational. The

above mentioned Table 2-11 includes the planned substation land area for each subproject. Each area is consistent with MPPTCL's existing substation land areas[7] and Japanese substation land areas[8].

With regard to the locations for the installation of the major substation equipment, such as main transformers and circuit breakers, outdoor type will be adopted for all the subprojects both in AIS and GIS. MPPTCL has successfully operated outdoor-type AIS substations; therefore, the introduction of outdoor-type GIS substations will be appropriate because enclosed GIS is more resistant to severe weather conditions than AIS.

2.4.4. Specifications of Transmission and Substation Equipment

The specifications of major transmission line and substation equipment were basically selected based on the International Electrotechnical Commission (IEC) and the Indian Standard (IS). IS is based on the IEC. The JICA Study Team surveyed some of MPPTCL's substations (see 2.4.8) and confirmed that no special technologies have been adopted. International manufacturers can design and produce equipment according to the IEC. Thus, the specifications which have been adopted in the Project will not harm fair competition under international competitive bidding.

2.4.5. Specifications of Main Transformer

The capacity of the main transformer is selected from the following standards determined by CEA.

- 400/220kV transformer: 315MVA
- 220/132kV transformer: 160, 100MVA
- 220/33kV and 132/33kV transformer: 63, 50MVA

[7] MPPTCL's standard substation land areas are as follows:
- 400kV AIS (400kV 8 feeders, 220kV 26, 132kV 15, 33kV 8): 500m x 380m = 19.0ha
- 220kV AIS (220kV 8 feeders, 132kV 15, 33kV 16): 250m x 256m = 6.40ha
- 132kV AIS (132kV 6 feeders, 33kV 8): 150m x 150m = 2.25ha

The feeders include T/L feeder bay, transformer bay, bus coupler, VT, etc.

[8] For Japanese 275/154kV AIS, corresponding to MPPTCL 220/132kV AIS, required land area is approx. 4ha. For Japanese 275/154kV GIS, 1-2ha are required.

2.4.6. Number of Line Feeders

The number of incoming transmission line feeders for each proposed substation is determined by the transmission line network planning. On the 33kV distribution line feeders, the number of outgoing distribution lines is normally 4 feeders for each 50MVA interconnecting transformer and 6 feeders for 63MVA ones.

2.4.7. Specifications of Circuit Breakers

The rated short-circuit breaking current, one of the most important specifications for circuit breakers, is selected from the following standards based on the power system analysis which was implemented by MPPTCL:

- 400kV circuit breaker: 40.0kA
- 220kV circuit breaker: 40.0kA
- 132kV circuit breaker: 31.0kA

2.4.8. Site Surveys

The Study Team carried out existing substation site surveys to confirm MPPTCL's substation equipment and the conditions. Included were the 220kV Jabalpur S/S, the existing 132kV Marhotal S/S, the existing 132kV Tejgarh S/S, and the existing 132kV E. Complex S/S. These sites have sufficient land space for installing equipment, and there are no obstacles which can incur additional construction cost.

The manufacturer for the 132kV AIS substation is most likely Crompton Greaves or Bharath Heavy Electrical Limited (BHEL), and that for the control panel is ABB or Alstom/Areva, with production in India. MPPTCL mentioned that all the substation items like Circuit Breakers, disconnecting switches, current transformers etc. are obtained from manufacturers like Crompton Greaves, BHEL, ABB, Siemens etc. due to the open tender system. It is possible to infer from the above statement that MPPTCL does not have any preferential manufacturer and that the lowest bidder wins the contract.

Photos of major substation equipment are shown from Figure 2-13 to Figure 2-25. While photos of outdoor-type GIS were taken in Japan, the rest were taken during the Site Survey.

Figure 2-13 220/132kV, 160MVA, 3-phase Transformer (Jabalpur 220kV Substation)

Figure 2-14 220/132kV, 40MVA x 3, Single-phase Transformer (Jabalpur 220kV Substation)

Figure 2-15 132/33kV, 63MVA, 3-phase Transformer (Marhotal 132kV Substation)

Figure 2-16 220kV Feeder Bay (Jabalpur 220kV Substation)

Figure 2-17 132kV Feeder Bay (Marhotal 132kV Substation)

Figure 2-18 33kV Feeder Bay (Marhotal 132kV Substation)

Figure 2-19 Control Building (Jabalpur 220kV Substation)

Figure 2-20 Control Building (Tejgarh 132kV Substation)

Figure 2-21 Control Panel (Tejgarh 132kV Substation)

Figure 2-22 Substation SCADA System (Jabalpur 220kV Substation)

Figure 2-23 220kV Transmission Line Protection Relay Unit by Toshiba

(Jabalpur 220kV Substation)

Figure 2-24 500kV Outdoor GIS Substation (TEPCO)

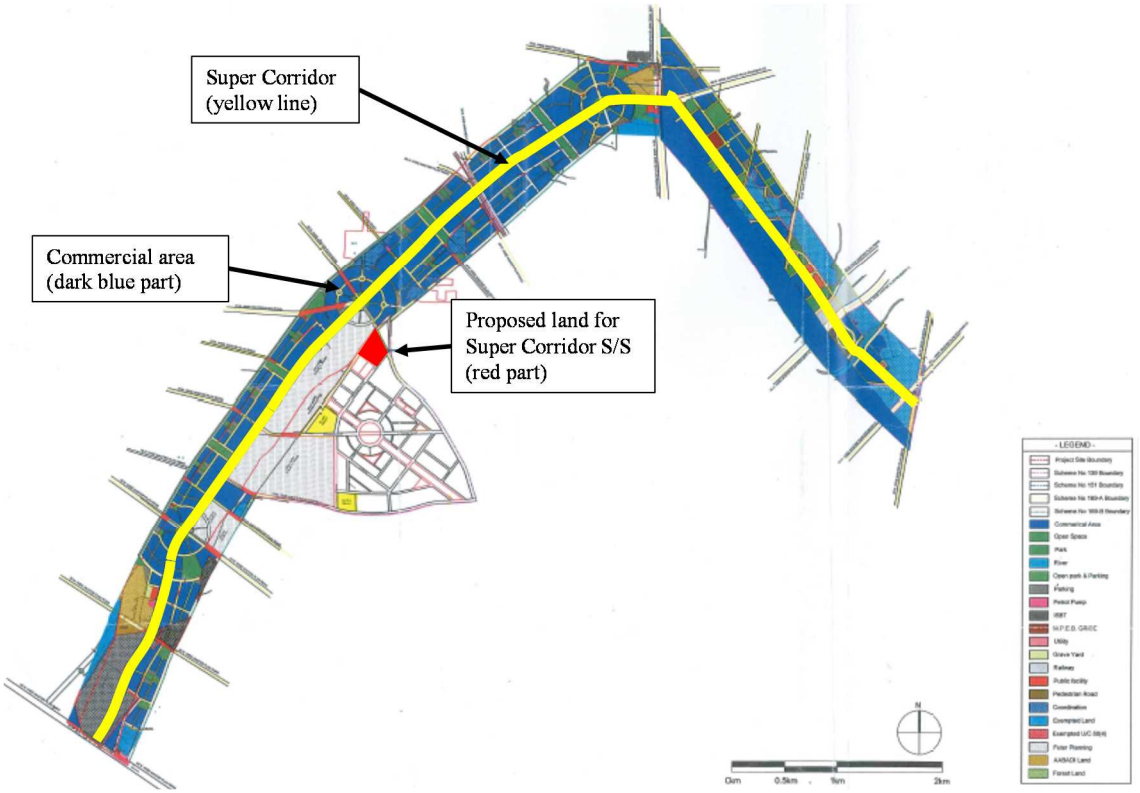
Figure 2-25 500kV Outdoor GIS Substation (TEPCO)

2.5. Subproject Study

To confirm the project site conditions, the Study Team visited subproject No.2, newly-constructed Super Corridor S/S, and Subproject No. 32, transformer-installed existing Tejgarh S/S. For the Super Corridor S/S, the Study Team has discussed and developed the conceptual design for the GIS substation.

2.5.1. Subproject No.2, Super Corridor S/S

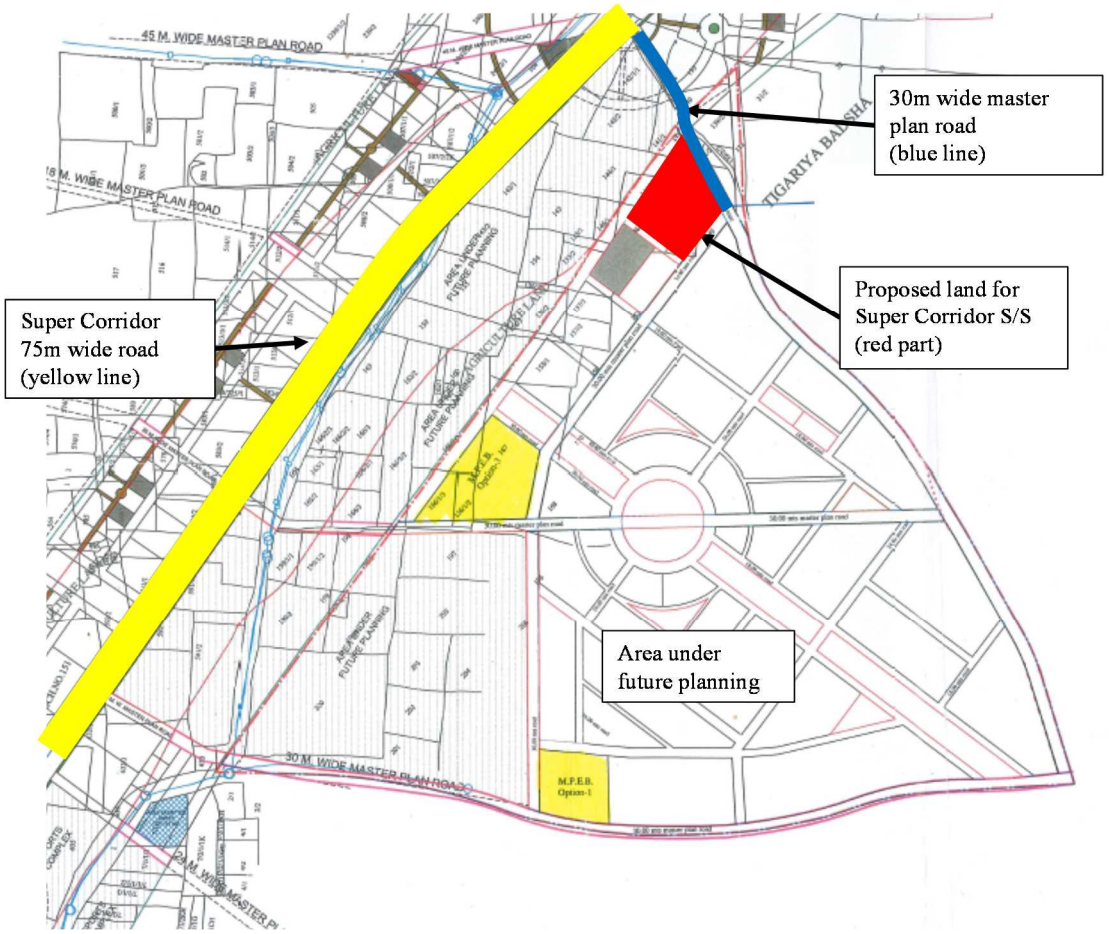
The site is located in Indore, which is the largest city in Madhya Pradesh. The neighboring area of the proposed site is undeveloped at present, but there are plans for it to be developed for an industrial and commercial complex in the next few years[9]. Figure 2-26 and Figure 2-27 show the regional development plan near the site. Along with a 75m-width main road, called Super Corridor, commercial areas have been designated by the local government, and big IT enterprises, such as Tata Consultancy Services and Infosys, have planned complexes there.



(Source: MPPTCL)

Figure 2-26 Regional Development Plan near Super Corridor S/S (Wide-view)

[9] http://www.supercorridor.in/

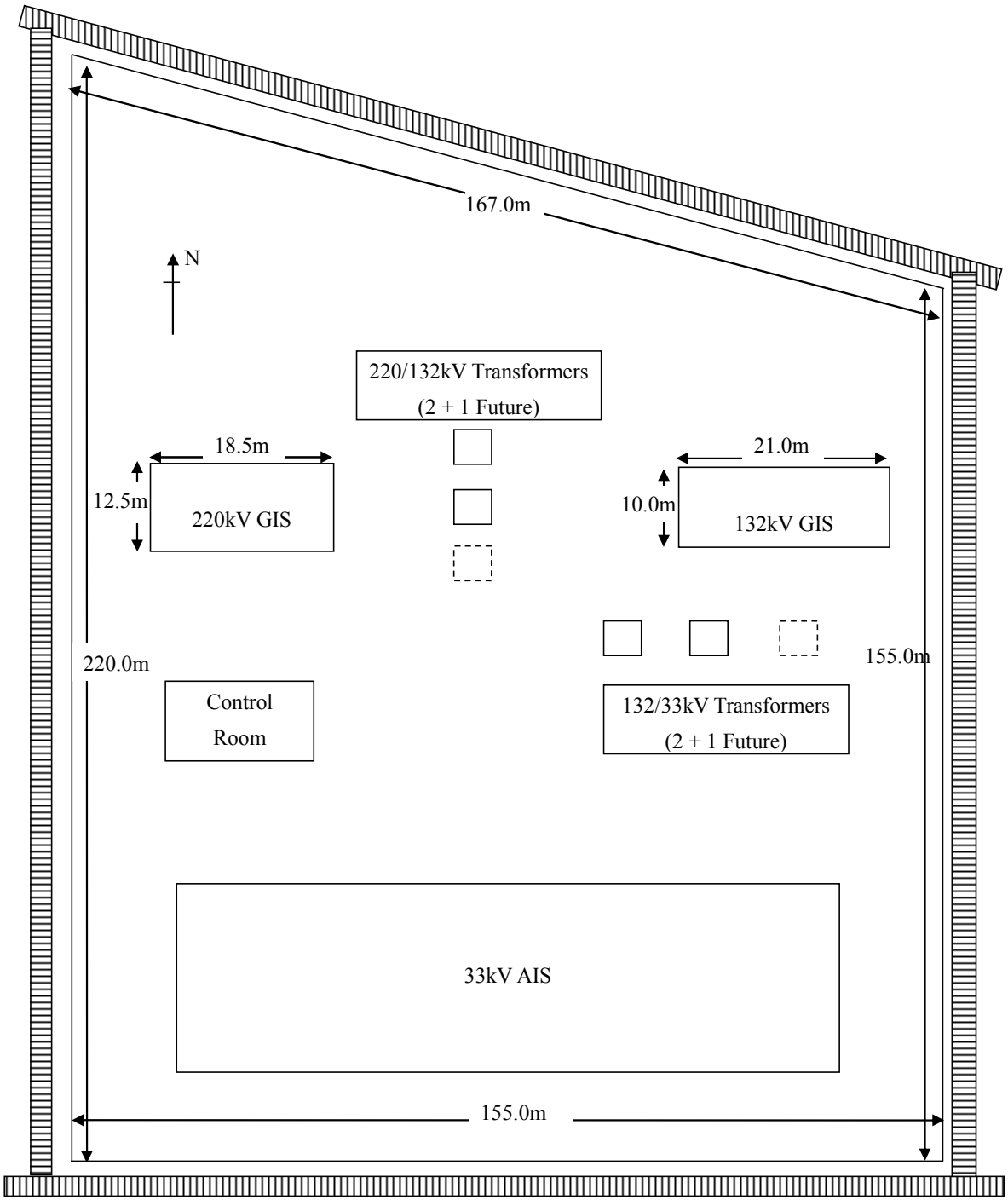


(Source: MPPTCL)

Figure 2-27 Regional Development Plan near Super Corridor S/S (Detailed-view)

For the planned substation, trapezoid-shaped land 155m on the shortest side has already been secured by MPPTCL (see Figure 2-28 and Figure 2-29). MPPTCL stated that the substation has two 220kV T/L feeders, four 132kV ones, and 6 33kV ones for the original stage, but the maximum capacity of the super corridor substation will increase rapidly. This substation would be used to supply power to the companies and residential area which will be set up in the Super Corridor development project. The reason for incorporating the GIS is to increase the number of feeders for the 220kV S/s, 132kV S/s and 33kV S/s in order to accommodate the huge power demand from the Super Corridor Development Zone. Based on MPPTCL's requirements, the Study Team developed the equipment layout at a conceptual level (Figure 2-29) and confirmed that the secured land area is sufficient for the GIS substation. The transport roads, 75m-wide main road and 30m-wide access road, are sufficient to transfer heavy equipment, such as transformers.

Figure 2-28 Candidate Site for Super Corridor S/S



(Source: JICA Study Team)

Figure 2-29 Layout for Super Corridor S/S

The GIS layout shown in Figure 2-29 is a conceptual level one based on the requirements of MPPTCL below. The location of the equipment will be optimized under the more specific requirements by MPPTCL or the Consultants in the implementation phase.

(1) General Conditions

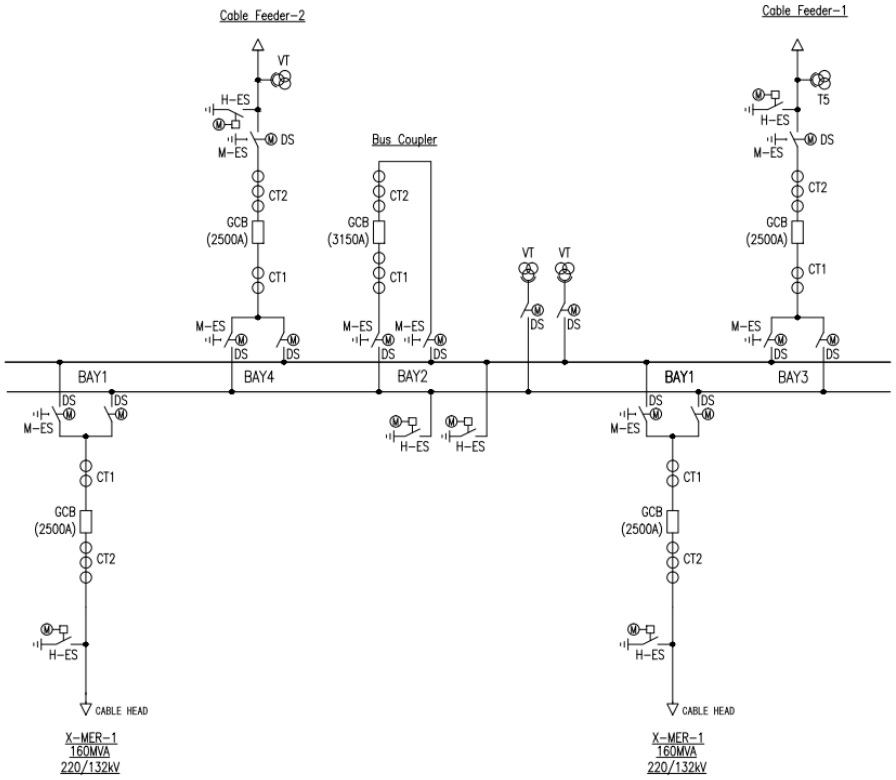
- Location: Both 220kV and 132kV shall be GIS Outdoor type GIS
- Ambient Temperature: 45 deg C
- Altitude: Does not exceed 1000m.

(2) General Rating of the 220kV GIS (Single Phase Encapsulated Type GIS)

- Number of Bays: 5
  Incoming Feeders: 2
  Outgoing Feeders: 2 (to 220kV/132kV Transformer)
  Bus Coupler and metering bay: 1
- System Configuration: Double Bus system type configuration.
- Termination: The termination involved is power cable termination.

Table 2-13 Specifications on 220kV GIS of Super Corridor S/S

Rated Voltage	220 kV
Rated Normal Current	2,000A
Rated Frequency	50 Hz
Rated Fault Withstand Current	40 kA (1 sec.)
Rated Insulation Level	Lightning Impulse: 1,050 kV
	Power Frequency: 460 kV
Rated SF_6 Gas Pressure (at 20°C, in abs.)	0.70 MPa
Operating mechanism of 220kV GCB	Spring type operating mechanism
Operating mechanism of 220kV GIS – Disconnecting Switch (DS) and Earthing Switch (ES)	3 Position type motor operated
Operating mechanism of 220kV GIS – High Speed Earthing Switch (HES)	Motor charged spring operated



(Source: JICA Study Team)

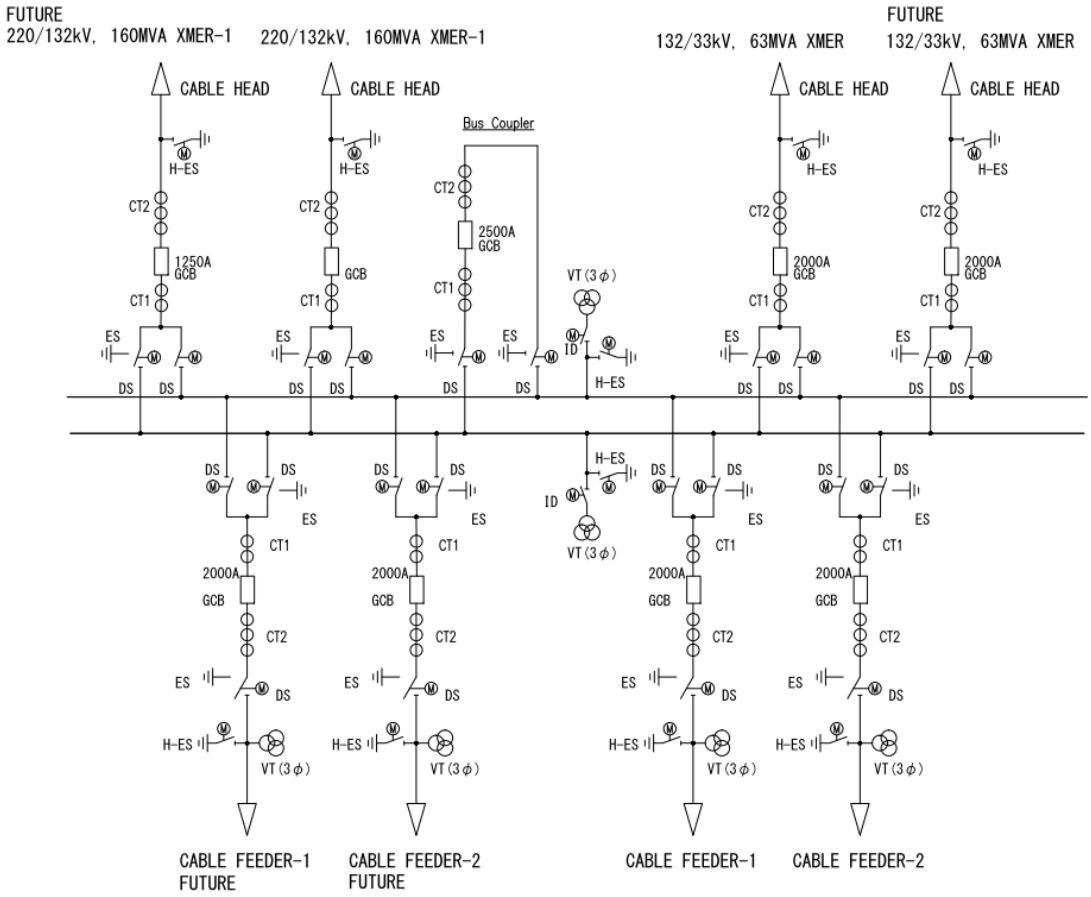
Figure 2-30 220kV GIS Single Line Diagram of Super Corridor S/S

(3) General Rating of the 132kV GIS (Three Phase Encapsulated GIS)

- Number of Bays: 9
  Incoming Feeders: 4
  Outgoing Feeders: 2 (to 220/132kV Transformer)
  Outgoing Feeders: 2 (to 132/33kV Transformer)
  Bus Coupler and metering bay: 1
- System Configuration: Double Bus system type configuration.
- Termination: The termination involved is power cable termination.

Table 2-14 Specifications on 132kV GIS of Super Corridor S/S

Rated Voltage	132 kV
Rated Normal Current	2,000A
Rated Frequency	50 Hz
Rated Fault Withstand Current	31.5 kA (1 sec.)
Rated Insulation Level	Lightning Impulse: 1,050 kV
	Power Frequency: 460 kV
Rated SF_6 Gas Pressure (at 20°C, in abs.)	0.70 MPa
Operating mechanism of 132kV GCB	Spring type operating mechanism
Operating mechanism of 132kV GIS – Disconnecting Switch (DS) and Earthing Switch (ES)	3 Position type motor operated
Operating mechanism of 132kV GIS – High Speed Earthing Switch (HES)	Motor charged spring operated



(Source: JICA Study Team)

Figure 2-31 132kV GIS Single Line Diagram of Super Corridor S/S

According to the interview during the site survey, multi-circuit monopole is planned to be applied partially to the quadruple-circuit section of 220 kV Pithampur – Super Corridor T/L and 132 kV LILO of Indore (Jetpura) – Depalpur T/L, which are both included in No. 2 sub-project and connected to the planned Super Corridor S/S, installed in the center of the road neighboring the Super Corridor S/S. An overview of the planned transmission line routes around the planned Super Corridor S/S is shown in the following figure.

Figure 2-32 Transmission Line Route around the Super Corridor S/S

2.5.2. Subproject No.32, Tejgarh S/S

The Tejgarh S/S is a substation developed by the JICA Phase I Project. Since an area demand increase is predicted in the near future, one 132kV/33kV 50MVA transformer will be installed in the Project. In general, MPPTCL's standard substation layout requires transformer expansion space. In the Tejgarh S/S (photos in Figure 2-33), the transformer installation location has been secured next to the existing transformer and construction work will be easy as there is plenty of work space around this. The Study Team also confirmed that there is no obstruction that may hinder transformer transportation from this access road to the installation location. Considering one transformer was already transported when the Tejgarh substation newly constructed, transporting additional one will be certainly carried out. MPPTCL states that a new access road will be constructed by contractors from the existing main road to the construction site for new substations if necessary. According to MPPTCL, the locations of new substations are close to existing roads. This means that building new access roads will have only minor impacts on the total Project budget and construction period.

Figure 2-33 Transformer Installation Location on Tejgarh S/S

2.6. Rationale of Project Cost

For calculating the major transmission/substation costs, MPPTCL normally uses unit cost data, called the Schedule of Rates, which is approved by MPERC, and calculates the cost of the Project with the cost data. This unit cost is applied not only in the Project, but also in general planning procedure in MPPTCL. The Schedule of Rates is revised every year in consideration of the actual market prices. This means that MPPTCL uses suitable unit prices in their cost calculation.

The Study Team compared the unit cost with some reference costs in other states in India to check its rationale. Table 2-15 and Table 2-16 show a comparison of transmission line construction and substation equipment costs respectively. Although there are divergences by area or by rated voltage, the T/L construction costs of MPPTCL are around 10%-70% higher than those of Odisha Power Transmission Company Limited (OPTCL), and the substation equipment costs of MPPTCL are almost 40% higher than those of OPTCL. Considering the average inflation rate, 7.8%[10], the costs of MPPTCL are acceptable.

[10] JICA, FY2015-16 Appraisal Parameters for Japanese ODA Loans for India

Table 2-15 Comparison of Transmission Line Construction Costs

Voltage	Double Circuit Transmission Line Construction Cost [INR Lakhs/km]		
	The Project	OPTCL (Rate as of 2014)	TANTRANSCO (Rate as of 2011)
400 kV	197.0	130.0	183.9
220 kV/230kV	92.9	61.5	64.5
132 kV/110kV	67.9	41.5	39.8

(Source: DPR and the JICA Study Team)

Table 2-16 Comparison of substation equipment unit prices

Equipment	Unit Price [INR Lakhs]	
	MPPTCL (FY2015-16)	OPTCL (FY2014-15)
160MVA 220/132/33kV transformer	771.5	536.3
63MVA 132 /33kV transformer	442.9	262.4
220kV SF6 circuit breaker	22.1	13.1
132kV SF6 circuit breaker	9.4	6.0
33kV SF6 circuit breaker	3.0	2.0

(Source: DPR and JICA Study Team)

For the new technologies, including LL-ACSR and GIS, MPPTCL does not have the unit cost mentioned above. These unit costs are derived from TEPCO's actual experience.

2.7. Contribution by this Project to Japanese Companies in Madhya Pradesh

There are several Japanese factories and companies in Madhya Pradesh state. The largest Japanese company, Bridgestone India Pvt. Ltd., is connected to the 132 kV bus of Pithampur 220 kV substation in the Indore area, and the contract demand/maximum demand is 8 MW. The second largest company, of 500 kVA (0.5 MVA), is Panasonic India Pvt. Ltd., which is also connected to the 33 kV Novino distribution feeder from Pithampur 220 kV substation in the Indore area. The only two large size customers are found in the study.

Subproject No. 2 is to strengthen the source-side transmission system of Pithampur 220 kV substation, and this contributes to improving the power supply reliability for the Japanese companies. Figure 2-34 illustrates the power system near subproject No. 2.

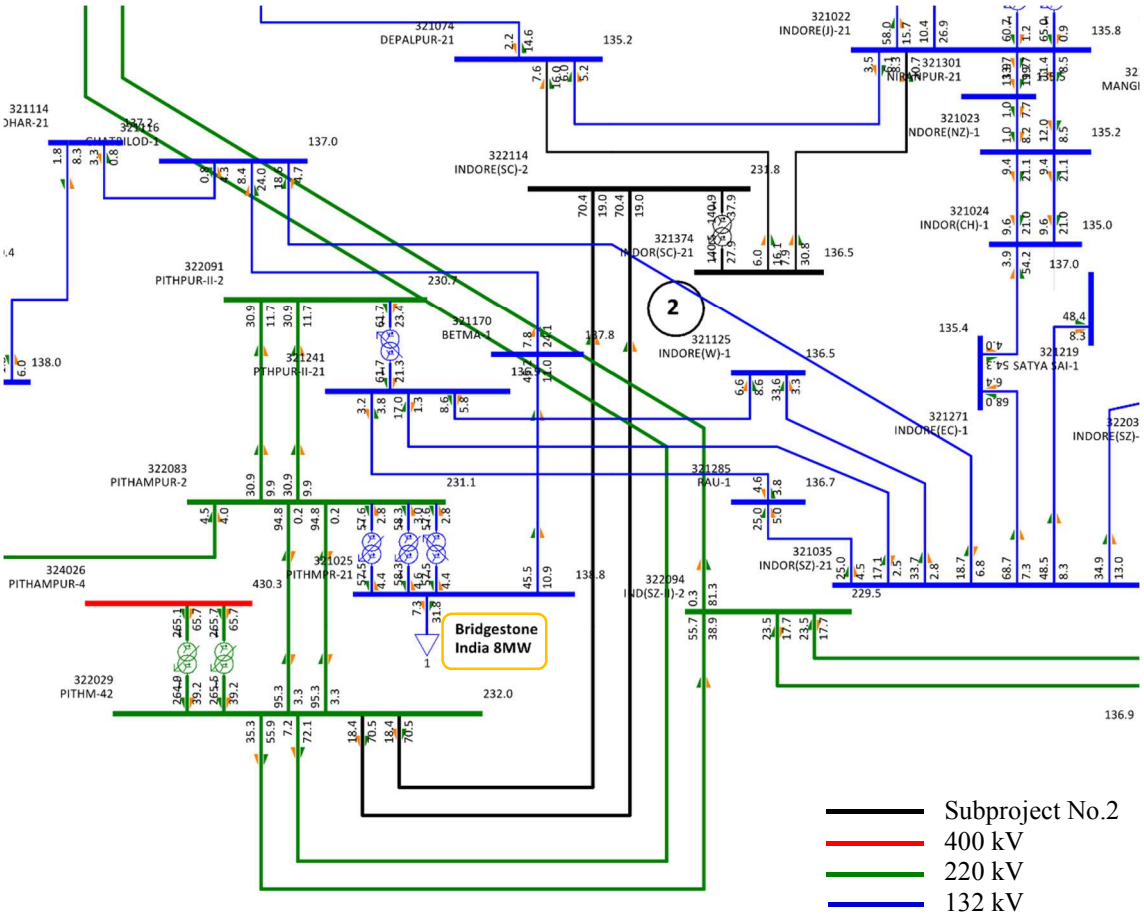
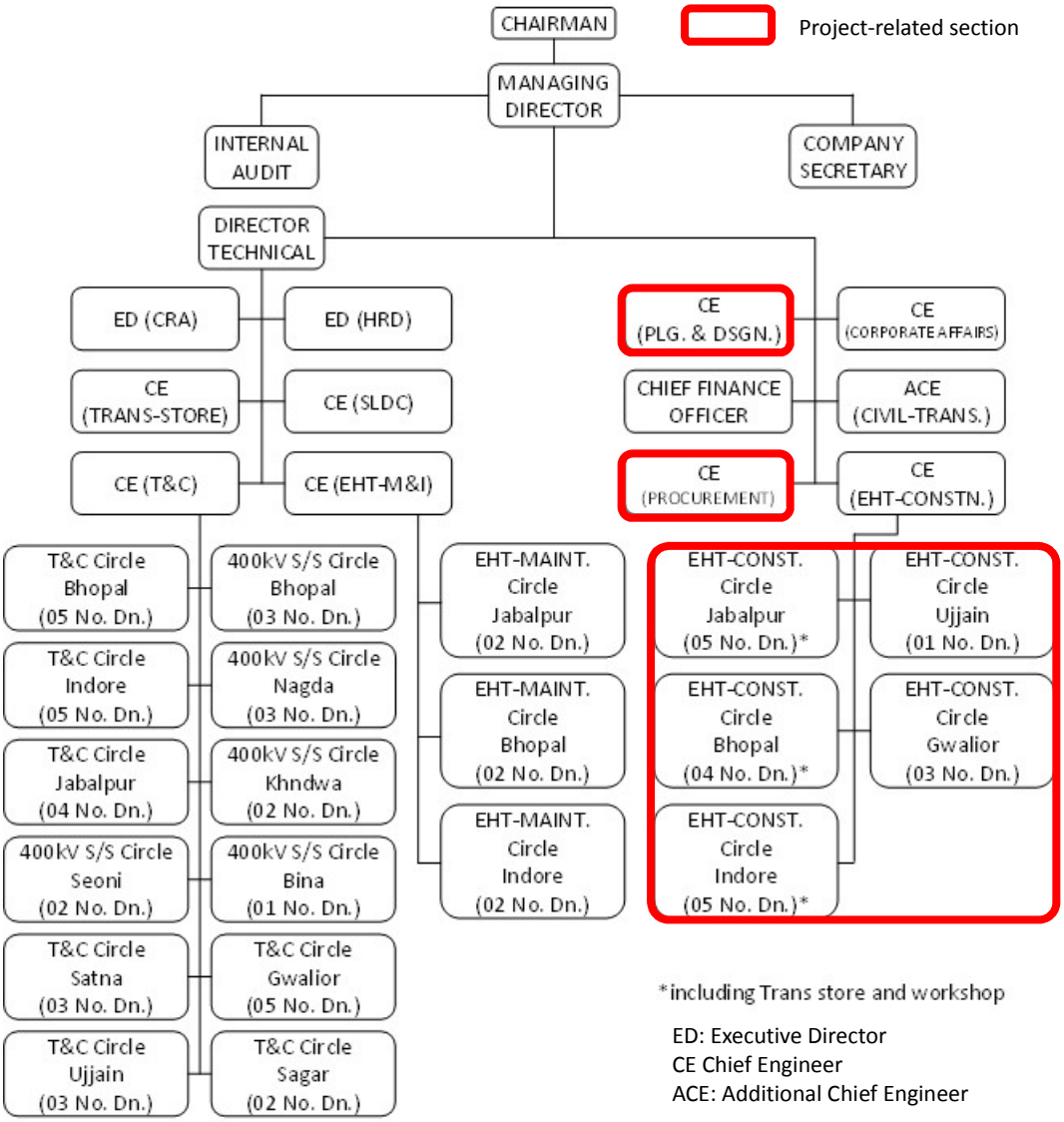


Figure 2-34 Power System Diagram around Subproject No. 2

Chapter 3. Project Implementation Scheme and Schedule

3.1. Organization of the Implementation Agency

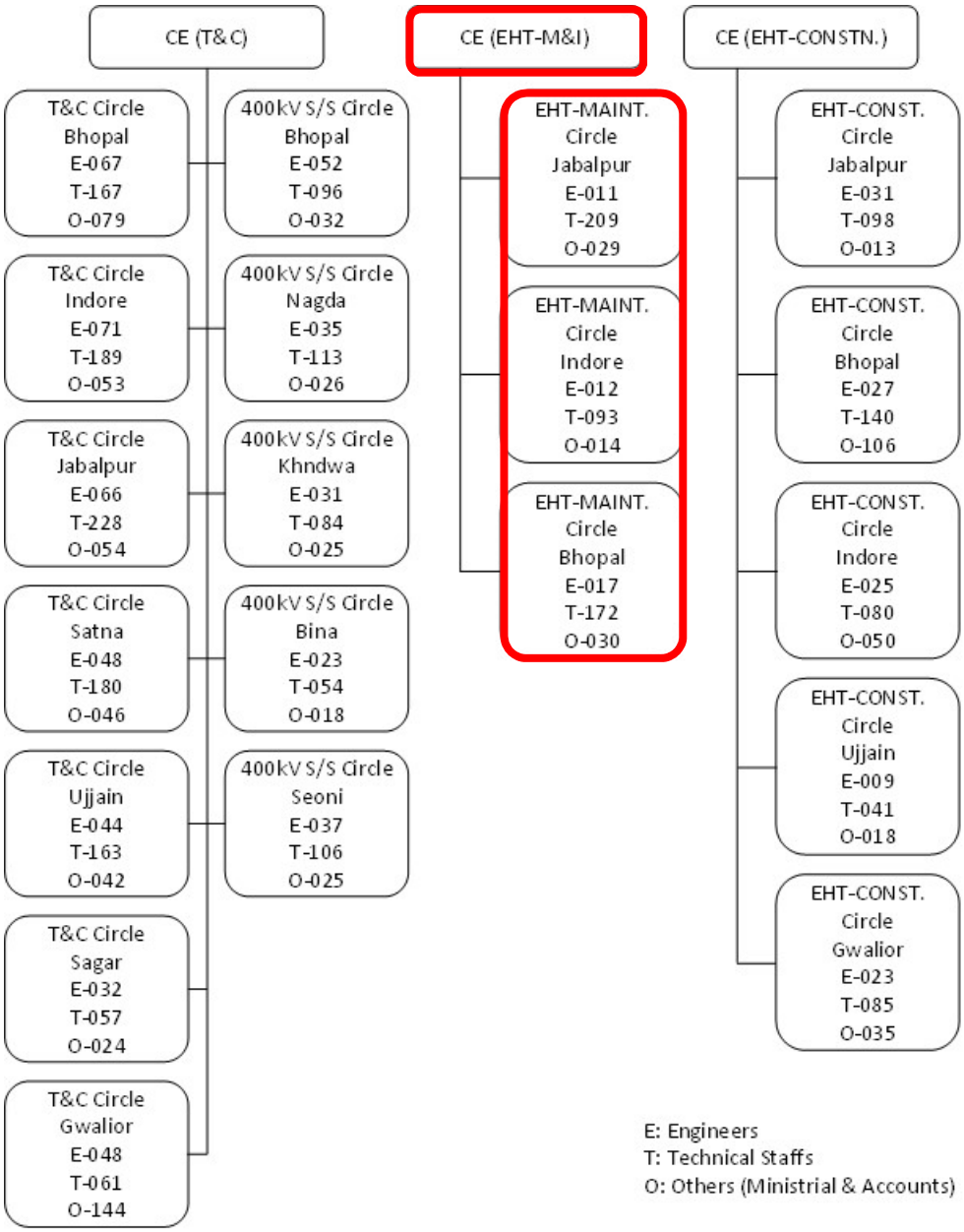
MPPTCL, which is the implementation agency for the Project, consists of the Headquarters and field circles, and the number of staff is approx. 5,000 in total at present. The organization chart is shown in the figure below. In the Project, the engineering (design), procurement, and construction supervision are executed by the Planning & Design, Procurement, and EHT-Construction sections, respectively.



(Source: MPPTCL)

Figure 3-1 Organization Chart of MPPTCL

There are three types of circles in the field which are for EHT-Construction, EHT-Maintenance and Inspection (M&I) and EHT-T&C. The framework of those circles and the staff assignment as well as the number of staff in each circle are shown in the figure below. And the EHT-M&I sections are in charge of the operation, maintenance and management after implementation of the Project.



（Source: MPPTCL）

Figure 3-2 Staff Assignment in Each Circle

The personnel distribution plan of MPPTCL up to 2017 is shown in the table below. CLASS-I, II, III and IV corresponds to senior engineer, engineer, junior engineer and technical staff, respectively. The staff number is on a downward trend overall but this trend is due to natural attrition, automation due to SCADA introduction and replacement of staff mainly of class-III and class-IV with outsourced workers.

Table 3-1 Personnel Distribution Plan up to 2017

				AS ON 31/03/2014
CLASS	CE (EHT Const.)	CE (EHT-M&I)	CE (T&C)	Total
CLASS-I	29	13	80	122
CLASS-II	93	36	154	283
CLASS-III	363	145	1455	1963
CLASS-IV	444	413	955	1812
Total	929	607	2644	4180
				AS ON 31/03/2015
CLASS	CE (EHT Const.)	CE (EHT-M&I)	CE (T&C)	Total
CLASS-I	29	13	80	122
CLASS-II	93	36	154	283
CLASS-III	363	145	1455	1963
CLASS-IV	452	419	969	1840
Total	937	613	2658	4208
				AS ON 31/03/2016
CLASS	CE (EHT Const.)	CE (EHT-M&I)	CE (T&C)	Total
CLASS-I	27	12	77	116
CLASS-II	91	34	147	272
CLASS-III	332	128	1386	1846
CLASS-IV	433	404	930	1767
Total	883	578	2540	4001
				AS ON 31/03/2017
CLASS	CE (EHT Const.)	CE (EHT-M&I)	CE (T&C)	Total
CLASS-I	26	11	74	111
CLASS-II	84	33	144	261
CLASS-III	285	104	1247	1636
CLASS-IV	415	385	876	1676
Total	810	533	2341	3684

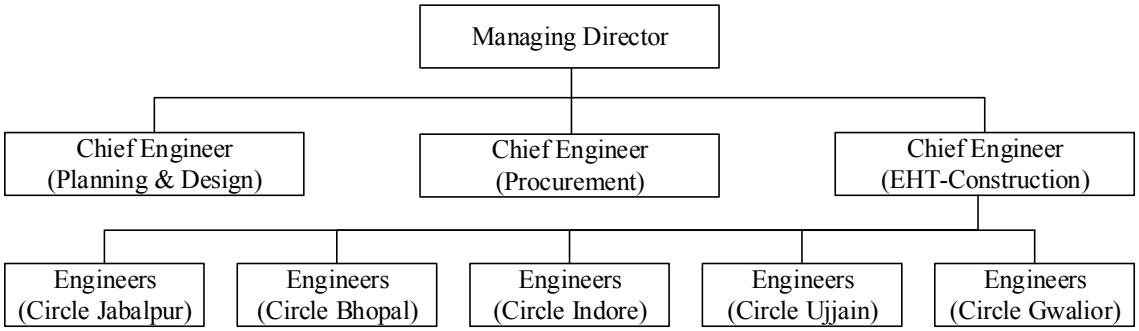
（Source: MPPTCL）

MPPTCL has implemented not only self-funded transmission line and substation development but also a JICA Phase 1 Project and power grid improvement project funded by ADB[11] without any difficulty, so it seems that there would be no concerns on the project management aspects.

[11] The details of the ADB projects are as follows:
(1) Madhya Pradesh Power Sector Development Program, Loans 1869, Loan amount USD 200 million, Approval 2001. http://www.adb.org/documents/india-madhya-pradesh-power-sector-development-program-loans-1868-1869
(2) Madhya Pradesh Power Sector Investment Program, Loans 2323/2346, Loan amount USD 250 million, Approval 2007. http://www.adb.org/projects/32298-023/main, http://www.adb.org/projects/32298-043/main

3.2. Project Implementation Framework

Figure 3-3 shows the implementation framework for the Project. Chief Engineer (Planning & Design) will be responsible for the design for transmission lines and substations in advance of the procurement. Then, Chief Engineer (Procurement) will be proceed the procurement process. In the construction stage, the Chief Engineer (EHT-Construction) will be supervising the construction works under the five area-wise circles. This implementation scheme is MPPTCL's general procedure, which was also adopted in the JICA Phase I Project. It seems that there would be no concerns because there have been no difficulties so far.



(Source: JICA Study Team)

Figure 3-3 Implementation Structure

At the implementation stage, regarding the conventional transmission lines and substations, no consultants are needed because MPPTCL has sufficient project experience, including the JICA Phase I Project. The Study Team also confirmed that LL-ACSR, as one of the new technologies, does not need any technical assistance because it does not require any special knowledge or skills to procure and operate the conductors. On the other hand, for GIS subprojects, the Study Team recommended to MPPTCL that assistance from a technical consultant be employed to design the substation based on an understanding of the basic structure of GIS, to evaluate bidding proposals, and to establish O&M manuals for MPPTCL. MPPTCL, however, insists that there is no need for consulting services because EPC contracts do not require any design work by the owner, and the O&M manuals are prepared only through the support of the EPC contractor. The needs of the consultant should be discussed later.

With regard to the construction supervision, the area-wise EHT construction circles of MPPTCL are in charge. There are 5 circles - Indore, Bhopal, Jabalpur, Ujjain and Gwalior - which take care of transmission line and substation construction. The territories of each EHT construction circle are color-coded and shown in the figure below.

（Source: MPPTCL）

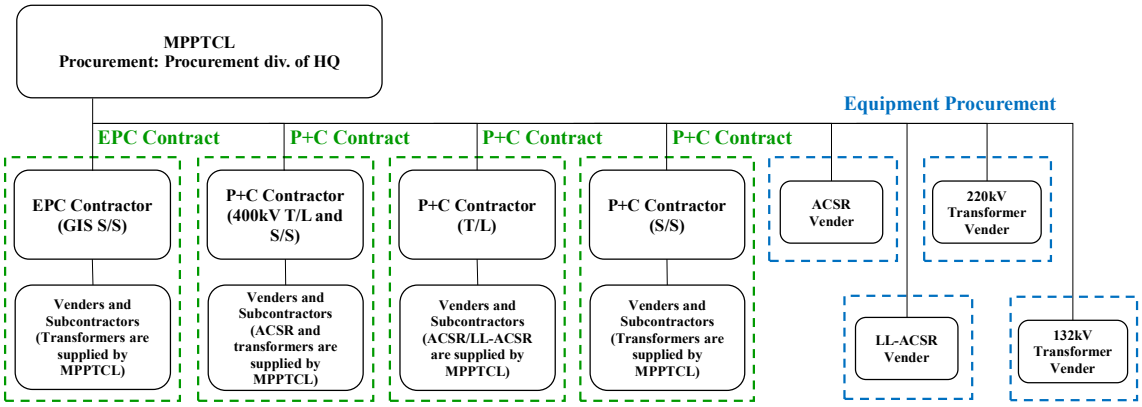
Figure 3-4 Territories of the EHT-Construction Circles

3.3. Procurement Packaging

MPPTCL has confirmed the procurement scheme as shown in Figure 3-5 and Table 3-2, in which the 33 subprojects will be compiled into 8 packages. In MPPTCL's similar projects, the packaging is generally defined considering criteria such as geography, equipment and size of contract. In addition, the additional new technology application, GIS, is considered in the packaging of the Project.

- Regarding the new technology, the subprojects with GIS are packaged separately into substation and transmission line contracts. GIS are executed by EPC contract.
- For the conventional AIS and transmission line construction, Procurement and Construction will be executed by contractors while Engineering will be done by MPPTCL.
- For 220kV and 132kV transformers in substations, LL-ACSR and ACSR are procured by MPPTCL and supplied to the contractors.

- The procurements of LL-ACSR and ACSR are separated because different manufactures are expected.
- The procurement of transformers are separated between 220kV and 132kV because production line capacity is limited for some manufactures.
- The construction packages are separated between T/L and S/S as MPPTCL's request. Only for the construction of 400kV T/L and S/S is carried out in one package because the components of 400kV T/L and S/S are limited.
- The size of each package is adjusted so that it is not too large as compared with past experiences of MPPTCL in order to enable proper management by them. For reference, MPPTCL stated that an average amount of one package is Rs. 60-70 Crores, and Rs. 250 Crores per package in the bigger contracts.



(Source: JICA Study Team)

Figure 3-5 Procurement Package

Table 3-2 Packaging of Subprojects

Subproject	NAME OF LINE WORKS	Line Work		New/Upgrading Substation Work		Feeder Bay Extension		Total Cost [INR Lakhs]							Procurement Package							
		Route Length [km]	LL-ACSR	Substation Name, Capacity & Associated Feeder Bays	GIS	Name of Sub-station	No. of Bays	Transmission Line	ACSR/ LL-ACSR (procured by MPPTCL)	Substation	220kV Transformer (procured by MPPTCL)	132kV Transformer (procured by MPPTCL)	Feeder Bay Extension	Total	1 (GIS, EPC)	2 (LL-ACSR)	3 (ACSR)	4 (220kV Transformer)	5 (132kV Transformer)	6 (P+C, 400kV)	7 (P+C, T/L)	8 (P+C, S/S)
1	LILO of one circuit of 400kV Khandwa - Rajgarh PGCIL line at Chhegaon 400kV Substation (D/C)	5						1072.42	276.35					1348.77			1			1		
						Chhegaon400(2)	2						1061.98	1061.98						1		
	400kV Bus Reactor at Chhegaon 400kV S/S			1x125 MVAR						985.60				985.60						1		
2	Pithampur400-Super Corridor 220kV DCDS line	50	LL-ACSR					5442.92	1623.70					7066.62		1					1	
						Pithampur400(2)	2						404.94	404.94								1
				Super Corridor (Indore) 220/132kV with GIS (1x160+1x63) + 220kV FB(2) +132kV FB(2)	GIS					7589.69	781.43	442.88		8814.00	1			1	1			
	LILO of One ckt of Indore(Jetpura) - Depalpur 132kV DCDS Line at Super Corridor (Indore) 220kV S/s.(D/C)	13						710.28	135.80					846.08			1				1	
4	Charging/Upgradation of Chichli220 - Udaipura DCDS line on 220kV level	-		Udaipura 220kV S/s (Upgradation) (1x160) MVA + 220kV FB(2)		Chichli220(2)	2			1572.43	771.46		347.69	2691.58				1				1
5	Chhatarpur-Tikamgarh 220kV DCSS line	110	LL-ACSR					7630.24	1541.37					9171.61		1					1	
						Chhatarpur (1) Tikamgarh (1)	2						413.11	413.11								1
6	400/220kV Additional Transformer at Bina 400kV S/S			1x315 MVA						2983.90				2983.90						1		
	LILO of Bina220 - Ganjbasoda 220kV line at Bina(MPPTCL) 400kV S/s	10						1056.09	189.05					1245.14			1				1	
						Bina(MP)400 (2)	2						448.57	448.57								1
7	Rewa220 - Rewa UMSP 220kV DCDS line	30	LL-ACSR					2458.35	841.58					3299.93		1					1	
	Rewa UMSP - Sidhi 220kV DCDS line	60						4690.93	1122.11					5813.04			1				1	
						Rewa220 (2) Sidhi220 (2) Rewa UMSP (4)	8						1575.69	1575.69								1
9	Julwania400 - Pati(Silawad) 132kV DCSS Line	40						2032.27	215.65					2247.92			1				1	
				Pati(Silawad) 132/33kV 50MVA + 132kV FB(1)		Julwaniya400(1)	1			982.66		342.60	97.45	1422.71					1			1
10	LILO of Mangliya - IndoreSZ 132kV line at Mahalaxmi	3						218.66	32.26					250.92			1				1	
				Mahalaxmi 132/33kV 63MVA + 132kV FB(2)						1127.17		452.85		1580.02					1			1
11	Julwania400 - Shahpura 132kV DCSS Line	65						3795.84	346.39					4142.23			1				1	
				Shahpura 132/33kV 50MVA + 132kV FB(1)		Julwaniya400(1)	1			985.23		342.60	97.45	1425.28					1			1
12	Datia220 - Bhitarwar 132kV DCSS Line	40						2074.63	215.65					2290.28			1				1	
				Bhitarwar 132/33kV 50MVA + 132kV FB(1)		Datiya220(1)	1			985.23		342.60	104.07	1431.90					1			1
13	MugaliaChhap220 - Mahwadia 132kV DCDS Line	10						709.44	105.28					814.72			1				1	
				Mahwadia 132/33kV 50MVA + 132kV FB(2)		MugaliyaChhap(2)	2			1051.60		342.60	194.89	1589.09					1			1
15	Sidhi220 - Madwas 132kV DCSS Line	50						2991.23	268.28					3259.51			1				1	
				Madwas 132/33kV 50MVA + 132kV FB(1)		Sidhi220(1)	1			985.23		342.60	97.26	1425.09					1			1
16	Panagar220 - Dheemarkheda 132kV DCSS Line	65						3652.61	346.39					3999.00			1				1	
				Dheemarkheda 132/33kV 50MVA + 132kV FB(1)		Panagar220(1)	1			985.23		342.60	104.07	1431.90					1			1

Subproject	NAME OF LINE WORKS	Line Work		New/Upgrading Substation Work		Feeder Bay Extension		Total Cost [INR Lakhs]							Procurement Package							
		Route Length [km]	LL-ACSR	Substation Name, Capacity & Associated Feeder Bays	GIS	Name of Sub-station	No. of Bays	Transmission Line	ACSR/ LL-ACSR (procured by MPPTCL)	Substation	220kV Transformer (procured by MPPTCL)	132kV Transformer (procured by MPPTCL)	Feeder Bay Extension	Total	1 (GIS, EPC)	2 (LL-ACSR)	3 (ACSR)	4 (220kV Transformer)	5 (132kV Transformer)	6 (P+C, 400kV)	7 (P+C, T/L)	8 (P+C, S/S)
17	Prithivipur-Orchha 132kV DCSS Line	30						2189.65	164.71					2354.36			1				1	
				Orchha 132/33kV 50MVA + 132kV FB(1)		Prithvipur(1)	1			985.23		342.60	99.57	1427.40					1			1
18	Sirmour220 - Atraila 132kV DCSS line	35						2056.22	190.18					2246.40			1				1	
				Atraila 132/33kV 50MVA + 132kV FB(1)		Sirmour220 (1)	1			985.23		342.60	95.63	1423.46					1			1
19	Udaipura - Tendukheda 132kV DCSS line	45						2433.51	242.81					2676.32			1				1	
				Tendukheda 132/33kV S/s (1x50) MVA + 132kV FB(1)		Udaipura (1)	1			985.23		342.60	96.19	1424.02					1			1
20	Gohad - Gormi 132kV DCSS line	25						1494.08	139.24					1633.32			1				1	
				Gormi 132/33kV S/s (1x50) MVA + 132kV FB(1)		Gohad (1)	1			985.23		342.60	91.69	1419.52					1			1
21	Narsinghgarh - Suthaliya 132kV DCSS line	50						2725.60	268.28					2993.88			1				1	
				Suthaliya 132/33kV S/s (1x50) MVA + 132kV FB(1)		Narsinghgarh (1)	1			985.23		342.60	95.63	1423.46					1			1
22	LILO of Satna220 - Kymore 132kV line at Unchhera 132kV S/s	5						497.82	52.64					550.46			1				1	
				Unchhera 132/33kV S/s (1x50) MVA + 132kV FB(2)						1077.76		342.60		1420.36					1			1
23	Sidhi - Sinhawal 132kV DCSS line	50						3137.77	268.28					3406.05			1				1	
				Sinhawal 132/33kV S/s (1x50) MVA + 132kV FB(1)		Sidhi220(1)	1			985.23		342.60	97.26	1425.09					1			1
24	2nd ckt of Rajgarh(B) - Raghogarh 132kV DCSS line up to Chachoda 132kV S/s	61						1516.20	326.02					1842.22			1				1	
				Chachoda 132/33kV S/s (1x50) MVA + 132kV FB(1)		Rajgarg(B)(1)	1			985.23		342.60	104.07	1431.90					1			1
25	Maneri - Mandla 132kV DCSS line	80						5067.37	424.50					5491.87			1				1	
						Maneri(1) Mandla(1)	2						195.20	195.20								1
26	Sukha (Jabalpur)			+ 2x50 MVA						1051.50	1133.88			2185.38				1				1
27	Hoshangabad 220kV (2nd)			+ 1x160 MVA						590.35	771.46			1361.81				1				1
28	Barwaha 220kV (3rd)			+ 1x160 MVA						616.67	771.46			1388.13				1				1
29	Betma 132kV			+ 50 MVA						268.20		332.63		600.83					1			1
30	Khirkiya 132kV			+ 50 MVA						272.47		332.63		605.10					1			1
31	Amla 132kV			+ 50 MVA						252.00		332.63		584.63					1			1
32	Tejgarh 132kV			+ 50 MVA						268.13		332.63		600.76					1			1
33	Satwas 132kV			+ 50 MVA						260.80		332.63		593.43					1			1
34	Sitamau 132kV			+ 50 MVA						264.43		332.63		597.06					1			1
35	Baroda 132kV			+ 50 MVA						276.24		332.63		608.87					1			1
36	Amrawadkhurd 132kV			+ 50 MVA						263.81		332.63		596.44					1			1
	TOTAL							59654.13	9336.52	32592.94	4229.69	8353.17	5822.41	119988.86	7589.69	4006.65	5329.87	4229.69	8353.17	6103.90	58581.71	25794.18

(Source: MPPTCL and JICA Study Team)

3.4. Implementation Schedule

The project implementation schedule as shown in Figure 3-6 was created from discussion with MPPTCL in respect of the following conditions. It should be noted that the requirements of the consultant are still under discussion.

- In Package 1: EPC for GIS subproject and Package 2: LL-ACSR procurement, it is assumed that the consultant assists with the procurement process.
- In Package 2: LL-ACSR and Package 3: ACSR procurements, it is assumed that it will take a minimum of 8 months to deliver the conductors. In the actual schedule, the materials are delivered along with the construction work of Packages 1, 6, 7, and 8, and it should be completed at least 6 months before the completion of the construction.
- In Package 4: 220kV and Package 5: 132kV transformer procurements, it is assumed that it will take a minimum of 8 months to deliver the transformers, and that one 132kV transformer and two 220kV ones are delivered in a month. In the actual schedule, the materials are delivered along with the construction work of Packages 1, 6, 7, and 8, and it should be completed at least 6 months before the completion of the construction.
- In Packages 6, 7 and 8: Procurement and Construction, it is assumed that the maximum will be 26 months, based on MPPTCL and TEPCO's past experience.

FY	2015-16						2016-17												2017-18												2018-19												2019-20											
Month	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
JICA Pledge					■																																															
E/N						■																																															
L/A						■																																														
Project Completion																																																				■	
Pkg. 1: EPC for GIS Substation																																																				
(1-a) Consultant Selection																																																			
(1-b) Consultancy Service																																																			
(1-c) EPC Contractor Selection																																																			
1.Preparation of Tender Documents & JICA's Approval without Pre-qualification																																																			
2.Tender Period																																																			
3.Evaluation of Bids																																																			
4.JICA Approval of Bid Evaluation																																																			
5.Contract Negotiation																																																			
6.JICA Approval of Contract																																																			
7.Opening of Letter of Credit and Issuance of Letter of Commitment																																																			
(1-b) EPC Work																												■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Pkg. 2: LL-ACSR Procurement																																																				
(2-a) Consultant Selection																																																			
(2-b) Consultancy Service																																																			
(2-c) Manufacture Selection																																																			
(2-d) Manufacturing																																																			
Pkg. 3: ACSR Procurement																																																			
(3-a) Manufacture Selection																																																			
(3-b) Manufacturing																																																			
Pkg. 4: 220kV Transformer Procurement																																																			
(4-a) Manufacture Selection																																																			
(4-b) Manufacturing																																																			
Pkg. 5: 132kV Transformer Procurement																																																			
(5-a) Manufacture Selection																																																			
(5-b) Manufacturing																																																			
Pkg. 6: Procurement & Construction for 400kV T/L and S/S																																																			
(6-a) Detailed Design by MPPTCL																																																			
(6-b) P+C Contractor Selection																																																			
(6-c) Contractor Work																																																			
Pkg. 7: Procurement & Construction for 220kV and 132kV T/L																																																			
(7-a) Detailed Design by MPPTCL																																																			
(7-b) P+C Contractor Selection																																																			
(7-c) Contractor Work																																																			
Pkg. 8: Procurement & Construction for 220kV and 132kV S/S																																																			
(8-a) Detailed Design by MPPTCL																																																			
(8-b) P+C Contractor Selection																																																			
(8-c) Contractor Work																																																			

(Source: JICA Study Team)

Figure 3-6 Project Implementation Schedule

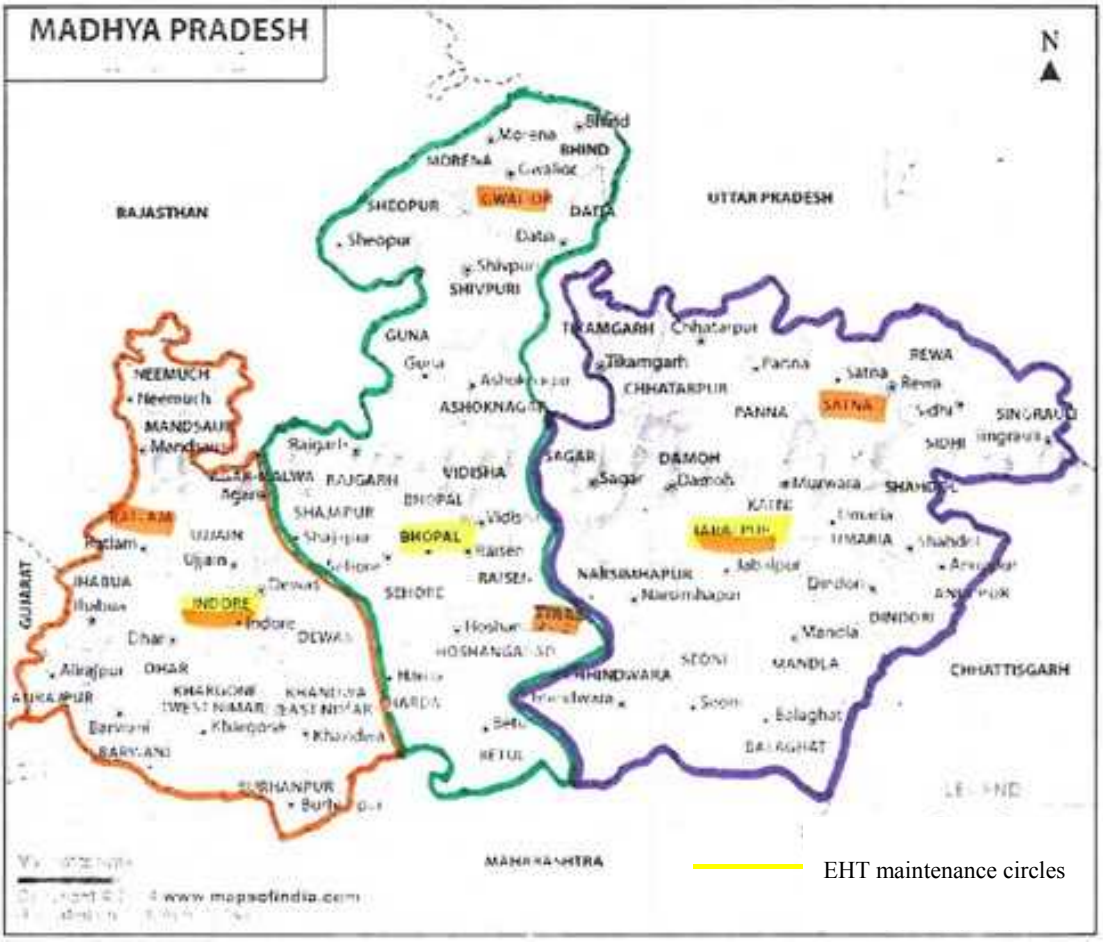
3.5. Procurement and Construction

Contracts with equipment venders and EPC and PC (Procurement and Construction) contractors mentioned above will be independently procured under the International Competitive Bidding (ICB) without Prequalification (PQ). FIDIC Yellow Book will be used for the procurement. The above conditions were discussed and confirmed between JICA and MPPTCL in the JICA Fact Finding Mission for the Project in September 2015.

3.6. Operation and Maintenance Framework

3.6.1. Operation and Maintenance Framework

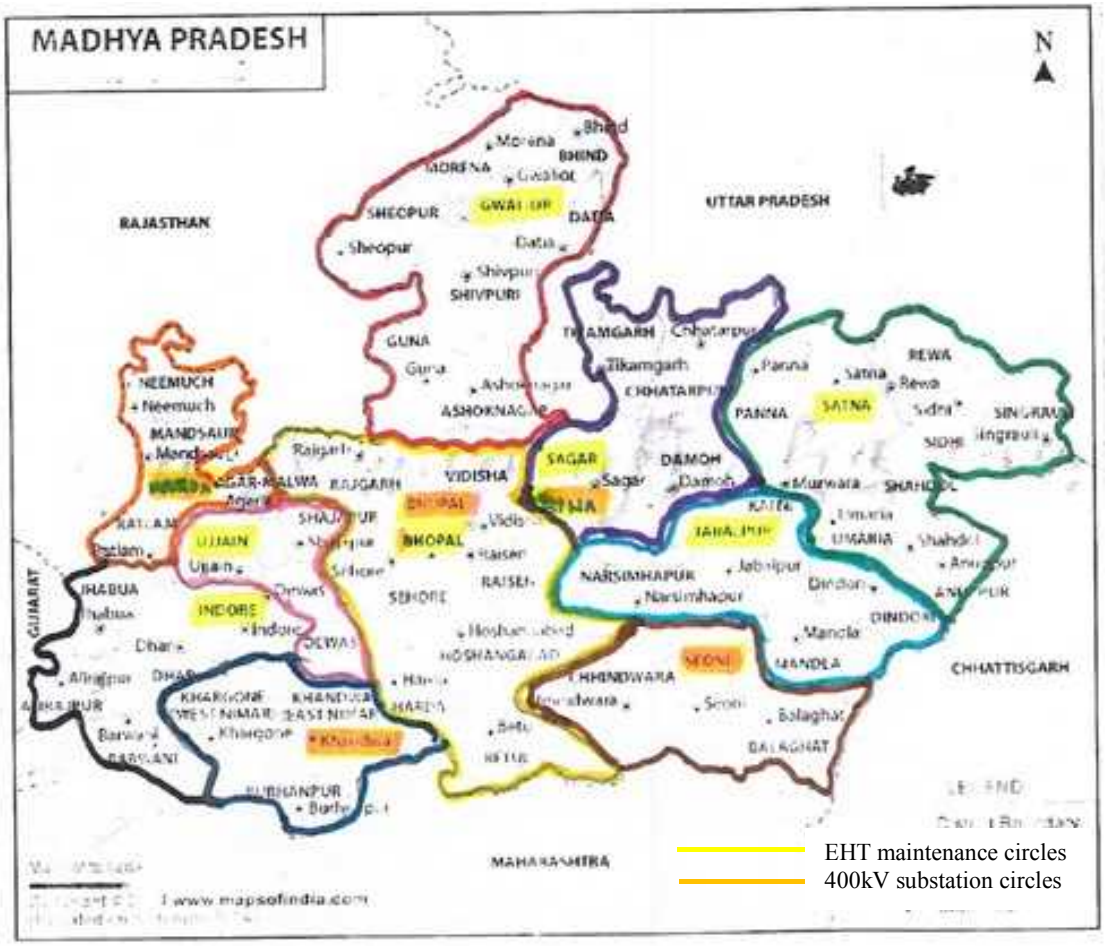
After completion of each subproject, the projects will be handed over to MPPTCL's EHT maintenance circles, which will then look after them in the same way as other existing facilities. There are three EHT maintenance circles, in Indore, Bhopal and Jabalpur, which take care of the transmission line and substation maintenance in MPPTCL. Those circles will conduct the maintenance of the transmission lines and substations which would be constructed in the Project, in each area. The territories of each EHT maintenance circle are color-coded and shown in the figure below. As described above, MPPTCL runs their business with the wheeling charge and the periodic inspection or maintenance has been implemented by themselves. Therefore it seems that the necessary capital for O&M has been reserved soundly.



(Source: MPPTCL)

Figure 3-7 Territories of the EHT-Maintenance Circles

There are also seven T&C (Testing & Communication) circles and five 400 kV substation circles and each area is defined the same as the EHT maintenance circles.



(Source: MPPTCL)

Figure 3-8 Territories of the T&C Circles

3.6.2. Inspection and Maintenance of the Transmission Lines and Substation Equipment

MPPTCL conducts preventive maintenance of the transmission lines in a planned manner. MPPTCL also conducts live-line work of transmission lines and was the first to adopt this in India.

Regarding the inspection of the transmission lines, MPPTCL has set each implementation frequency, such as faulty insulator detection once a year and short circuit & grounding fault patrol within 3 days after the occurrence, etc., and implements it as appropriate. As for the maintenance work of the transmission lines, their implementation frequency is also defined, such as immediately, once per half year, once per year, etc., based on the type of trouble or work such as foundation repair, member replacement, insulator replacement or insulator washing.

For the substation equipment, periodic inspections are carried out by MPPTCL. As an example of transformer inspection, oil parameter test and dissolved gas analysis are scheduled twice a year. For

circuit breakers, insulation resistance and operating time are measured twice a year. In general, the test schedules are more frequent than those in Japan.

3.7. Operation and Effect Indicators

In order to monitor the Project operation and verify the Project effectiveness, the JICA Study Team proposed the operation and effect indicators shown in the table below considering the difficulty in monitoring the indicators on each sub-project by MPPTCL.

Table 3-3 Operation and Effect Indicators for the Project

Indicator Items	Unit	Baseline	Target
Availability Factor	%	N/A	99.35
Transmission Loss	%	N/A	2.82

For the targets, the minimum values required for the Project were assumed based on MPPTCL's past achievements. Depending on the progress of the Project, the revision of the target values themselves and continuous efforts to achieve the targets by MPPTCL would be required.

Chapter 4. New Technologies for Transmission Line and Substation Equipment

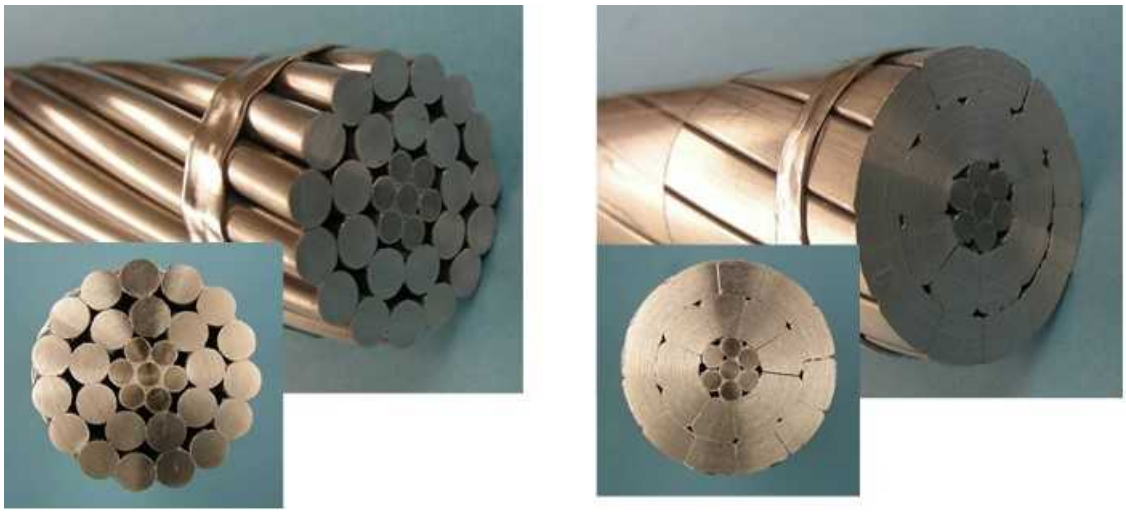
4.1. Low Loss Conductor

4.1.1. Features of the Low Loss Conductor (LL-ACSR)

LL-ACSR is an Aluminum Conductor Steel Reinforced (ACSR) conductor whose aluminum wires are trapezoidal shaped; therefore, the share of the cross-sectional area of the aluminum layer is higher than that of a conventional conductor. Due to this, the LL-ACSR can reduce loss compared to conventional conductors with the same outer diameter.

When compared at the same resistance, downsizing of the tower is expected by applying LL-ACSR, which has a more compact body and a lower wind pressure load than conventional conductors.

The following figures show the configuration of the conventional ACSR and the LL-ACSR.



(Source: Courtesy of SEI LTD.)

Figure 4-1 (left) Conventional ACSR and (right) LL-ACSR

4.1.2. LL-ACSR for the Project

As described before, MPPTCL uses standardized towers with standard conductors such as twin ACSR Moose for 400 kV, single ACSR Zebra for 220 kV and single ACSR Panther for 132 kV transmission lines. Therefore, the proposed LL-ACSR for the Project should be used with the standard towers without modification, the same as the standard conductors.

The JICA Survey Team proposed the LL-ACSR comprised of high tensile strength steel wire, which can reduce core weight and cross section while securing equivalent tensile strength as a standard conductor, and increase the cross section of aluminum while keeping conductor weight and outer diameter lower than a standard conductor. This enables the LL-ACSR to reduce electrical resistance from 10 to 20%. In order to obtain the best possible loss reduction effect, galvanized extra high strength (1,960 MPa or higher) steel wires or aluminum-clad extra high strength (1,770 MPa or higher) steel wires should be applied to the steel core.
The technical specifications of the LL-ACSR equivalent to each standard conductor are shown in the following tables.

Table 4-1 Technical Specification of the LL- ACSR (Moose equivalent) (for 400 kV)

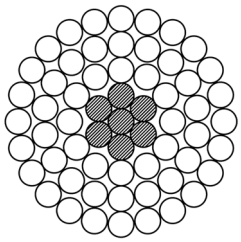
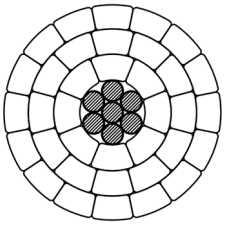
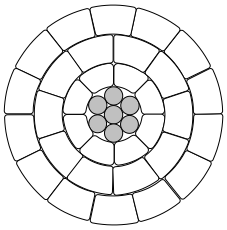
		(ref.) ACSR Moose	LL-ACSR/AS	LL-ACSR/UGS
Cross Sectional Area	AL	528.5 mm^2	589.2 mm^2	606.78 mm^2
	Steel	68.5 mm^2	49.48 mm^2	40.08 mm^2
	Total	597.0 mm^2	638.7 mm^2	646.86 mm^2
Conductor Diameter		31.77 mm	29.8 mm	30.2 mm
Conductor Weight		2,004 kg/km	1,991 kg/km	1,998 kg/km
Max. D.C. Resistance at 20 deg. C		0.05552 ohm/km	0.0484 ohm/km	0.0477 ohm/km
Min. Breaking Strength		161.2 kN	163.2 kN	160.7 kN
Modulus of Elasticity		GPa	70.2 GPa	70.7 GPa
Coefficient of Linear Exp.		19.5 x 10^{-6}/deg.C	20.9 x 10^{-6}/deg.C	20.9 x 10^{-6}/deg.C
Cross Sectional View				

Table 4-2 Technical Specification of the LL-ACSR (Zebra equivalent) (for 220 kV)

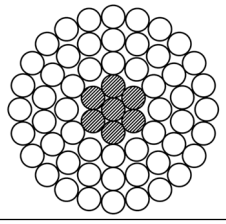
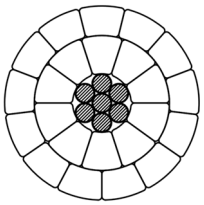
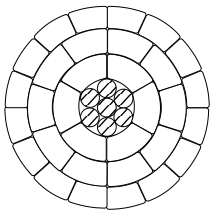
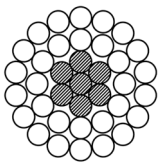
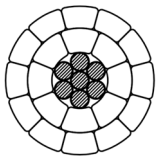
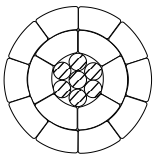
		(ref.) ACSR Zebra	LL-ACSR/AS	LL-ACSR/UGS
Cross Sectional Area	AL	428.9 mm^2	480.4 mm^2	491.84 mm^2
	Steel	55.59 mm^2	40.08 mm^2	33.00 mm^2
	Total	484.5 mm^2	520.5 mm^2	524.84 mm^2
Conductor Diameter		28.62 mm	26.9 mm	27.21 mm
Conductor Weight		1,621 kg/km	1,620 kg/km	1,623 kg/km
Max. D.C. Resistance at 20 deg. C		0.06915 ohm/km	0.0592 ohm/km	0.0588 ohm/km
Min. Breaking Strength		130.32 kN	132.6 kN	132.8 kN
Modulus of Elasticity		70.9 GPa	70.1 GPa	70.9 GPa
Coefficient of Linear Exp.		20.9 x 10^{-6}/deg.C	20.9 x 10^{-6}/deg.C	20.9 x 10^{-6}/deg.C
Cross Sectional View				

Table 4-3 Technical Specification of the LL-ACSR (Panther equivalent) (for 132 kV)

		(ref.) ACSR Panther	LL-ACSR/AS	LL-ACSR/UGS
Cross Sectional Area	AL	212.1 mm^2	243.4 mm^2	260.16 mm^2
	Steel	49.5 mm^2	35.75 mm^2	31.67 mm^2
	Total	261.6 mm^2	279.2 mm^2	291.83 mm^2
Conductor Diameter		21.00 mm	19.8 mm	20.48 mm
Conductor Weight		976 kg/km	931.5 kg/km	972.2 kg/km
Max. D.C. Resistance at 20 deg. C		0.139 ohm/km	0.1152 ohm/km	0.111 ohm/km
Min. Breaking Strength		89.67 kN	92.2 kN	93.57 kN
Modulus of Elasticity		89.1 GPa	75.7 GPa	77.4 GPa
Coefficient of Linear Exp.		18.0 x 10^{-6}/deg.C	19.8 x 10^{-6}/deg.C	19.7 x 10^{-6}/deg.C
Cross Sectional View				

(Source: Courtesy of FUJIKURA LTD. & SEI LTD.)

4.1.3. Sag Comparison

The conductor sag needs to be equivalent to the conventional conductor when the LL-ACSR is applied. The following figure shows the sag comparison of the standard span length between the conventional ACSR Zebra and the LL-ACSR (Zebra equivalent). This figure shows that each conductor sag is almost the same and it is confirmed that there would be no sag increment problem due to conductor change.

Figure 4-2 Sag Comparison between the Conventional ACSR and the LL-ACSR

4.1.4. Construction Cost

The JICA Study Team estimated the LL-ACSR applied transmission line construction cost based on the transmission line (double circuit double string) construction cost for the Project. As shown in the following table, the transmission line construction cost using LL-ACSR is approx. 13% higher than the normal construction cost.

Table 4-4 Comparison of the Transmission Line Construction Cost

Voltage	Construction Cost (Lakhs/km) [INR]		Cost increment by applying LL-ACSR
	with Standard Conductor	With LL-ACSR	
400 kV	197.0	212.7	8.0%
220 kV	92.9	105.1	13.1%
132 kV	67.9	77.0	13.4%

(Source: DPR)

4.1.5. Criteria for LL-ACSR Application

The Study Team determines numerical value criteria at each voltage level for application of LL-ACSR. Since the criteria are given in numerical values, the economic benefit of LL-ACSR application for each subproject is easily verified. The Study Team develops a simple evaluation method which needs a peak power flow on a transmission line only and determines whether the LL-ACSR application is justified or not.

The transmission loss reduction contributes to reducing power plant investment costs and fuel consumption. This study assumes that the incremental cost for initial investment must be recovered within 20 years, earlier than the 50 years' standard lifetime of transmission lines in MPPTCL, by using power flows in the year 2018-19 as initial conditions and assuming they are stable for 20 years. This means MPPTCL would install LL-ACSR if the initial investment cost can be recovered within 20 years. However, this assumption of stable power flow in later years is very conservative, since it covers rural/remote areas, where demand growth in the future is expected and the lifetime of the lines is very long. This study takes increased power flows of 25% higher than the original power flow in the year 2018-19 as the initial power flow, as per the discussion with MPPTCL.

The following shows assumptions and conditions to evaluate the criteria. Conditions for current carrying capacity calculation of transmission lines are shown in

Table 4-5. The criteria are shown in Table 4-6 and the calculation results are shown from Table 4-7 to Table 4-9.

Assumptions and conditions to evaluate the criteria:

a) Power Flow: Year 2018-19 (Amended: Year 2018-2019×1.25)
b) Peak Power Cost (PPC): 5.0 INR/kWh
c) Load Factor (LF): 0.700 (MPPTCL's assumption)
d) Loss Load Factor (LLF): 0.532 (= 0.8×LF×LF + 0.2×LF) (MPPTCL's assumption)
e) Power Factor (PF): 95%
f) AC Resistance $R_{ac} = R_{dc20} \times (1 \times 0.004 \times (Temp.-20))$ [ohm/km]
g) Transmission Line Cost: Estimated Weighted Average Cost for DCDS in the Project
h) Recovery years of Initial Investment Cost: 20 years
i) No Escalation of Power Unit Cost (Conservative Assumption)
j) No Power Flow Increase from Initial Condition (Conservative Assumption)
k) No Discount rate (Low interest Rate Applied to JICA ODA loan)
l) No Tower Design Changes

Table 4-5 Calculation Conditions for Current Carry Capacity

Elevation above Sea Level	0 m
Ambient Temperature	45 deg C
Solar Absorption Coefficient	0.8
Solar Radiation	1045 W/m^2
Emissivity Constant	0.45
Wind Velocity	0.6 m/sec
Wind Direction (Right Angle to Conductor)	25 deg.
Effective Angle of Incidence of Sun's rays	90 deg.

(Source: Manual on Transmission Planning Criteria CEA and JICA Study Team)

Table 4-6 Criteria for LL ACSR Application

Voltage	Criteria for LL ACSR Application
400 kV	250 MW
220 kV	76 MW
132 kV	25 MW

(Source: JICA Study Team)

Table 4-7 Calculation of 132 kV LL ACSR Application Criteria

Voltage			132 [kV]							
Transmission Line			Cost / Line		Max. capacity @75°C		Conductor DC resistance @ 20°C			
ACSR PANTHER 210mm2			6,636,598	[INR/km/tower]	375[A]	86 [MVA]	0.1363	[ohm/km]		
LL ACSR 240mm2			7,544,495	[INR/km/tower]	404[A]	92 [MVA]	0.1152	[ohm/km]		
Incremental cost			453,949	[INR/km/circuit]						
Number of circuits in tower			2							
(A)	Peak power flow per circuit			[MW]	20	22	24	26	28	30	32
(B)	Peak current per circuit	(B)=(A) / Volt / sqrt(3) / PF / 1000		[A]	92.1	101.3	110.5	119.7	128.9	138.1	147.3
(C)	Conductor temperature	ACSR PANTHER 210mm2		[°C]	58.5	58.7	59.0	59.3	59.6	60.0	60.3
(D)	Conductor temperature	LL ACSR 240mm2		[°C]	57.9	58.2	58.4	58.7	59.0	59.3	59.6
(E)	Conductor resistance Rac	ACSR PANTHER 210mm2		[ohm/km]	0.157	0.157	0.158	0.158	0.158	0.158	0.158
(F)	Conductor resistance Rac	LL ACSR 240mm2		[ohm/km]	0.133	0.133	0.133	0.133	0.133	0.133	0.133
(G)	Power loss 3 x (B) x (B) x Rac / 1000	ACSR PANTHER 210mm2		[kW/km]	4.0	4.8	5.8	6.8	7.9	9.0	10.3
(H)	Power loss 3 x (B) x (B) x Rac / 1000	LL ACSR 240mm2		[kW/km]	3.4	4.1	4.9	5.7	6.6	7.6	8.7
(I)	Peak loss reduction per circuit	(I)=(G)-(H)		[kW/km]	0.6	0.8	0.9	1.1	1.2	1.4	1.6
(J)	Annual loss reduction per circuit	(J)=(I) x 8760hrs x LLF x PPC		[INR/km/year]	14587	17673	21061	24755	28755	33065	37688
(K)	Recovery years	(K)=Incremental cost / (J)		[Year]	31.1	25.7	21.6	18.3	15.8	13.7	12.0
(L)	Annual energy saved	(J)=(I) x 8760hrs x LLF x 40km		[kWh/40km/year]	116695	141383	168492	198037	230041	264523	301507

(Source: JICA Study Team)

Table 4-8 Calculation of 220 kV LL ACSR Application Criteria

Voltage			220 [kV]							
Transmission tower cost			Cost / Line		Max. capacity @75° C		Conductor DC resistance @ 20° C			
ACSR ZEBRA 400mm2			9,135,159	[INR/km/tower]	550[A]	210 [MVA]	0.0674	[ohm/km]		
LL ACSR 480mm2			10,354,885	[INR/km/tower]	583[A]	222 [MVA]	0.0592	[ohm/km]		
Incremental cost			609,863	[INR/km/circuit]						
Number of circuits in tower			2							
(A)	Peak power flow per circuit			[MW]	60	65	70	75	80	85	90
(B)	Peak current per circuit	(B)=(A) / Volt / sqrt(3) / PF / 1000		[A]	165.7	179.6	193.4	207.2	221.0	234.8	248.6
(C)	Conductor temperature	ACSR ZEBRA 400mm2		[°C]	61.0	61.2	61.5	61.8	62.1	62.4	62.8
(D)	Conductor temperature	LL ACSR 480mm2		[°C]	60.4	60.7	60.9	61.2	61.5	61.8	62.1
(E)	Conductor resistance Rac	ACSR ZEBRA 400mm2		[ohm/km]	0.078	0.079	0.079	0.079	0.079	0.079	0.079
(F)	Conductor resistance Rac	LL ACSR 480mm2		[ohm/km]	0.069	0.069	0.069	0.069	0.069	0.069	0.069
(G)	Power loss 3 x (B) x (B) x Rac / 1000	ACSR ZEBRA 400mm2		[kW/km]	6.5	7.6	8.8	10.1	11.5	13.0	14.6
(H)	Power loss 3 x (B) x (B) x Rac / 1000	LL ACSR 480mm2		[kW/km]	5.7	6.7	7.7	8.9	10.1	11.4	12.8
(I)	Peak loss reduction per circuit	(I)=(G)-(H)		[kW/km]	0.8	0.9	1.1	1.3	1.4	1.6	1.8
(J)	Annual loss reduction per circuit	(J)=(I) x 8760hrs x LLF x PPC		[INR/km/year]	18585	21839	25363	29157	33226	37571	42196
(K)	Recovery years	(K)=Incremental cost / (J)		[Year]	32.8	27.9	24.0	20.9	18.4	16.2	14.5
(L)	Annual energy saved	(J)=(I) x 8760hrs x LLF x 40km		[kWh/40km/year]	148682	174714	202901	233260	265810	300571	337564

(Source: JICA Study Team)

Table 4-9 Calculation of 400 kV LL ACSR Application Criteria

Voltage			400 [kV]							
Transmission tower cost			Cost / Line		Max. capacity @75° C		Conductor DC resistance @ 20° C			
ACSR Twin MOOSE 520mm2			19,700,212	[INR/km/tower]	1231[A]	853 [MVA]	0.0274	[ohm/km]		
LL ACSR Twin 590mm2			21,231,125	[INR/km/tower]	1301[A]	901 [MVA]	0.0242	[ohm/km]		
Incremental cost			765,457	[INR/km/circuit]						
Number of circuits in tower			2							
(A)	Peak power flow per circuit			[MW]	200	220	240	260	280	300	320
(B)	Peak current per circuit	(B)=(A) / Volt / sqrt(3) / PF / 1000		[A]	303.9	334.3	364.6	395.0	425.4	455.8	486.2
(C)	Conductor temperature	ACSR Twin MOOSE 520mm2		[°C]	61.2	61.4	61.6	61.8	62.1	62.3	62.6
(D)	Conductor temperature	LL ACSR Twin 590mm2		[°C]	60.6	60.8	61.0	61.2	61.5	61.7	62.0
(E)	Conductor resistance Rac	ACSR Twin MOOSE 520mm2		[ohm/km]	0.032	0.032	0.032	0.032	0.032	0.032	0.032
(F)	Conductor resistance Rac	LL ACSR Twin 590mm2		[ohm/km]	0.028	0.028	0.028	0.028	0.028	0.028	0.028
(G)	Power loss 3 x (B) x (B) x Rac / 1000	ACSR Twin MOOSE 520mm2		[kW/km]	8.8	10.7	12.7	14.9	17.3	19.9	22.7
(H)	Power loss 3 x (B) x (B) x Rac / 1000	LL ACSR Twin 590mm2		[kW/km]	7.8	9.4	11.2	13.2	15.3	17.6	20.0
(I)	Peak loss reduction per circuit	(I)=(G)-(H)		[kW/km]	1.0	1.2	1.5	1.7	2.0	2.3	2.7
(J)	Annual loss reduction per circuit	(J)=(I) x 8760hrs x LLF x PPC		[INR/km/year]	24024	29095	34661	40723	47286	54352	61926
(K)	Recovery years	(K)=Incremental cost / (J)		[Year]	31.9	26.3	22.1	18.8	16.2	14.1	12.4
(L)	Annual energy saved	(J)=(I) x 8760hrs x LLF x 40km		[kWh/40km/year]	192188	232762	277286	325785	378285	434815	495408

(Source: JICA Study Team)

4.1.6. Potential Transmission Lines with LL-ACSR

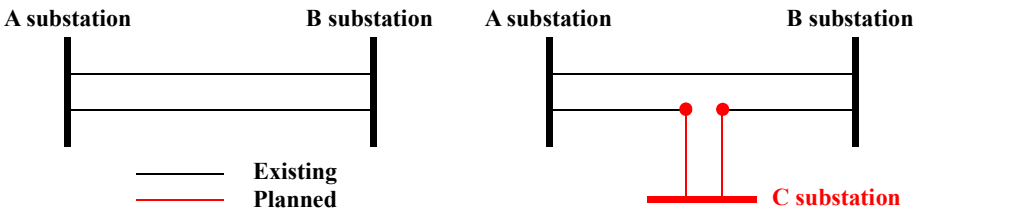
Table 4-10 shows the potential transmission lines with LL-ACSR, and Table 4-11 shows the evaluation results. As shown in Table 4-11, 9 transmission lines are selected as the potential transmission lines with LL-ACSR if the original power flows in the year 2018-19 are applied as the initial power flow. As explained in Section 4.1, it was agreed to use a 25% increased power flow on the transmission lines as the initial power flow in this project. As a result, 12 transmission lines are selected as lines with LL-ACSR in the Project.

Several new transmission lines are connected to existing transmission lines as Line-In-Line-Out (LILO), as shown in Figure 4-3. The Project doesn't apply LL-ACSR to these LILO lines as per the discussion with MPPTCL, because the existing lines use the standard conductors of the conventional ACSRs (Moose, Zebra and Panther), and the line lengths for LILO are short.12 In addition, since it is the first trial for MPPTCL to install LL-ACSRs, MPPTCL will demonstrate the application of LL-ACSR in a 220 kV system as pilot projects, and 132 kV system projects are excluded from the list. As a result, 3 transmission lines (187 km) with a total circuit length of 264 km are selected as the potential transmission lines with LL-ACSR.

Table 4-10 Potential Transmission Lines with LL-ACSR

SN	kV	Subproject No.	From	To	Length [km]	No. of circuits	Description
3	220	2	Indore	Pithanpur	50	2	DCDS
10	220	5	Chhatarpur	Tikamgarh	110	1	DCSS
13	220	7	Rewa UMSP	Rewa (existing)	27	2	DCDS
			Transmission Line Length			187 km	
			Circuit Length			264 km	

(Source: JICA Study Team)



(Source: JICA Study Team)

Figure 4-3 LILO

[12] It is assumed that MPPTCL prioritized maintenance efficiency over economic effect because the proposed LL-ACSR has a different sized steel core diameter from the standard conductor and MPPTCL may prepare a different-sized maintenance tool.

Table 4-11 Evaluation Results of LL-ACSR Application

SN	kV	sub-project No.	From	To	Line Length (km)	No. of cct	Criteria (MW)	Initial MW in 2018-2019		Initial MW × 1.25 in 2018-2019		Description
								MW	LL-ACSR	MW	LL-ACSR	
1	400	1	Cheggaon	Khandwa	5	1	250	411.7	Applicable	514.6	Applicable	DCDS/LILO
2	400	1		Rajgarh (PGCIL)	5	1	250	307.8	Applicable	384.8	Applicable	DCDS/LILO
3	220	2	Indore	Pithanpur	50	2	76	70.5	N/A	88.1	Applicable	DCDS
4	132	2	(Super corridor)	Indore J	13	1	25	30.8	Applicable	38.5	Applicable	DCDS/LILO
5	132	2		Depalpur	13	1	25	16.1	N/A	20.1	N/A	DCDS/LILO
6	220	4	Udaipura	Chichli	-	2	76	24.5	N/A	30.6	N/A	No line work
7	220	5	Chhatarpur	Tikamgarh	110	1	76	65.8	N/A	82.3	Applicable	DCSS
8	220	6	Bina	Bina (existing)	10	1	76	143.8	Applicable	179.8	Applicable	DCDS/LILO
9	220	6		Ganjbasoda	10	1	76	109.6	Applicable	137.0	Applicable	DCDS/LILO
10	220	7	Rewa UMSP	Rewa (existing)	30	2	76	138.6	Applicable	173.3	Applicable	DCDS
11	220	7		Sidhi	60	2	76	73.0	N/A	91.3	Applicable	DCDS
12	132	9	Pati	Julwaniya	40	1	25	14.0	N/A	17.5	N/A	DCSS
13	132	10	Inodre SZ	Magliya	3	2	25	7.0	N/A	8.8	N/A	DCDS/LILO
14	132	11	Shahpura	Julwaniya	65	1	25	11.9	N/A	14.9	N/A	DCSS
15	132	12	Bhirarwar	Datiya	40	1	25	9.6	N/A	12.0	N/A	DCSS
16	132	13	Mahwadiya	Mugaliyachhap	10	1	25	13.0	N/A	16.3	N/A	DCSS
17	132	15	Madwas	Sidhi	50	1	25	13.5	N/A	16.9	N/A	DCSS
18	132	16	Dheemarkheda	Panagar	65	1	25	12.7	N/A	15.9	N/A	DCSS
19	132	17	Orchha	Prithvipur	30	1	25	15.3	N/A	19.1	N/A	DCSS
20	132	18	Atraila	Sirmour	30	1	25	12.4	N/A	15.5	N/A	DCSS
21	132	19	Tendukheda	Udaipura	45	1	25	18.9	N/A	23.6	N/A	DCSS
22	132	20	Gormi	Gohad	25	1	25	18.8	N/A	23.5	N/A	DCSS
23	132	21	Suthaliya	Narsinghgarh	50	1	25	18.9	N/A	23.6	N/A	DCSS
24	132	22	Unchhera	Satna	5	1	25	30.8	Applicable	38.5	Applicable	DCSS/LILO
25	132	22		Kymore	5	1	25	11.8	N/A	14.8	N/A	DCSS/LILO
26	132	23	Sinhawal	Sidhi	50	1	25	19.5	N/A	24.4	N/A	DCDS/LILO
27	132	23		Deosar	50	1	25	0.6	N/A	0.8	N/A	DCDS/LILO
28	132	24	Chachoda	Rajgarh	61	1	25	25.4	Applicable	31.8	Applicable	DCSS
29	132	25	Maneri	Mandla	80	1	25	33.7	Applicable	42.1	Applicable	DCSS

4.1.7. Line Constants and Capacity

Table 4-12 shows the transmission line constants based on the conditions shown in Table 4-5. Because the Project proposes to utilize the existing tower designs for the conventional conductors by replacing the standard ACSR conductors with the equivalent LL-ACSRs, the differences in line constants exclusive of resistance reduction by LL-ACSR are minute. Table 4-13 shows the current carrying capacities under different conditions. Since the aluminum section area of LL-ACSR is larger than that of the equivalent conventional ACSR, the current carrying capacities of LL-ACSR are 5% larger than those for the conventional ones.

Table 4-12 Line Constants

Type		R [ohm/km]	X [ohm/km]	Y [uF/km]
LL-ACSR	**400 kV LL-ACSR 580 Twin**	0.02952	0.31057	0.01186
	220 kV LL-ACSR 490 Single	0.07222	0.39964	0.00911
	132 kV LL-ACSR 240 Single	0.14054	0.39593	0.00920
ACSR	**400 kV ACSR Moose Twin**	0.03337	0.30856	0.01194
	220 kV ACSR Zebra Single	0.08223	0.39575	0.00920
	132 kV ACSR Panther Single	0.16629	0.39223	0.00929

Type		R [pu]	X [pu]	Y [pu]
LL-ACSR	**400 kV LL-ACSR 580 Twin**	0.0000185	0.0001941	0.0059624
	220 kV LL-ACSR 490 Single	0.0001492	0.0008257	0.0013852
	132 kV LL-ACSR 240 Single	0.0008066	0.0022723	0.0005035
ACSR	**400 kV ACSR Moose Twin**	0.0000209	0.0001928	0.0060034
	220 kV ACSR Zebra Single	0.0001699	0.0008177	0.0013994
	132 kV ACSR Panther Single	0.0009544	0.0022511	0.0005085

Note: 100 MVA Base, Resistance at 75°C

(Source: JICA Study Team)

Table 4-13 Current Carrying Capacity

Types - LL-ACSR	Ambient Temp.	Current [A] at Conductor Temp.			Active Power [MW]at Power Factor 95%		
	˚C	65˚C	75˚C	85˚C	65˚C	75˚C	85˚C
400 kV LL-ACSR 580 Twin	**30**	1492	1809	2066	324	393	449
	40	1066	1492	1806	232	324	392
	45	762	1301	1658	166	283	360
	48	494	1171	1562	107	254	339
220 kV LL-ACSR 490 Single	**30**	666	803	915	145	174	199
	40	483	665	802	105	145	174
	45	355	583	737	77	127	160
	48	247	527	695	54	114	151
132 kV LL-ACSR 240 Single	**30**	458	545	616	100	118	134
	40	344	456	542	75	99	118
	45	267	404	501	58	88	109
	48	208	369	474	45	80	103

Types - ACSR	Ambient Temp.	Current [A] at Conductor Temp.			Active Power [MW] at Power Factor 95%		
	˚C	65˚C	75˚C	85˚C	65˚C	75˚C	85˚C
400 kV ACSR Moose Twin	**30**	1415	1722	1971	307	374	428
	40	1001	1416	1721	217	308	374
	45	701	1231	1578	152	267	343
	48	426	1104	1485	93	240	323
220 kV ACSR Zebra Single	**30**	630	762	870	137	165	189
	40	453	629	761	98	137	165
	45	327	550	699	71	119	152
	48	219	496	658	48	108	143
132 kV ACSR Panther Single	**30**	425	507	574	92	110	125
	40	317	424	505	69	92	110
	45	245	375	466	53	81	101
	48	187	342	441	41	74	96

(Source: JICA Study Team)

4.1.8. Requirements for the LL-ACSR Procurement

For introduction of the LL-ACSR, the JICA Study Team proposed the following requirements for procurement to secure the quality and performance of the conductor.

a) The LL-ACSR shall be made up of formed (trapezoidal shaped) aluminum wires, and round zinc-coated extra high strength (1,960 MPa or higher) steel wires or aluminum-clad extra high strength (1,770 MPa or higher) steel wires.
b) Outer diameter & D.C. resistance of the LL-ACSR shall be less than those of the equivalent ACSR conductor.
c) Manufacturing and supply experience for the LL-ACSR shall be at least twenty (20) years.
d) Operation record for the LL-ACSR shall be a minimum of three (3) years.
e) Total supply quantity of the LL-ACSR for the last twenty years shall be a minimum of two thousand (2,000) km in total.

Firstly, the JICA Study Team set the requirements to secure the necessary performance.

The requirements are a) to obtain sufficient electrical loss reduction effect securing tensile strength, keeping outer diameter the same as the conventional ACSR and maximizing the share of the aluminum layer of the total cross sectional area; and b) it is better to specify the target value. Secondly, the JICA Study Team set requirements c) through to e) to secure the quality.

The proposed LL-ACSR uses high tensile strength steel wires as the core and this requires highly-skilled processing. Therefore, at least 20 years' manufacturing & supply experience, considering the long life cycle of the conductor, and a minimum of 3 years' operation record were set as the requirements in order to select well-skilled and richly-experienced manufacturers who can produce LL-ACSR with a stable quality. It's believed that these requirements on the actual achievement contribute to the long-term sound facility operation after the introduction. If the manufacturing & supply experience were set shorter, such as 5 years, it is thought that this would be insufficient to secure the quality because the probability of a problem occurring when a serious defect has developed during manufacturing is low.

Also, in order to select a highly experienced manufacturer, the total supply quantity of the LL-ACSR was set as a minimum of 2,000 km.

4.1.9. Maintenance Tools for the LL-ACSR

The stringing tools MPPTCL owns are for their standard conductors and their performance against the equivalent LL-ACSR has not been verified. Therefore, for the introduction of the LL-ACSR, the JICA Study Team recommends a performance verification of these tools by tensile experiment and so on. In addition, dice for conductor compression joints MPPTCL owns need to be prepared.

4.2. Gas Insulated Switchgear (GIS)

4.2.1. Basics Concept of GIS

Gas Insulated Switchgear is a type of switchgear in which the conductors, circuit breakers, disconnecting switches, earthing switches, current transformer and voltage transformer are all connected and enclosed inside a metal enclosure with SF6 gas as an insulating medium. The advantages of using GIS over AIS are as follows:

- Compactness: The size of the substation layout is dramatically reduced by incorporating GIS.
- Protection against pollution: Since all the conductors in the GIS are enclosed, it is well

protected against pollution, sandstorms and humidity. And it can reduce its operating noise for surrounding areas.

- Higher workers' safety: Since all the energized conductors are enclosed, it offers increased safety for the workers when the patrol and maintenance work.
- Higher seismic and wind resistance.

4.2.2. General Standards Applied for the GIS

The following standards are applied for GIS in general. GIS are manufactured according to the standards that are applicable in the country of manufacture.

- IEC 62271-203: Gas-insulated Metal-enclosed Switchgear for Rated Voltages of 52 kV & above.
- IEC 60694: Common Specifications for High-Voltage Switchgear and Control gear Standards.
- IEC 62271-100: High Voltage Alternative Current Circuit Breakers.
- IEC 62271-102: Alternating Current Disconnectors & Earthing Switches.
- IEC 60044-1: Instrument Transformer, Part-1 : Current Transformer
- IEC 60044-2 : Instrument Transformer, Part-2 : Voltage Transformer
- IEC 62271-209: Cable Connection for Gas-insulated Metal-enclosed Switchgear for Rated Voltages of 72.5kV & above.
- The pressure vessel for the GIS is designed according to the standards applicable in the country of manufacture.

4.2.3. Recommendation for GIS Specification and Procurement Condition

The Study Team proposed the following recommendation as GIS specification and procurement condition aiming to procure high quality product from experienced manufacturers:

a) Leakage rate of SF6 gas is 0.1%/year. Routine test of at least one GIS bay is to be done before dispatch from the factory.

b) The internal maintenance of the gas circuit breaker has to be done without removing or dismantling the gas circuit breaker operating mechanism. Also, the maintenance of the operating mechanism of the gas circuit breaker has to be done with very little or no

modification work on the internal parts of the circuit breaker.

c) Placement of current transformer on both sides of the Gas Circuit Breaker of the GIS for effective isolation of faults occurring between the GCB and the line side current transformer.

d) Separate local control panel from the GIS for higher reliability of the panel.

e) The GIS manufacturers (or parent company) have a long history of supply experience and that a similar class GIS has been in operation for more than 18 years.

f) The GIS manufacturers (or parent company) need to obtain a successful Operational Certificate for more than 18 years for a similar class of GIS from the power system companies.

The details of each items will be explained in the next section. MPPTCL and the JICA Study Team has reached the agreement in the items a)-d), but not agreed in the items e) and f) because MPPTCL express the concerns regarding the fairness for the less-experienced manufacturers.

4.2.4. Explanation for Recommendation for GIS specification.

a) Leakage rate of SF6 gas is 0.1%/year. Routine test of at least one GIS bay is to be done before dispatch from the factory.

The GIS is designed and routinely tested for at least 1 bay such that the gas leakage rate is less than 0.1%/year compared to the standard 0.5%/year as mentioned in the IEC. This is referred to because the SF6 gas enclosed in the GIS is a Greenhouse gas. Though IEC has specified 0.5%/year, if the leakage rate of 0.1%/year can be achieved then the greenhouse effect can be reduced. Also, the total gas filling cycle for the entire life span of the GIS can be reduced. The graph below indicates an example of SF6 gas leakage in Japan. At present, the major international GIS manufacturers has achieved this criteria.

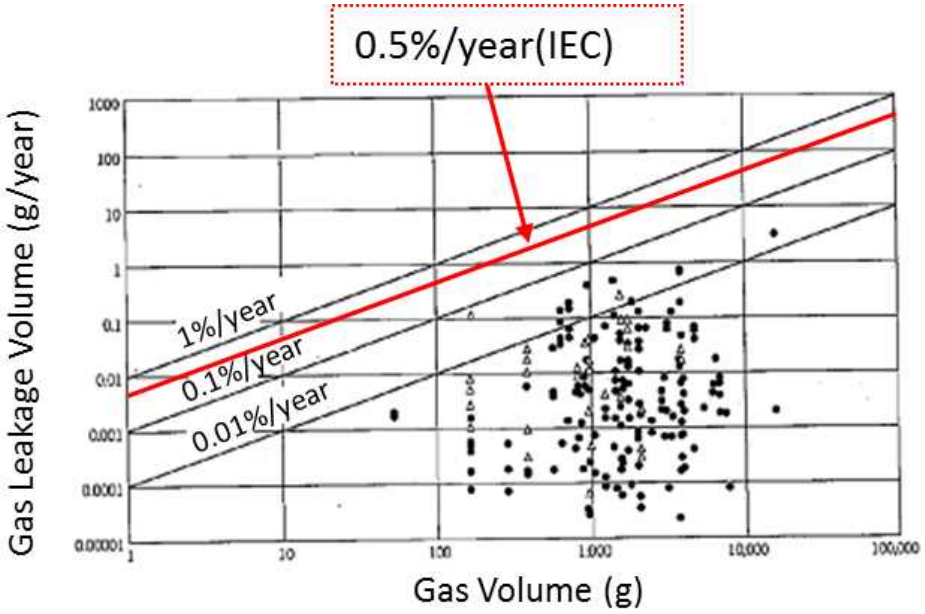


Figure 4-4 Field Data of SF6 Gas Leakage in Japan

b) The internal maintenance of the gas circuit breaker has to be done without removing or dismantling the gas circuit breaker operating mechanism. Also, the maintenance of the operating mechanism of the gas circuit breaker has to be done with very little or no modification work on the internal parts of the circuit breaker.

The circuit breaker operating mechanism box has a high number of moving parts. If the operating mechanism is removed or dismantled at the site (where the proper environmental conditions like a clean room, which is available in factory, are not available), that will affect the settings of the operating mechanism box of the circuit breaker. As the figure below, having the operating mechanism for the gas circuit breaker below the circuit breaker will improve the reliability of the equipment because it can reduce the risk of the contamination of dust during the maintenance work. For 132kV class GIS, this can be achieved by placing the operating mechanism at the bottom of the gas circuit breaker. Generally, 220kV type GIS is a horizontal type GIS, hence the operating mechanism can be easily removed without modifying the internal parts of the GCB. (The figure below is a typical 132kV GIS with bottom operating mechanism)

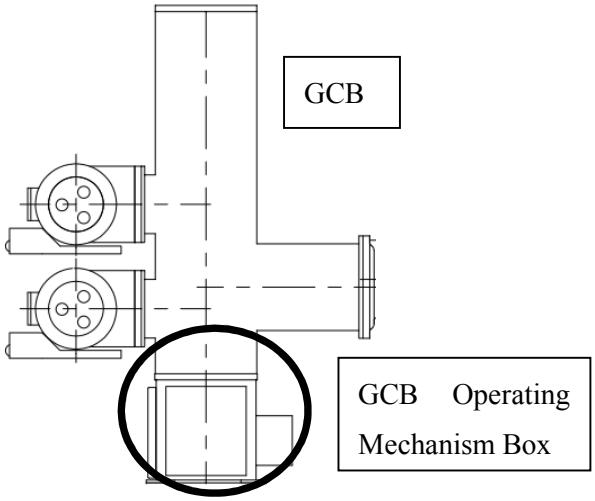


Figure 4-5 Example of Arrangement of GCB and its Operating Mechanism Box

c) Placement of current transformer on both sides of the Gas Circuit Breaker of the GIS for effective isolation of faults occurring between the GCB and the line side current transformer

With the current transformers placed both sides of the circuit breaker, if there is a fault in the GIS at the line side (which is after the circuit breaker and current transformer 2 as shown in the below figure), the line side current transformer will detect the fault rather than bus side current transformer. Since the relay has been set accordingly, the circuit breaker will operate, isolating the fault.

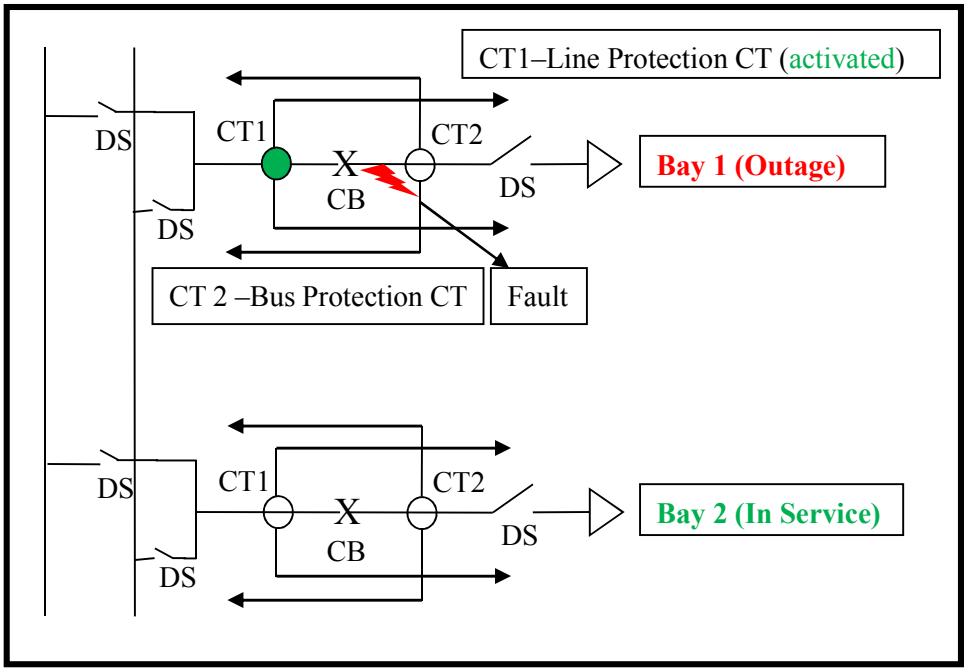


Figure 4-6 Example of Fault Detection (CTs on both Sides of GCB)

In the case that there was no CT before the circuit breaker, the bus bar protection relay would detect the fault and cause the shutdown of the substation.

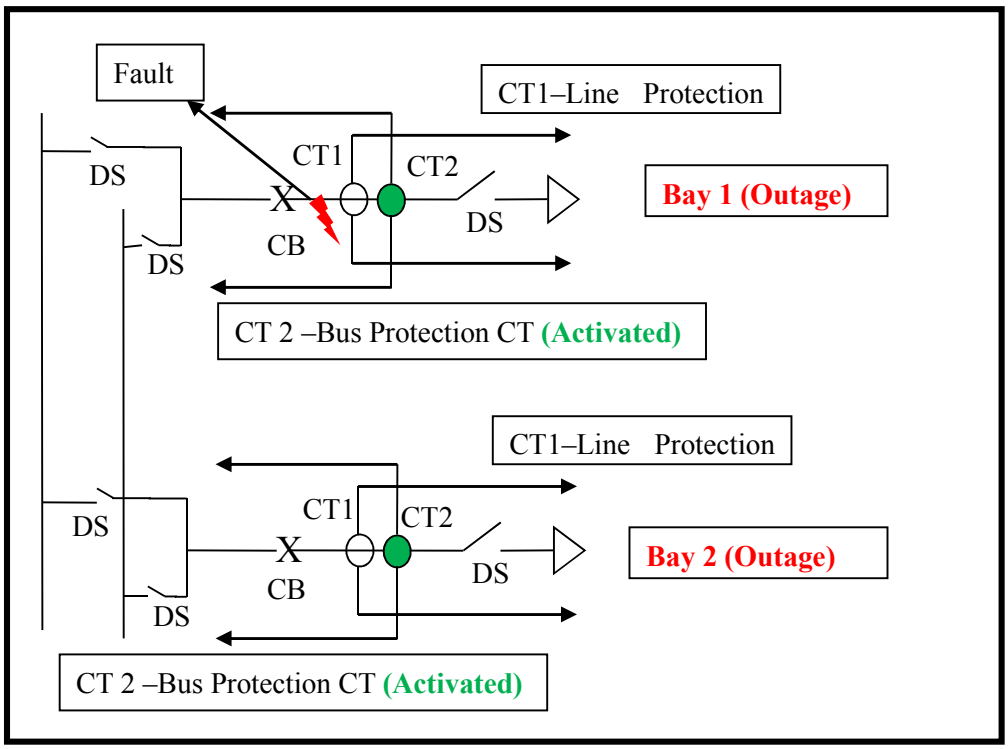


Figure 4-7 Example of Fault Detection (CTs on Busbar Side of GCB)

Thus, having current transformers on both sides of the circuit breaker removes the blind spot which is between the GCB and the line side current transformer. This can reduce the tripping of all the breakers in the substation since the busbar protection current transformer is not activated.

d) Separate local control panel from the GIS for higher reliability of the panel

It is necessary to have separation between the local control panel and the GIS. This ensures that the vibrations from circuit breaker operation will not affect the local control panel, thereby reducing any misoperations in the local control panel.

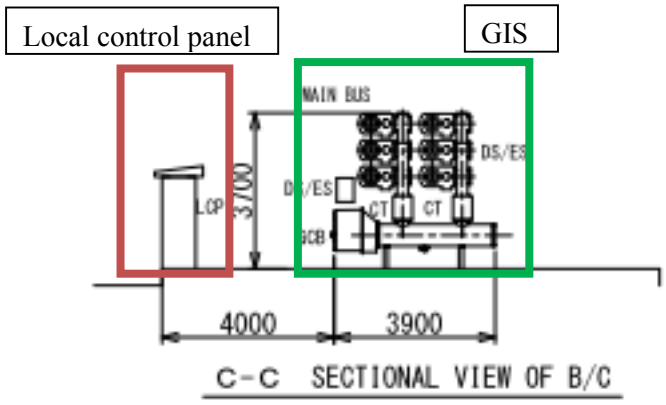


Figure 4-8 Example of Location of Local Control Panel

e) The GIS manufacturers (or parent company) have a long history of supply experience and that a similar class GIS has been in operation for more than 18 years.

If the GIS manufacturers (or Parent Company) have a long history of supply experience of GIS at various sites across the world then this supply history experience would be sufficient for their subsidiaries to participate in the tender. This is because the design, quality procedure and manufacturing procedure of the parent company would be completely transferred to its subsidiaries. However, the parent company should have a long history of supply experience and their GIS has to be in operation for more than 18 years (generally the period for internal maintenance of the circuit breaker) with proper maintenance.

f) The GIS manufacturers (or parent company) need to obtain a successful Operational Certificate for more than 18 years for a similar class of GIS from the power system companies.

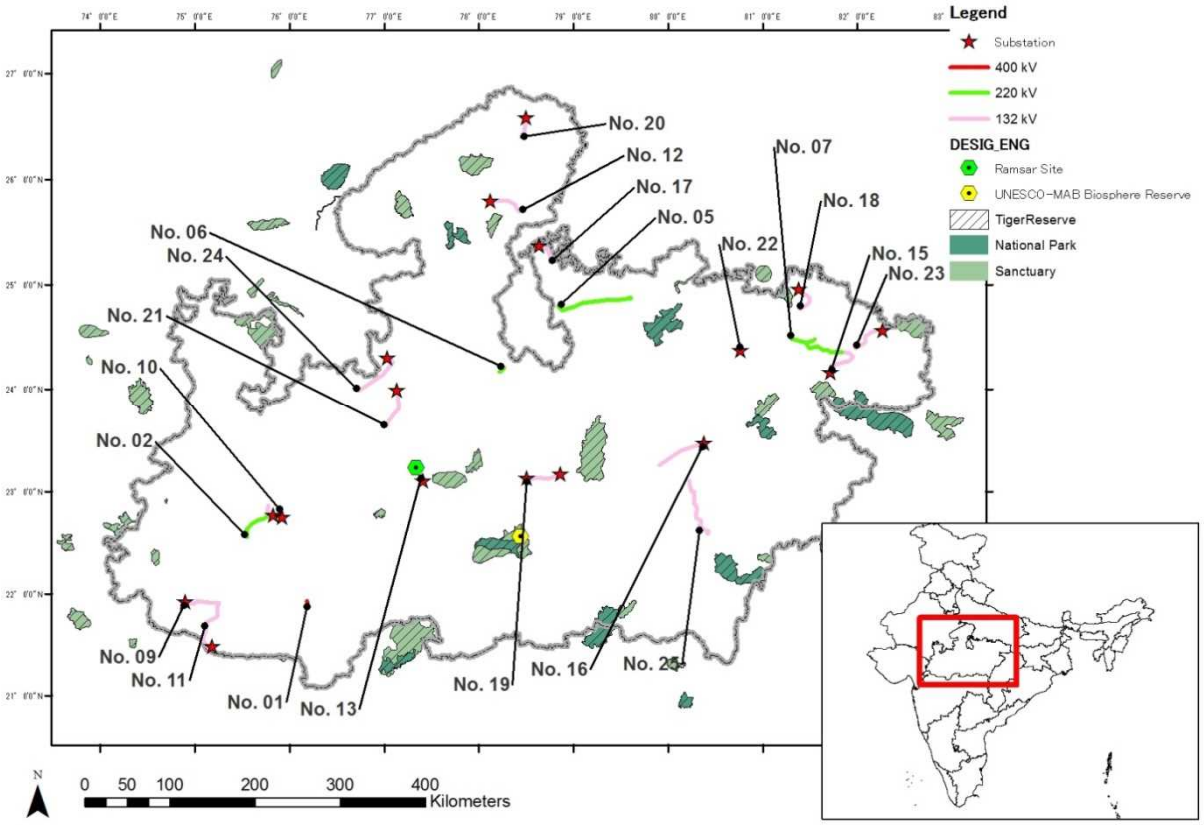
Chapter 5. Environmental and Social Considerations

5.1. Documents related to Environmental and Social Considerations

Substation and Transmission projects in India do not require an Environmental Impact Assessment (EIA) or Initial Environmental Examinations (IEE) according to the Environmental Impact Assessment Notification, 2006 and further amendments in Jan 2009, Dec 2009, Apr 2011, and Jan 2012. However, in order to fulfill the requirement in JICA GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS (2010), MPPTCL prepared a draft IEE (Appendix 1) and Screening form (Appendix 2). The IEE is still at the draft stage in September 2015. It will be finalized later. In addition to this, the JICA study team prepared a Checklist (see Appendix 3).

5.2. Impact on Protected Areas

MPPTCL excluded some sub-projects in order to avoid possible impacts on protected areas. In the end, all the sub-projects were located outside of protected areas such as National Parks and Sanctuaries (see Figure 5-1). Some states in India stipulate Buffer Zones or Eco-Sensitive areas of 10 km around the National Parks or Sanctuaries, but Madhya Pradesh state does not stipulate such areas. Therefore, no direct impact is expected from any of the sub-projects.



(Source: JICA Study Team)

Figure 5-1 Protected Areas and Project Locations

5.3. Impact on Protected Species

Based on the International Union for Conservation of Nature (IUCN) there are 1,333 red list species (higher than Least Concern) in India and disclosed habitats of 46 species are covered in Madhya Pradesh state (see Table 5-3). Examining distribution areas and project locations shows that 16 to 27 species have their habitats in sub-project sites. For three relatively limited habitat species (Lindsaea malabarica, Panthera tigris, Panthera pardus), Sub-projects No. 5, No.12, No.13, No.15, No.18, No.19, No.22, and No.25 are in the known habitats or possible Tiger corridors. These sub-projects might affect the habitats directly or indirectly. When the important corridors are fragmented by the project, the regional extinction risk will be increased by decreasing gene biodiversity. When hunting areas are decreased, the regional extinction risk will be increased by difficulty of maintaining the number of individuals. When human habitat expands near to the habitat of the protected species, the conflict risk between people and wildlife will be increased.

When the right of ways make the access to the habitat easier, poaching risk will be increased. In order to minimize the impact on Tiger population, the transmission routes should be selected after intensive discussion not only with Forest Department but also Wildlife Department. The height of the towers, height of the vegetation in the right of way, management of the vegetation in the right of way, access rules of the people, and poaching controls had better be examined carefully. Not only the Tiger but also biological survey for other protected species is also recommended before route selection.

Table 5-1 The IUCN Red List Species for Which Known Habitats Are in Madhya Pradesh

	Scientific Name	Common Name	IUCN Red List category*
Plants	Ammannia nagpurensis		EN
	Lindsaea malabarica		NT
	Utricularia praeterita		NT
Mammals	Cuon alpinus	Indian Wild Dog	EN
	Hipposideros durgadasi	Durga Das's Leaf-nosed Bat	EN
	Manis crassicaudata	Indian Pangolin	EN
	Panthera tigris	Tiger	EN
	Bos gaurus	Indian Bison	VU
	Lutrogale perspicillata	Indian Smooth-coated Otter	VU
	Melursus ursinus	Sloth Bear	VU
	Prionailurus rubiginosus	Rusty-spotted Cat	VU
	Rucervus duvaucelii	Barasingha, Swamp Deer	VU
	Rusa unicolor	Sambar Deer	VU
	Tetracerus quadricornis	Four-horned Antelope	VU
	Antilope cervicapra	Blackbuck	NT
	Hyaena hyaena	Striped Hyena	NT
	Panthera pardus	Leopard	NT
Reptiles	Gavialis gangeticus	Indian Gharial	CR
	Crocodylus palustris	Mugger	VU
Turtles	Batagur dhongoka	Three-striped Roofed Turtle	EN
	Chitra indica	Indian Narrow-headed Softshell Turtle	EN
	Batagur kachuga	Bengal Roof Turtle	CR

	Scientific Name	Common Name	IUCN Red List category*
	Nilssonia gangetica	Indian Softshell Turtle	VU
	Hardella thurjii	Crowned River Turtle	VU
	Geoclemys hamiltonii	Black Pond Turtle	VU
	Nilssonia hurum	Indian Peacock Softshell Turtle	VU
	Nilssonia leithii	Leith's Softshell Turtle	VU
Anura	Philautus sanctisilvaticus	Sacred Grove Bushfrog	CR
Fish	Tor khudree	Black Mahseer	EN
	Thynnichthys sandkhol	Sandkhol Carp	EN
	Silonia children		EN
	Clarias magur	Wagur	EN
	Amblyceps arunchalensis		EN
	Ailia coila	Gangetic ailia	NT
	Anguilla bengalensis	Indian Mottled Eel	NT
	Anguilla bicolor	Shortfin Eel	NT
	Bagarius bagarius		NT
	Bagarius yarrelli		NT
	Chitala chitala		NT
	Labeo pangusia	Pangusia labeo	NT
	Microphis deocata		NT
	Ompok bimaculatus		NT
	Ompok pabo		NT
	Parambassis lala	Highfin Glassy Perchlet	NT
	Wallago attu		NT
Odonata	Indothemis carnatica		NT

*: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT)

(Source: IUCN)

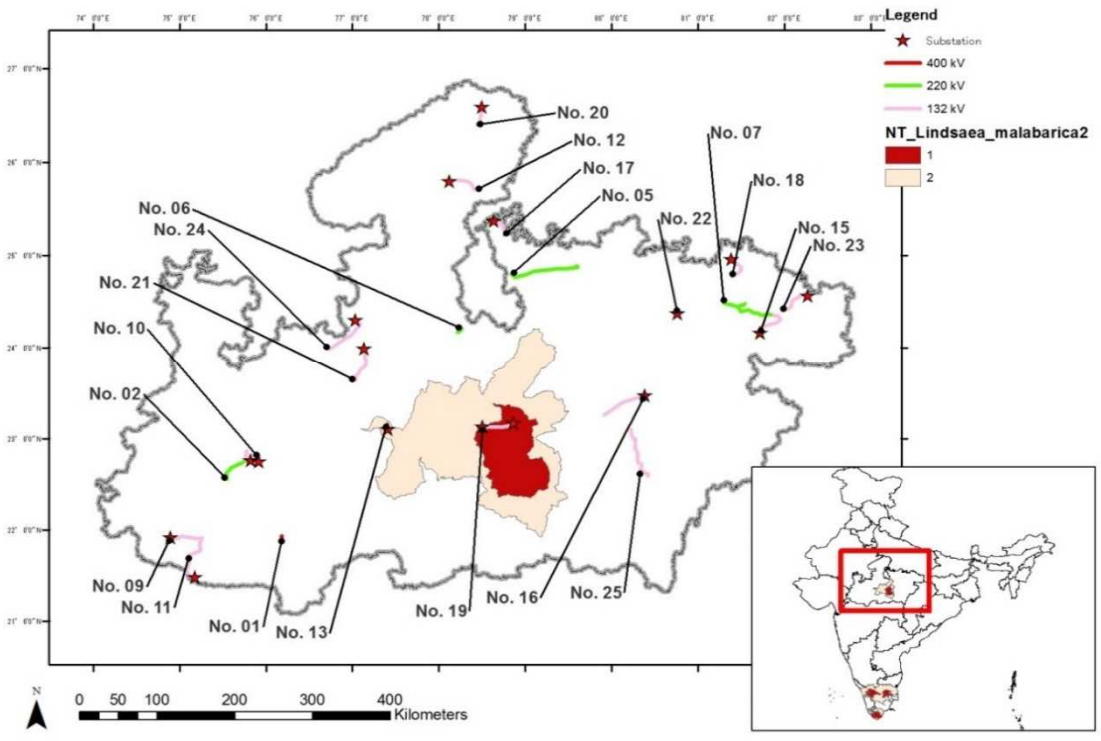
Table 5-2 Possible Affected IUCN Red List Species Which Have Limited Habitats

Project No	Project Name	Lindsaea malabarica	Panthera tigris (Tiger)	Panthera pardus (Leopard)
1	LILO of one circuit of 400kV Khandwa - Rajgarh PGCIL line at Chhegaon 400kV Substation (D/C)	-	-	-
	400kV Bus Reactor at Chhegaon 400kV S/S	-	-	-
2	Pithampur 400-Super Corridor 220kV DCDS line	-	-	-
	LILO of One ckt of Indore (Jetpura) - Depalpur 132kV DCDS Line at Super Corridor (Indore) 220kV S/s. (D/C)	-	-	-
4	Charging/Upgradation of Chichli 220 - Udaipura DCDS line on 220kV level	-	-	-
5	Chhatarpur-Tikamgarh 220kV DCSS line	-	-	Extant
6	400/220kV Additional Transformer at Bina 400kV S/S	-	-	-
	LILO of Bina 220 - Ganjbasoda 220kV line at Bina (MPPTCL) 400kV S/s	-	-	-
7	Rewa 220 - Sidhi 220kV DCDS line through Rewa UMSP	-	-	-
9	Julwania 400 - Pati (Silawad) 132kV DCSS Line	-	-	-
10	LILO of Mangliya - IndoreSZ 132kV line at Mahalaxmi	-	-	-
11	Julwania 400 - Shahpura 132kV DCSS Line	-	-	-
12	Datia 220 - Bhitarwar 132kV DCSS Line	-	-	Extant
13	MugaliaChhap 220 - Mahwadia 132kV DCDS Line	Probably Extant	-	-
15	Sidhi 220 - Madwas 132kV DCSS Line	-	Near*	Extant
16	Panagar 220 - Dheemarkheda 132kV DCSS Line	-	Near*	-
17	Prithivipur-Orchha 132kV DCSS Line	-	-	-
18	Sirmour 220 - Atraila 132kV DCSS line	-	Near*	-
19	Udaipura - Tendukheda 132kV DCSS line	Extant	-	-

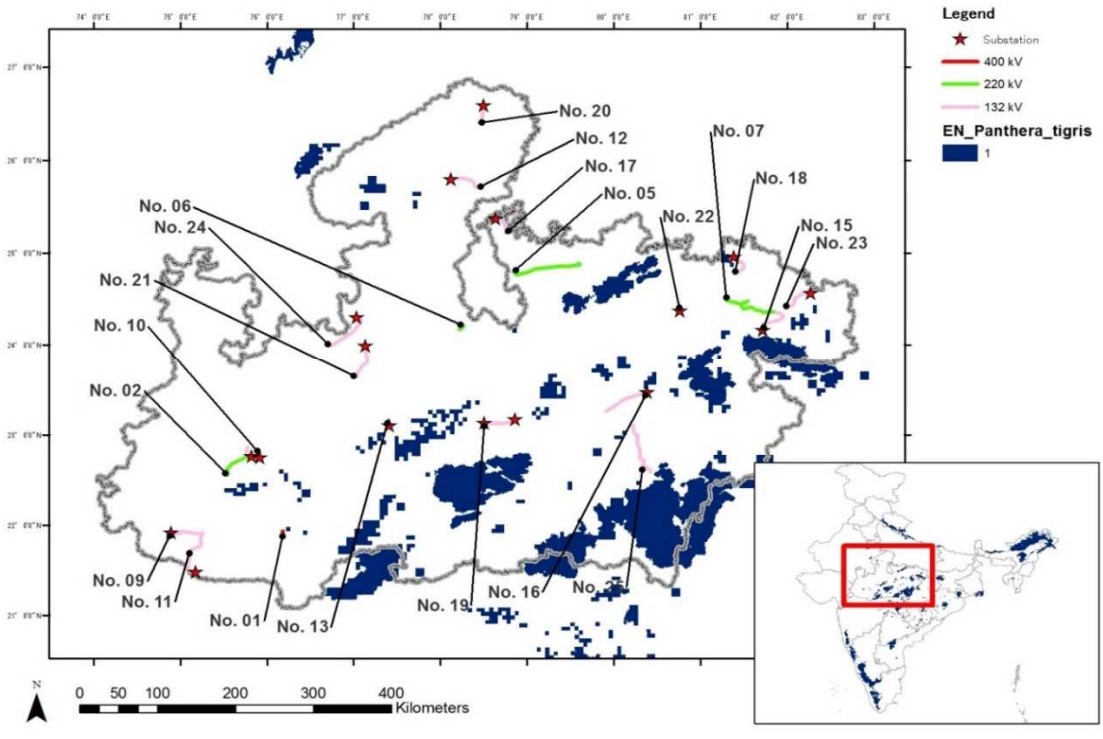
20	Gohad - Gormi 132kV DCSS line	-	-	-
21	Narsinghgarh - Suthaliya 132kV DCSS line	-	-	-
22	LILO of Satna 220 - Kymore 132kV line at Unchhera 132kV S/s	-	-	Extant
23	LILO of one ckt of Sidhi 220 - Deosar 132kV line at Sinhawal 132kV S/s	-	-	-
24	2nd ckt of Rajgarh(B) - Raghogarh 132kV DCSS line up to Chachoda 132kV S/s	-	-	-
25	Maneri - Mandla 132kV DCSS line	-	Near*	Extant

*: Estimated by JICA Study Team

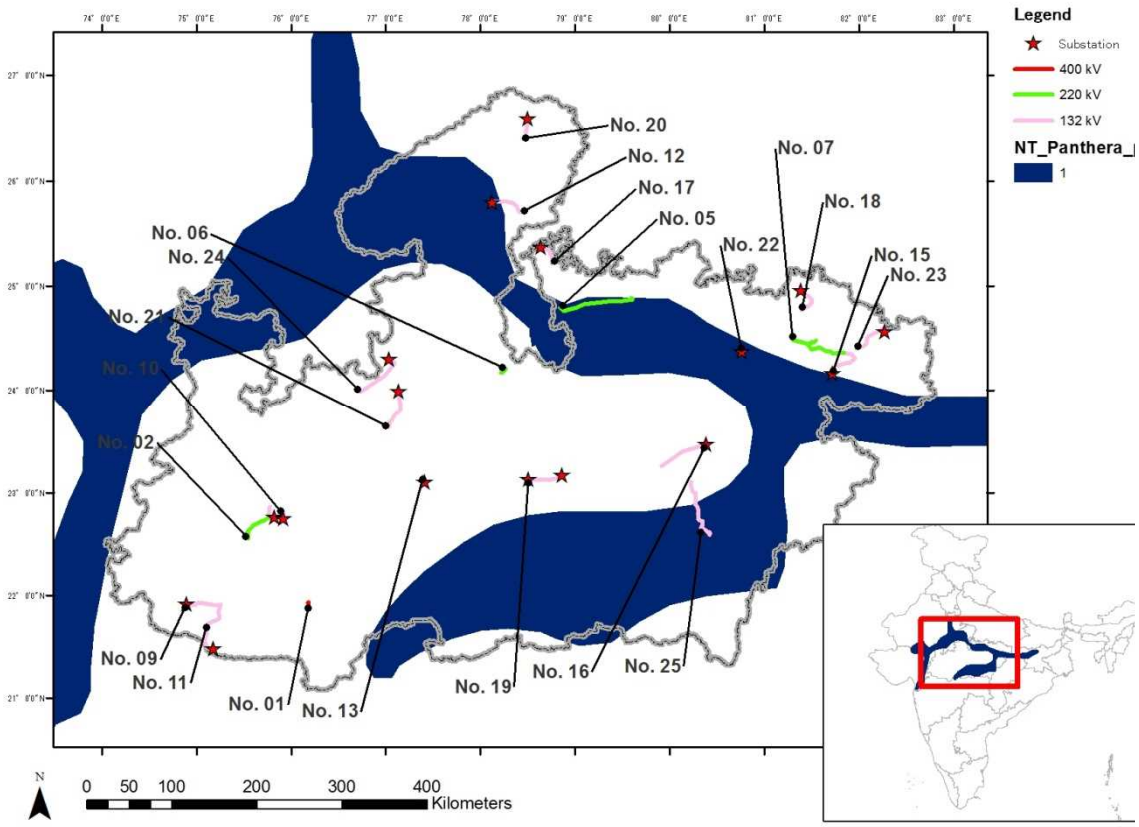
(Source: JICA Study Team)



(a) Distribution of Habitats of Lindsaea Malabarica



(b) Distribution of Habitats of Panthera Tigris



1: Extant 2: Probably Extant

(c) Distribution of Habitats of Panthera Pardus

(Source: IUCN)

Figure 5-2 Distribution of Habitats of the Possible Affected IUCN Red List Species

5.4. Impact on Forest

Original plans were located in the forest areas, but in order to avoid the impact on forests, MPPTCL backed away from some of the sub-projects and changed the T/L routes and SS locations. The route maps from September 2015 show the remaining forest impact, which is 24.2 km. 67.7 ha of forest will be affected by 9 sub-projects. Forest clearance will be required because the trees under the ROW should be cleared. According to the Online Submission & Monitoring of Environmental, Forests and Wild Life Clearance User Manual (2015) the review agents for the forest clearance will change based on the affected area, such as National level reviews for 40 ha and more, State level reviews for under 40 ha and simple reviewing procedures for under 5 ha.

Table 5-3 Forest Area Affected by Subprojects

No	Project Name	T/L length [km]	RoW [ha]
7	Rewa 220 – Sidhi 220kV DCDS line through Rewa UMSP	3.0	10.5
9	Julwania 400 – Pati (Silawad) 132kV DCSS Line	0.5	1.4
11	Julwania 400 – Shahpura 132kV DCSS Line	6.0	16.2
13	MugaliaChhap 220 - Mahwadia 132kV DCDS Line	1.5	4.1
15	Sidhi 220 - Madwas 132kV DCSS Line	0.2	0.5
17	Prithivipur-Orchha 132kV DCSS Line	2.0	5.4
18	Sirmour 220 - Atraila 132kV DCSS line	1.0	2.7
23	Sidhi 220 - Sinhawal 132kV DCSS line	1.0	2.7
25	Maneri - Mandla 132kV DCSS line	9.0	24.3
	Total	24.2	67.7

(Source: MPPTCL)

Affected forest area will be examined by Forest Department and compensation cost to planting trees will be estimated. The proponent will pay for the cost and Forest Department will plant the trees at the adequate places.

5.5. Resettlement

The final T/L routes are not fixed as of September 2015, so the impact on resettlements cannot be confirmed. However, MPPTCL has already selected routes to avoid resettlement so far and illegal settlers are planned to be avoided, so the possibility of a huge number of resettlements seems to be very low. The actual situation should be monitored during the implementation stage.

5.6. Land Acquisition

Based on the Indian Electricity Act (2003), land for substations should be acquired, but the land for Transmission lines, including towers and ROW, does not need to be acquired by project proponents. MPPTCL has planned to select government land for substations, so land acquisition for substations will not happen. Therefore, no land acquisition is expected.

5.7. Impact on Land Use

According to the Indian Electricity Act (2003), the land for T/L towers and under the ROW cannot be used during construction but it can be used as agricultural land during operation. Land use for construction of buildings over 4m and settlements will be prohibited during operation. MPPTCL

will pay crop compensation for reduced income during construction based on the Indian Electricity Act (2003). The estimated compensation cost would be around INR 183,497,000.

Table 5-4 Estimated Crop Compensation Cost during Construction

No.	Name	Length [km]	ROW [ha]	Unit Cost*1 [INR/ha]	Cost As per Estimate [INR]
1	LILO of one circuit of 400kV Khandwa - Rajgarh PGCIL line at Chhegaon 400kV Substation (D/C) 400kV Bus Reactor at Chhegaon 400kV S/S	5.0	26.0	40,192	1,045,000
2	Pithampur 400-Super Corridor 220kV DCDS line LILO of One ckt of Indore (Jetpura) - Depalpur 132kV DCDS Line at Super Corridor (Indore) 220kV S/s. (D/C)	63.0	210.1	60,995	12,815,000
5	Chhatarpur-Tikamgarh 220kV DCSS line	110.0	385.0	56,000	21,560,000
6	400/220kV Additional Transformer at Bina 400kV S/S LILO of Bina 220 - Ganjbasoda 220kV line at Bina (MPPTCL) 400kV S/s	10.0	35.0	64,429	2,255,000
7	Rewa 220 - Sidhi 220kV DCDS line through Rewa UMSP	90.0	315.0	58,342	18,378,000
9	Julwania 400 - Pati (Silawad) 132kV DCSS Line	40.0	108.0	72,199	7,798,000
10	LILO of Mangliya 220 –Indore 132kV Line at Mahalaxmi	3.0	8.1	74,691	605,000
11	Julwania 400 - Shahpura 132kV DCSS Line	65.0	175.5	78,374	13,755,000
12	Datia 220 - Bhitarwar 132kV DCSS Line	40.0	108.0	72,315	7,810,000
13	MugaliaChhap 220 - Mahwadia 132kV DCDS Line	10.0	27.0	83,878	2,265,000
15	Sidhi 220 - Madwas 132kV DCSS Line	50.0	135.0	73,219	9,885,000
16	Panagar 220 - Dheemarkheda 132kV DCSS Line	65.0	175.5	72,707	12,760,000
17	Prithivipur-Orchha 132kV DCSS Line	30.0	81.0	83,664	6,777,000
18	Sirmour 220 - Atraila 132kV DCSS line	35.0	94.5	74,292	7,021,000
19	Udaipura - Tendukheda 132kV DCSS line	45.0	121.5	71,523	8,690,000
20	Gohad - Gormi 132kV DCSS line	25.0	67.5	74,963	5,060,000
21	Narsinghgarh - Suthaliya 132kV DCSS line	50.0	135.0	72,111	9,735,000
22	LILO of Satna 220 - Kymore 132kV line at Unchhera 132kV S/s	5.0	13.5	89,630	1,210,000
23	Sidhi 220 - Sinhawal 132kV DCSS line 132kV	50.0	135.0	74,414	10,046,000
24	2nd ckt of Rajgarh (B) - Raghogarh 132kV DCSS line up to Chachoda 132kV S/s	61.0	164.7	40,540	6,677,000
25	Maneri - Mandla 132kV DCSS line	80.0	216.0	80,334	17,353,000
Total		932.0	2,736.9	1,468,810	183,497,000

Note *1: Unit Cost is calculated based on Cost as per estimate from MPPTCL.

(Source: MPPTCL)

Initial Environmental Examinations

for

Madhya Pradesh Power Sector Transmission Project

[Draft version]

October 2015

Madhya Pradesh Power Transmission Company Limited

[This document is prepared only for JICA's contact mission. This document is not officially required for the Government of India based on The Environmental Impact Assessment Notification, 2006 and further amendments in Jan 2009, Dec 2009, Apr 2011, and Jan 2012.]

CONTRIBUTORS

No.	Full name	Title	Signature
1	S. P. Gupta	Chief Engineer (Procurement)	

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ACRONYMS

AIS	:	Air Insulated Substation
AP	:	Affected People
BOD	:	Biochemical oxygen demand
EIA	:	Environmental Impact Assessment
EMP	:	Environment management plan
GIS	:	Gas Insulated Substation
GOI	:	Government of India
HHs	:	Households
IEE	:	Initial Environmental Examination
IPP	:	Independent Power Producer
IUCN	:	The International Union for Conservation of Nature
JICA	:	Japan International Cooperation Agency
MPPTCL	:	Madhya Pradesh Power Transmission Corporation Limited
PMU	:	Project Management Unit
ROW	:	Right-of-Way
SF6	:	Sulfur hexafluoride
SIA	:	Social Impact Assessment
SS	:	Substation
TML	:	Transmission line

1 General Introduction

Madhya Pradesh, with an area of 308,000 sq.km is the second largest state in India after Rajasthan. It is part of the peninsular plateau of India, lying in the north central part, whose boundary can be classified in the north by the plains of Ganga-Yamuna, in the west by the Aravali, in the east by the Chhattisgarh plain and in the south by the Tapti valley and the plateau of Maharashtra.

About 80% of the population earns income from agriculture. Recent rapid development of Value Adding Industries utilizing rich mineral resources (17% of India's total), teak wood and bamboo etc. from vast forests of about 7.9 million hectares, points to additional bulk power demand. For the sustainable development of the state of Madhya Pradesh, an electricity power supply gap of 1,344MW (2011) and T&D loss of 43% (2011) will be the urgent issues.

To cope with the increasing demand for electricity in Madhya Pradesh state, Madhya Pradesh Power Transmission Corporation Limited (MPPTCL) prepared a Detailed Project Report (DPR) for the Madhya Pradesh Power Sector Transmission Project for expected financial cooperation from the Japanese government, concerning transmission system development with new technologies like Low electrical power Loss Conductor (LLC), High Temperature Low Sag (HTLS), or Gas Insulated Switchgear (GIS), to stabilize and reduce losses in the power transmission system. Further refinement is needed for the project.

1.1 Objectives of The Initial Environmental Examination

MPPTCL has proposed the following 33 subprojects in the DPR. As per EIA notification 2006, Environmental clearance is not necessary for a transmission project. An IEE is prepared to learn whether there are any Environmental Impacts caused by the subprojects in consideration of JICA GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS (2010).

The objective of the IEE report for the Project is to determine and assess preliminarily potential impacts on the environment, propose suitable mitigation measures against negative impacts, and prepare the environment monitoring system.

1.2 IEE Study Implementation Arrangement

The Construction Department of MPPTCL has prepared the IEE based on literature survey and desk study. Neither physical environmental site survey nor biological site survey is conducted.

2 Policy and Legal Framework

2.1 Indian Laws

Environmental Impact Assessment Notification 2006 stipulates the projects which require Environmental Clearance based on a reviewed Environmental Impact Assessment Report. According to the Notification, transmission line projects and substation projects do not require Environmental Clearance or an Environmental Impact Assessment Report. Land acquisition for substations has to follow Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. If the projects fall in forest areas, MPPTCL has to follow the Indian Forest Act for the compensation. The following are the major Acts and Notifications relevant to the Project.

- The Environment (Protection) Act, 1986, amended 1991
- The Environmental Impact Assessment Notification, 2006 and further amendments in Jan 2009, Dec 2009, Apr 2011, and Jan 2012
- The Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003
- The Air (Prevention and Control of Pollution) Act 1981, amended 1987
- Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013
- Indian Forest Act, 1927
- Scheduled Castes and Scheduled Tribes (Prevention of Atrocities Act), 1989
- The National Green Tribunal Act, 2010
- S.O No. 1035 (E), [12/05/2011] - E-waste Management and Handling Rules 2011

The workflow for Forest Clearance Process

(1) User Agency can register to get the login credentials from http://efclearance.nic.in. Thereafter, project details can be submitted along with all required documents [Form-A (Part-I)/Form-B (Part-I)/Form-C (Part-I) etc.]. When U.A. submits all these details, an acknowledgement letter would be sent (by System) to email-id of (Applicant) User Agency. Acknowledgement letter may contain some information including unique proposal number. U.A. may refer this unique proposal number for future reference.

(2) Nodal Officer scrutinizes the proposal (within 10 days) and sends an acceptance letter to User Agency, if all relevant documents are uploaded properly by U.A. If any document is missing or any other information is needed, Nodal Officer may ask U.A. to upload those missing information. Timeline will start only if Nodal officer accepts the proposal.

(3) When, Nodal Officer sends the acceptance letter to U.A., proposal details are forwarded automatically to concerned

DFOs and DCs for their necessary action.

(4) DFO can view the proposal after logging in to portal and can take print out (if needed) of the entire details and then process it. After that, he/she uploads the part-II of Form-A/Form-B/Form-C on the portal along with his/her recommendation and Site Inspection report.

(5) When, DFO uploads his/her recommendation and Site Inspection Reports on the portal, proposal details are forwarded automatically to concerned CF/CCF for the necessary action.

(6) District Collector (DC) can view the proposal after logging in to portal. He/she has to upload FRA document (that must include Forest rights settlement details) on the portal. and can take print out (if needed) of the entire details and then process it. After that, he/she uploads the part-III of Form-A on the portal along with his/her recommendation and Site Inspection report (if site inspection done).

(7) When, CF/CCF uploads his/her recommendation and Site Inspection Reports on the portal, proposal details are forwarded automatically to concerned Nodal Officer for the necessary action.

(8) Nodal Officer can view the proposal and recommendations of DFO and CF/CCF after logging in to portal and can take print out (if needed) of the entire details and then process it. After that, he/she uploads the part-IV of Form-A on the portal along with his/her recommendation and Site Inspection report (if site inspection done).

(9) When, Nodal Officer uploads his/her recommendation and Site InspectionReports on the portal, proposal details are forwarded automatically to concerned State Secretary for the necessary action.

(10) State Secretary can view the proposal and recommendations of DFO, CF/CCF and Nodal Officer after logging in to portal and can take print out (if needed) of the entire details and then process it. After that, he/she uploads the part-V of Form-A on the portal along with his/her recommendation.

(11) When, State Secretary uploads his/her recommendation on the portal, proposal details are forwarded automatically to concerned Regional Office or Head Office, Delhi as per the flow defined in the system.

Source (OSMEFWC User Mannual Version 1)

2.2 JICA Guidelines

JICA GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS (2010) provides JICA's policy and requirements. Appendix 3 of the JICA guidelines shows sensitive projects and "Power transmission and distribution lines involving large-scale involuntary resettlement, large-scale logging, or submarine electrical cables" is listed in Appendix 3. The Project might not cause large-scale involuntary resettlement (it has not been confirmed by site survey) or large-scale logging (Forest area would be around 69.9 ha). Therefore, it might be categorized as B.

3 Project Description

MPPTCL has proposed the following 33 subprojects in the DPR, as shown in Table 3-1.

Table 3-1 List of 33 sub-projects

No.	Project description
1	LILO of one circuit of 400kV Khandwa - Rajgarh PGCIL line at Chhegaon 400kV Substation (D/C) 400kV Bus Reactor at Chhegaon 400kV S/S
2	Pithampur400-Super Corridor 220kV DCDS line LILO of One ckt of Indore (Jetpura) - Depalpur 132kV DCDS Line at Super Corridor (Indore) 220kV S/s.(D/C)
4	Charging/Upgradation of Chichli 220 - Udaipura DCDS line on 220kV level
5	Chhatarpur-Tikamgarh 220kV DCSS line
6	400/220kV Additional Transformer at Bina 400kV S/S LILO of Bina220 - Ganjbasoda 220kV line at Bina (MPPTCL) 400kV S/s
7	Rewa220 - Sidhi 220kV DCDS line through Rewa UMSP
9	Julwania400 - Pati (Silawad) 132kV DCSS Line
10	LILO of Mangliya 220 –Indore 132kV Line at Mahalaxmi
11	Julwania400 - Shahpura 132kV DCSS Line
12	Datia220 - Bhitarwar 132kV DCSS Line
13	MugaliaChhap 220 - Mahwadia 132kV DCDS Line
15	Sidhi 220 - Madwas 132kV DCSS Line
16	Panagar 220 - Dheemarkheda 132kV DCSS Line
17	Prithivipur-Orchha 132kV DCSS Line
18	Sirmour220 - Atraila 132kV DCSS line
19	Udaipura - Tendukheda 132kV DCSS line
20	Gohad - Gormi 132kV DCSS line
21	Narsinghgarh - Suthaliya 132kV DCSS line
22	LILO of Satna 220 - Kymore 132kV line at Unchhera 132kV S/s
23	Sidhi 220 - Sinhawal 132kV DCSS line 132kV
24	2nd ckt of Rajgarh(B) - Raghogarh 132kV DCSS line up to Chachoda 132kV S/s
25	Maneri - Mandla 132kV DCSS line
26	Sukha (Jabalpur)
27	Hoshangabad 220kV (2nd)
28	Barwaha 220kV (3rd)
29	Betma 132kV
30	Khirkiya 132kV
31	Amla 132kV
32	Tejgarh 132kV
33	Satwas 132kV
34	Sitamau 132kV
35	Baroda 132kV
36	Amrawadkhurd 132kV

(Source: DPR)

3.1 Background

In India, national energy consumption has continued to grow due to recent annual economic growth of over 8%, becoming the 4th largest in the world at the end of 2012. Supply has not kept up with the demand growth, with an 8.7% shortage in energy and 9.0% shortage in capacity, and a high national transmission and distribution (T&D) loss of 23.7% (2011) has also been an urgent issue.

To counter these problems, in energy sector reforms after the New Electricity Act was introduced in the 12th Five year Plan (2012-2017), new power developments will be focused exclusively on supercritical technology after the 13th Five year Plan (2018-2023) and T&D reinforcement and rural electrification will also be critical domestic issues.

Located in the central part of India, the State of Madhya Pradesh has the 2nd largest surface area in India and the 6th largest population, of 73 million. The state constitutes part of the Delhi-Mumbai Industrial Corridor, which is a mega-infrastructure project initiated by India and Japan, and has plans for industrial development in the future, including the development of a Special Economic Zone near Indore airport, a distribution center near Dewas and the industrial area of Pithampur. To achieve sustainable development in the state of Madhya Pradesh, a stable electricity power supply will be the urgent issue, but a power supply deficit of 455MW (2016-17, plan) is forecasted. In addition, the T&D loss of 27% (2014-15) should be reduced in the future. To strengthen the power system, the Japan International Cooperation Agency (JICA) provided a loan for the transmission project phase I in 2012. Since the phase I project was implemented successfully, JICA is now considering a phase II loan, which will include additional new technologies in transmission and substation equipment, to improve the power system further.

3.2 Project's Objectives

To cope with the increasing demand for electricity in Madhya Pradesh state, Madhya Pradesh Power Transmission Company Limited (MPPTCL) prepared a Detailed Project Report (DPR) for Transmission System Strengthening Works in Madhya Pradesh for expected financial cooperation from the Japanese government, concerning transmission system development with new technologies like Low Loss type ACSR (LL-ACSR) conductor, High Temperature Low Sag (HTLS) conductor, or Gas Insulated Switchgear (GIS), to stabilize and reduce losses in the power transmission system. Further refinement is needed for the project.

3.3 Project Location

MPPTCL has proposed the 33 subprojects in the DPR shown in Table 3-1. 21 of them contain construction of new transmission lines and 16 of them contain construction of new Sub-stations. 11 projects, No. 26 to No.36, are installing additional transformers, which are planned for the existing sub-stations. These projects will not require any new land or resettlement. Therefore, this IEE is mainly focused on the remaining 22 projects.

Table 3-2 List of 33 sub-projects

No.	Project description	TML (km)			Substation		Additional Transformer
		400 kV	220 kV	132 kV	Name	Required Area (ha)	
1	LILO of one circuit of 400kV Khandwa - Rajgarh PGCIL line at Chhegaon 400kV Substation (D/C) 400kV Bus Reactor at Chhegaon 400kV S/S	5	-	-	-	-	1x125 MVAR
2	Pithampur400-Super Corridor 220kV DCDS line LILO of One ckt of Indore (Jetpura) - Depalpur 132kV DCDS Line at Super Corridor (Indore) 220kV S/s.(D/C)	-	50	13	Super Corridor (Indore)	3.27	
4	Charging/Upgradation of Chichli 220 - Udaipura DCDS line on 220kV level	-			Udaipura	-	
5	Chhatarpur-Tikamgarh 220kV DCSS line	-	110		-	-	
6	400/220kV Additional Transformer at Bina 400kV S/S LILO of Bina 220 - Ganjbasoda 220kV line at Bina (MPPTCL) 400kV S/s	-	10		-	-	1x315 MVA
7	Rewa 220 - Sidhi 220kV DCDS line through Rewa UMSP	-	90		-	-	
9	Julwania 400 - Pati (Silawad) 132kV DCSS Line	-		40	Pati (Silawad)	4.00	
10	LILO of Mangliya 220 –Indore 132kV Line at Mahalaxmi	-		3	Mahalaxmi	unknown	

11	Julwania400 - Shahpura 132kV DCSS Line	-		65	Shahpura	2.25	
12	Datia220 - Bhitarwar 132kV DCSS Line	-		40	Bhitarwar	2.25	
13	MugaliaChhap 220 - Mahwadia 132kV DCDS Line	-		10	Mahwadia	5.00	
15	Sidhi 220 - Madwas 132kV DCSS Line	-		50	Madwas	3.30	
16	Panagar 220 - Dheemarkheda 132kV DCSS Line	-		65	Dheemarkheda	2.25	
17	Prithivipur-Orchha 132kV DCSS Line	-		30	Orchha	3.00	
18	Sirmour 220 - Atraila 132kV DCSS line	-		35	Atraila	4.00	
19	Udaipura - Tendukheda 132kV DCSS line	-		45	Tendukheda	3.82	
20	Gohad - Gormi 132kV DCSS line	-		25	Gormi	2.25	
21	Narsinghgarh - Suthaliya 132kV DCSS line	-		50	Suthaliya	3.28	
22	LILO of Satna 220 - Kymore 132kV line at Unchhera 132kV S/s	-		5	Unchhera	6.25	
23	Sidhi 220 - Sinhawal 132kV DCSS line 132kV	-		50	Sinhawal	unknown	
24	2nd ckt of Rajgarh (B) - Raghogarh 132kV DCSS line up to Chachoda 132kV S/s	-		61	Chachoda	unknown	
25	Maneri - Mandla 132kV DCSS line	-		80	-	-	
26	Sukha (Jabalpur)	-	-	-	-	-	+ 2x50 MVA
27	Hoshangabad 220kV (2nd)	-	-	-	-	-	+ 1x160 MVA
28	Barwaha 220kV (3rd)	-	-	-	-	-	+ 1x160 MVA
29	Betma 132kV	-	-	-	-	-	+ 50 MVA
30	Khirkiya 132kV	-	-	-	-	-	+ 50 MVA
31	Amla 132kV	-	-	-	-	-	+ 50 MVA
32	Tejgarh 132kV	-	-	-	-	-	+ 50 MVA
33	Satwas 132kV	-	-	-	-	-	+ 50 MVA
34	Sitamau 132kV	-	-	-	-	-	+ 50 MVA
35	Baroda 132kV	-	-	-	-	-	+ 50 MVA
36	Amrawadkhurd 132kV	-	-	-	-	-	+ 50 MVA

(Source: DPR)

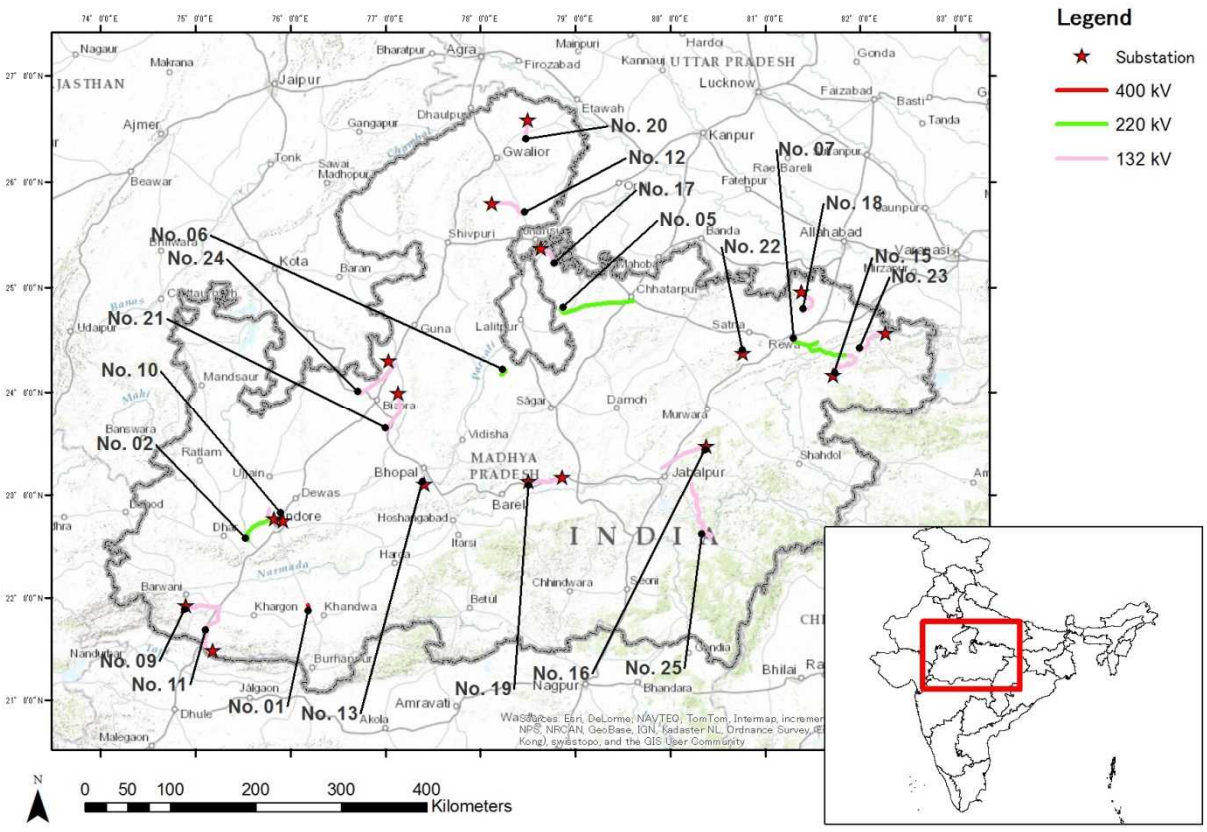


Figure 3-1 Project Location

3.4 Project area type and activities

3.4.1 Substations

16 new substations are proposed. Some of the locations are already identified but some of them are in the selection stage. All of the land planned is government-owned. The exact locations of the sub-stations will be finalized after site surveys. Residential areas and private land will be avoided and only government land without any houses will be selected for substations. The procedures from land selection to construction are as follows.

Table 3-3 Area Required for Substations

No.	Project description	Substation		Status*
		Name	Required Area (ha)	
2	Pithampur400-Super Corridor 220kV DCDS line LILO of One ckt of Indore (Jetpura) - Depalpur 132kV DCDS Line at Super Corridor (Indore) 220kV S/s.(D/C)	Super Corridor (Indore)	3.27	(i)
9	Julwania400 - Pati (Silawad) 132kV DCSS Line	Pati (Silawad)	4.00	(i)
10	Mangliya 220 - Mahalaxmi 132kV DCDS Line	Mahalaxmi	-	(i)
11	Julwania400 - Shahpura 132kV DCSS Line	Shahpura	2.25	(i)
12	Datia220 - Bhitarwar 132kV DCSS Line	Bhitarwar	2.25	(ii)
13	MugaliaChhap 220 - Mahwadia 132kV DCDS Line	Mahwadia	5.00	(v)
15	Sidhi 220 - Madwas 132kV DCSS Line	Madwas	3.30	(ii)
16	Panagar 220 - Dheemarkheda 132kV DCSS Line	Dheemarkheda	2.25	(ii)
17	Prithivipur-Orchha 132kV DCSS Line	Orchha	3.00	(i)
18	Sirmour 220 - Atraila 132kV DCSS line	Atraila	4.00	(ii)

19	Udaipura - Tendukheda 132kV DCSS line	Tendukheda	3.82	(iv)
20	Gohad - Gormi 132kV DCSS line	Gormi	2.25	(i)
21	Narsinghgarh - Suthaliya 132kV DCSS line	Suthaliya	3.28	(i)
22	LILO of Satna 220 - Kymore 132kV line at Unchhera 132kV S/s	Unchhera	6.25	(i)
23	LILO of one ckt of Sidhi 220 - Deosar 132kV line at Sinhawal 132kV S/s	Sinhawal	Land is being identified	(i)
24	2nd ckt of Rajgarh (B) - Raghogarh 132kV DCSS line up to Chachoda 132kV S/s	Chachoda	Land to be identified	(i)

*: (i) MPPTCL conducts site survey and selects government land without houses for substations. (1 month)

(ii) MPPTCL, the Site Selection Committee comprising SE (EHT-Constn), SE (T & C) and Civil Authority inspect the land and identify the location.

(iii) MPPTCL intimates the details of the land to the Energy of Government of MP. Energy department of Govt. of MP submits requisition to Revenue Department, GoMP for allotment of identified land.

(iv) The relevant Revenue Authority (Collector) allots the land to MPPTCL.

(v) Subsequent to allotment of land by the Collector, a contour plan of the land is furnished by the relevant EHT authority for developing the layout drawings of EHV substation.

3.4.2 Transmission Lines

The exact locations of the transmission lines will be decided after site surveys. All houses, including illegal squatters, will be avoided from the ROW. Procedures from site survey to construction of the transmission lines are as follows.

i. MPPTCL conducts survey for the ROW and examine some routes which will not fall on houses, including illegal squatters. (2 – 4 months)
ii. MPPTCL visits all the stakeholders along the proposed routes individually including the head of the village and explains the projects and land use restriction. (during No.1) ← not a meeting style
iii. MPPTCL finalizes the TML routes.
iv. MPPTCL applies for forest clearance if there are any forest areas in the ROW. (Max 1 year)
v. MPPTCL publishes section 164 notification in local papers as per Indian Electricity Act 2003 for the ROW.
vi. People can appeal to MPPTCL within 60 days.
vii. MPPTCL manages the appeals.
viii. MPPTCL starts construction for the Transmission Lines.

3.4.2.1 Tower Areas

The exact locations of the transmission towers have not been decided yet, because the transmission routes are not fixed. The average required area for Transmission Towers would be 25.03 m^2 to 165.44 m^2 per tower (Table 3-4). Estimated number of towers is 3,029 and required total area would be 9.9 ha (see Table 3-5). The transmission towers do not require land acquisitions. Land ownership will be with the Land Owner after construction (Regulation Telegraph Act 1885). Crop compensation will be paid during construction. The land owner can use the land as a vegetable garden after construction but construction building and tree plantation higher than 4 meters is not allowed (Law - Indian Electricity Act-2003). During operation the natural vegetation will be cut by MPPTCL for maintenance.

Table 3-4 Required Tower Area by Voltage

Voltage	Average height of the suspension tower	Average Tower area	Interval (m)
400 kV	80 m	165.44 m^2	333 m
220 kV	60 m	49.25 m^2	263 m
132 kV	40 m	25.03 m^2	250 m

Table 3-5 Estimated Tower Area

No.	400 kV	220 kV	132 kV	Total

	Length (km)	No. of Towers	Total tower Area (sqm)	Length (km)	No. of Towers	Total tower Area (sqm)	Length (km)	No. of Towers	Total tower Area (sqm)	Length (km)	No. of Towers	Total tower Area (sqm)
1	5	15	2,482	-	-	-	-	-	-	5	15	2,482
2	-	-	-	50	162	7,979	13	56	1,402	63	218	9,380
5	-	-	-	110	368	18,124	-	-	-	110	368	18,124
6	-	-	-	10	7	345	-	-	-	10	7	345
7	-	-	-	90	328	16,154	-	-	-	90	328	16,154
9	-	-	-	-	-	-	40	140	3,504	40	140	3,504
10	-	-	-	-	-	-	3	70	1,752	3	70	1,752
11	-	-	-	-	-	-	65	133	3,329	65	133	3,329
12	-	-	-	-	-	-	40	123	3,079	40	123	3,079
13	-	-	-	-	-	-	10	39	976	10	39	976
15	-	-	-	-	-	-	50	158	3,955	50	158	3,955
16	-	-	-	-	-	-	65	232	5,807	65	232	5,807
17	-	-	-	-	-	-	30	105	2,628	30	105	2,628
18	-	-	-	-	-	-	35	105	2,628	35	105	2,628
19	-	-	-	-	-	-	45	158	3,955	45	158	3,955
20	-	-	-	-	-	-	25	92	2,303	25	92	2,303
21	-	-	-	-	-	-	50	142	3,554	50	142	3,554
22	-	-	-	-	-	-	5	22	551	5	22	551
23	-	-	-	-	-	-	50	140	3,504	50	140	3,504
24	-	-	-	-	-	-	61	189	4,731	61	189	4,731
25	-	-	-	-	-	-	80	245	6,132	80	245	6,132
Total	5	15	2,482	260	865	42,601	667	2,149	53,789	932	3029	98,872

3.4.2.2 Right of Way

The exact locations of the right of way have not been decided yet. The locations will be finalized in the Detailed Design stage. The average width of ROW would be 27 m to 52 m (see Table 3-6). Estimated required area for ROW would be 2,521 ha (see Table 3-7). Activities during construction will be removal of buildings and vegetation clearance. Activities during operation will be vegetation clearance. Land ownership will not be changed after construction. Therefore, the land owner can keep using the land as agricultural land. But they cannot plant trees higher than 4 m or construct buildings. Habitation is prohibited under

the ROW.

Table 3-6 Average Width of Right of Way by Voltage

Voltage Level	Other than Forest ROW (m)	Forest ROW (m)
400 kV	52	46
220 kV	35	35
132 kV	27	27

Source: Ministry of Environment and Forest, Guidelines for diversion of forest land for non-forest purposes under the Forest Conservation Act, 1980 - guidelines for laying transmission lines through forest areas

Table 3-7 Estimated ROW Area

No.	400 kV		220 kV		132 kV		Total	
	Length (km)	ROW (ha)	Length (km)	ROW (ha)	Length (km)	ROW (ha)	Length (km)	ROW (ha)
1	5.0	26.0	-	-	-	-	5.0	26.0
2	-	-	50.0	175.0	13.0	35.1	63.0	210.1
5	-	-	110.0	385.0	-	-	110.0	385.0
6	-	-	10.0	35.0	-	-	10.0	35.0
7	-	-	90.0	315.0	-	-	90.0	315.0
9	-	-	-	-	40.0	108.0	40.0	108.0
10	-	-	-	-	3.0	8.1	3.0	8.1
11	-	-	-	-	65.0	175.5	65.0	175.5
12	-	-	-	-	40.0	108.0	40.0	108.0
13	-	-	-	-	10.0	27.0	10.0	27.0
15	-	-	-	-	50.0	135.0	50.0	135.0
16	-	-	-	-	65.0	175.5	65.0	175.5
17	-	-	-	-	30.0	81.0	30.0	81.0
18	-	-	-	-	35.0	94.5	35.0	94.5
19	-	-	-	-	45.0	121.5	45.0	121.5
20	-	-	-	-	25.0	67.5	25.0	67.5
21	-	-	-	-	50.0	135.0	50.0	135.0
22	-	-	-	-	5.0	13.5	5.0	13.5
23	-	-	-	-	50.0	135.0	50.0	135.0
24	-	-	-	-	61.0	164.7	61.0	164.7
25	-	-	-	-	80.0	216.0	80.0	216.0
Total	5.0	26.0	260.0	910.0	667.0	1,800.9	932.0	2,736.9

4 Scoping

Based on the project information and baseline data, environmental and social issues of concern are scoped. No serious impact is scoped. Some moderate impacts are the leaking out of Sulfur hexafluoride (SF6) from GIS substations during operation, tree cutting under the transmission lines, habitat fragmentation due to transmission lines, resettlement under the transmission lines, land acquisition at the substations, landscape impact caused by the transmission lines, impact on ethnic minorities, and accidents of workers. The scoping table is shown below.

Table 4-1 Scoping table

Item		Issues of concern*	
		Construction	Operation
Physical	Air pollution	C: Vehicle exhaust	-
	Water pollution	C: Turbid water from construction site	C: Human sewage from substation
	Waste	C: Cleared vegetation, demolition waste, domestic waste from workers	C: Damaged parts from substation and transmission line
	Soil pollution	-	-
	Noise and vibrations	C:Construction noise from construction vehicles	C: Machine Noise from substation
	Subsidence	-	-
	Offensive odors	-	-
	Bottom sediment	-	-
Natural	Protected area	B: Trees might be cut in some Protected areas	-
	Ecosystem	B: Fragmentation of the habitats might change ecosystems	B: Fragmentation of the habitats might change ecosystems
	Hydrology	-	-
	Topography and geology	C: Slope failures or landslides at the construction site	C: Concurrent slope failure might cause road blocking
Social	Resettlement	B: Houses under the TML or Substation	-
	Poverty	C: People under the poverty line might affect by the project	C: Land use restriction might prevent new business opportunities
	Ethnic Minorities and Indigenous Peoples	B: They might be affected by land acquisition/resettlement	-
	Livelihood and local economy	-	C: Project cause positive impact
	Land use and natural resource use	B: Land acquisition at the Substation	B: Land use restriction under the TML
	Water usage	-	-
	Infrastructure and social organizations of decision making	C:	-
	Interest opposition in the area	C: The unequal compensation might cause conflicts	-
	Local archeological, historical, cultural, and religious heritage	C: They might be damaged by construction work	-
	Landscape	B: Landscape near the tourism sites or cultural sites might be affected by TML	B: Landscape near the tourism sites or cultural sites might be affected by TML
	Gender	C: Project information might be explained to only gentlemen	C: Working opportunities for the ladies might be limited
	Children's right	C: If children is hired as workers, their right will be violated	-
	HIV/AIDS and Public Health	C: Infectious diseases brought by workers	-
	Working safety	B: Accidents during construction	B: Electrification, falling
Others	Accidents	-	C: Tower failure, electrification
	Global warming	-	B: Sulfur hexafluoride (SF_6)

*: A: Serious impact B: Moderate impact C: Negligible impact -: No impact

5 Survey methods

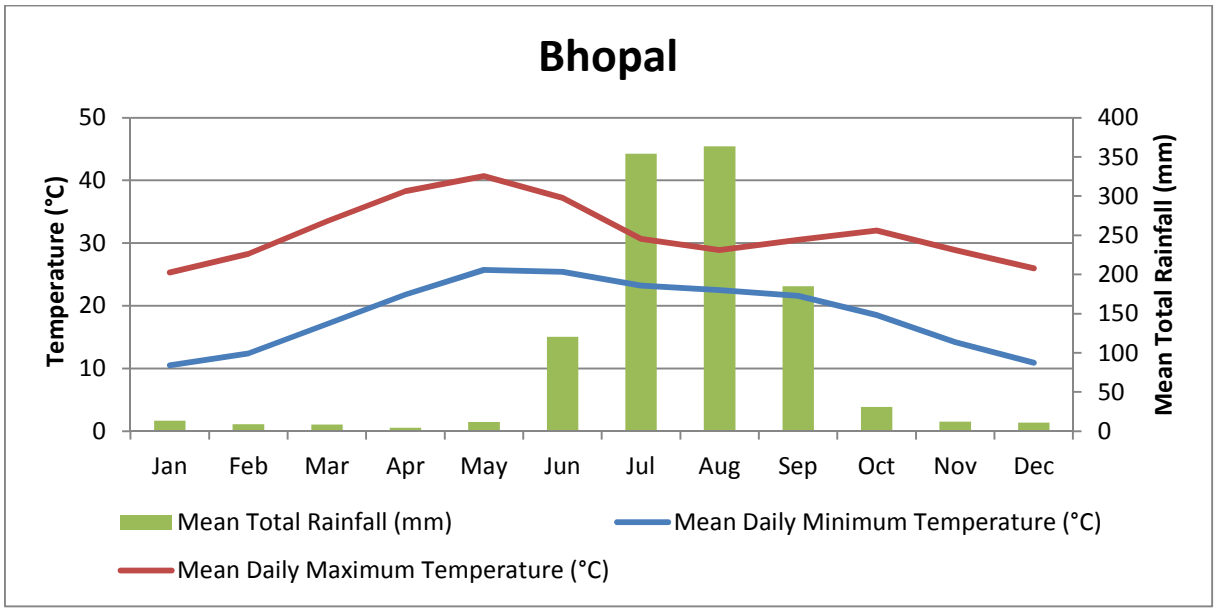
All the survey was conducted by literature survey. No site survey was conducted. Literature survey was conducted by JICA study team. Literature survey items are Climate, Topography, Geology, Forest, Protected area, protected species, Administrative boundaries, Population, Poverty, Ethnic groups, and Land use. All the survey was conducted from 12 July to 18 Sep 2015.

6 Survey Result

6.1 Physical Environment

6.1.1 Climate

The main climate in Madhya Pradesh is Tropical wet and dry or savanna climate (Aw) or Mediterranean climates (Cs). High land areas are Subtropical highland variety (Cw) or Semi-arid climate (Bs). For Bhopal, the dry season is from October to May and the wet season is from June to September. The hottest month is May (25.7 – 40.7 °C) and the coldest month is January (10.5 -25.3 °C).

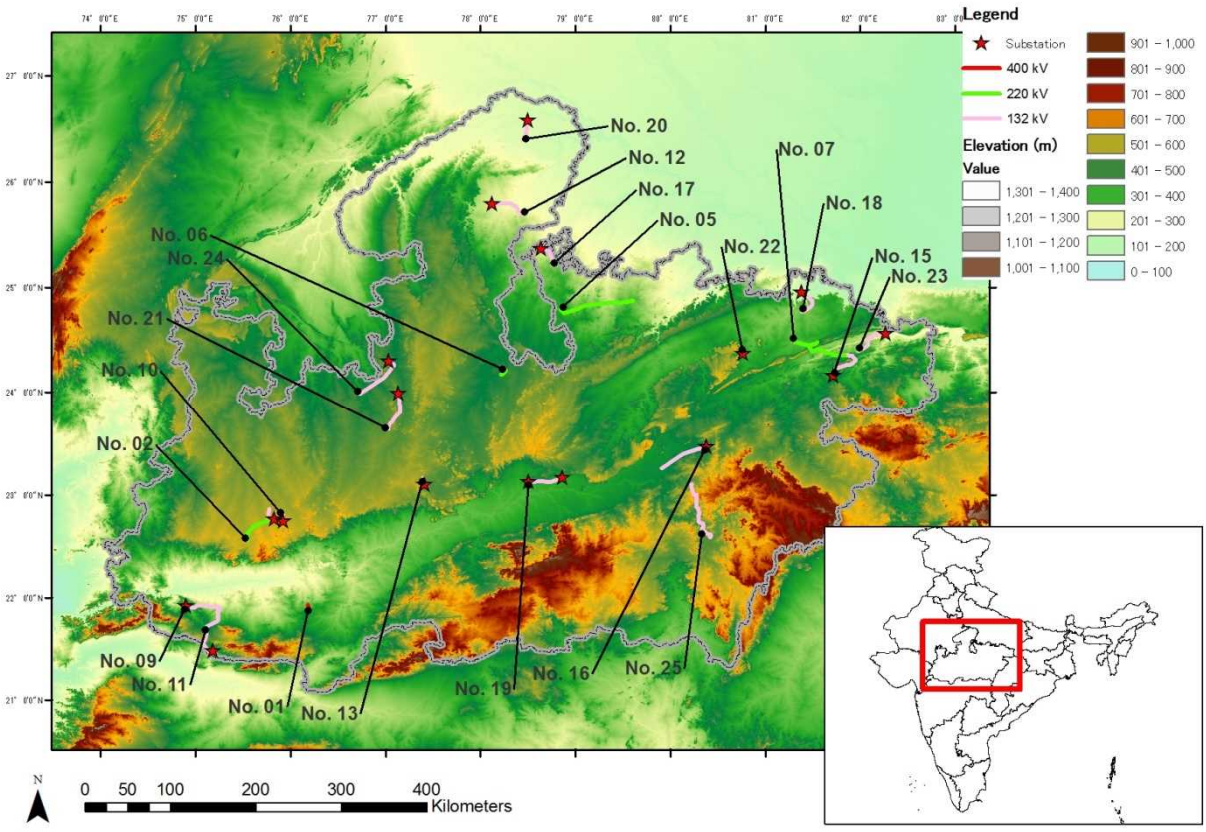


Source: World Meteorological Organization

Figure 6-1 Climatological Information (Bhopal, 1949-2000)

6.1.2 Topography

The geographical area of Madhya Pradesh is 308,252 sq. km, which constitutes 9.38% of the land area of the country. The topography of Madhya Pradesh is defined by the Narmada Sone Valley. It is a narrow and long valley extending through almost the whole of the state from east to west. The Sone valley forms the upper part; Shahdol and Sidhi districts lie in this valley. The lower part forms the Narmada valley. It has an average elevation of 300 m above MSL and is covered with alluvial soil. Jabalpur, Mandla, Narsinghpur, Hoshangabad, Raisen, Khandwa, Khargone and Barwani districts lie in this region. The Sone valley is narrower than the Narmada valley and alluvial deposit is also comparatively poor and thin; therefore, the Narmada valley is more important than the Sone valley for agricultural activities. To the north of this valley lies the Central Highlands, to the south, the Satpura-Maikal ranges and to the south-east, the eastern plateau. These three form the natural physiographic regions into which the state is divided. The Central Highlands are spread between the Narmada-Sone valley and the Aravali ranges to the west in a triangular form. The highlands slope towards the north and drain into the Yamuna. The highest peak in the state, Dhoopgarh, which rises to 1,360 m above MSL, lies in these ranges. The slope is sharp in the south face and gentle on the northern side. (Source: Government of Madhya Pradesh)



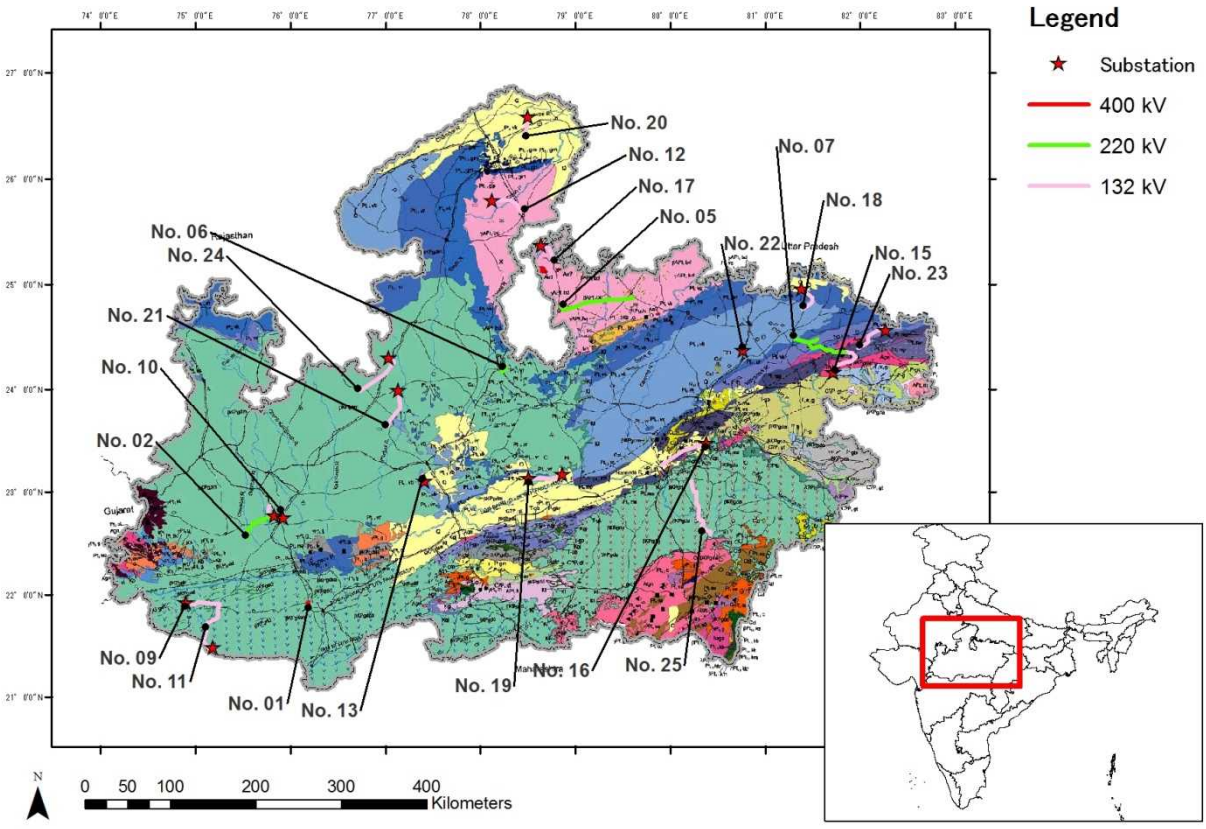
Source: GLASMO (www.iscgm.org/)

Figure 6-2 Topography Map of Madhya Pradesh

6.1.3 Geology

The oldest group of rocks, comprising Archaeans and Proterozoic formation, constitutes nearly 45% of the State. The next younger formation of Carboniferous to lower Cretaceous, comprising Gondwana Super Group, covers 10% of the area, while the formation of Cretaceous to Paleocene, comprising mostly Deccan Trap basalt, constitutes 38%. (Source: Minerals and Resources Department, Government of Madhya Pradesh)

Figure 3-1 shows a geological map of Madhya Pradesh.


Legend
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No. 02
No. 09
No. 11
No. 01
No. 13
No. 19
No. 16
No. 25
Rajasthan
Uttar Pradesh
Gujarat
N
0 50 100 200 300 400
Kilometers

Source: Geological Survey India

Figure 6-3 Geological Map of Madhya Pradesh

6.2 Natural Environment

6.2.1 Forest

According to the Forest Department of Madhya Pradesh the forest area of the state is 94,689.38 sq. km, constituting 30.71% of the geographical area of the state and 12.44% of the forest area of the country. Legally, this area has been classified into Reserved Forest, Protected Forest and Unclassified Forest, which constitute 65.36%, 32.84% and 1.7% of the forest area respectively. Per capita forest area is 0.16 ha., against the national average of 0.07 ha.

The forest cover has been classified into dense forest and open forest. The latest estimates from the Forest Survey of India, published in the State of Forest Report (SFR) 2003, suggest that the total forest cover of M.P. is 76,429 sq. km., which is 24.79% of the land area - dense forest constituting 13.57% and open forest, 11.22%. In addition to these two categories of cover, land having canopy cover of less than 10% is classified as scrub. The area under scrub is not included in the forest cover. Figure 6-4 shows the forest areas in Madhya Pradesh state.

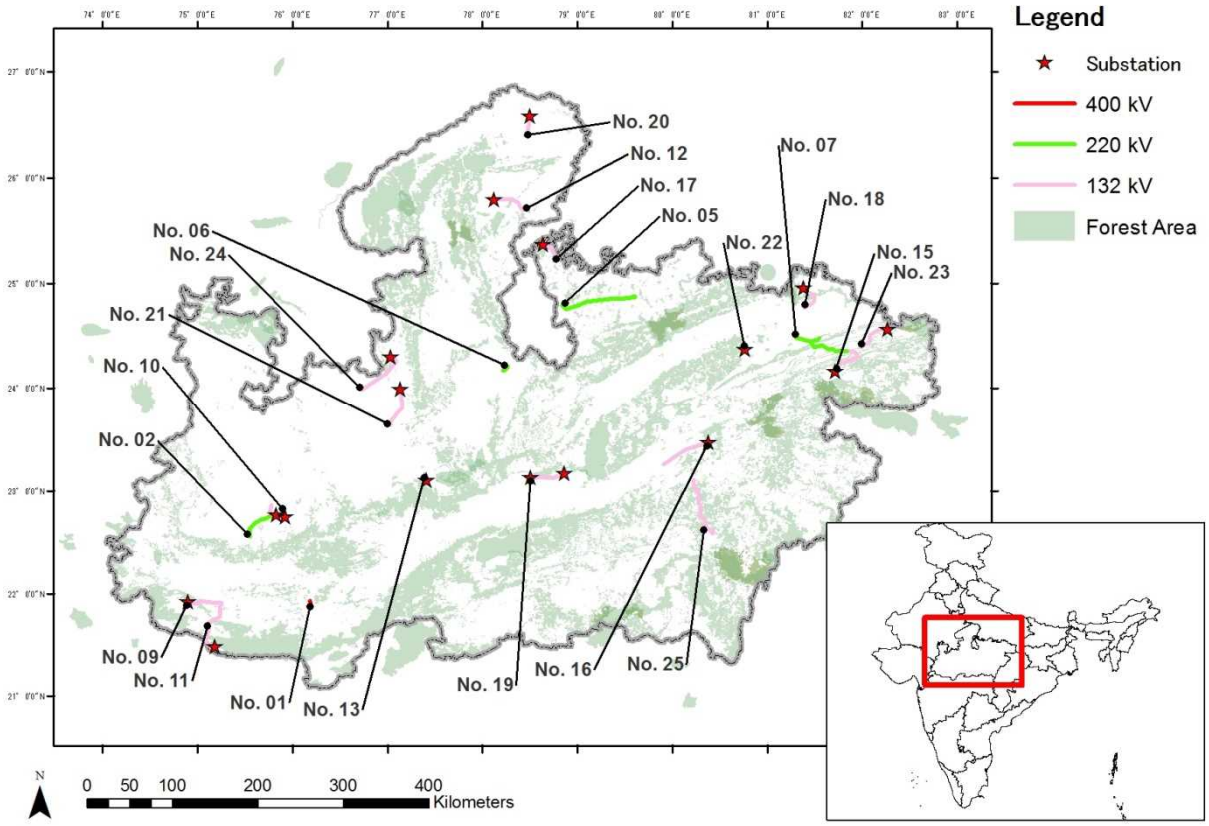


Figure 6-4 Tree Cover of Madhya Pradesh

6.2.2 Protected Areas

According to the Indian Forest Act 1927 and Environment (Protection) Act 1986, the designated forest areas are categorized as Reserved Forests and Protected Forests. The following table shows the forest types and restricted activities.

Table 6-1 Restrictions and required actions for TML by Forest Types

Class	Type	Restriction	Required permissions for TML/SS	Act and Regulations
RESERVED FORESTS	National Park	All activities are prohibited unless permitted.	Permission from supreme court	Environment (Protection) Act 1986, Notification from Ministry of Environment & Forests
	Sanctuary	Prohibited activity is taking weapons into a sanctuary. Permitted activities are investigation or study of sanctuary, photography,	Permission from supreme court	Environment (Protection) Act 1986, The wildlife

		scientific research, tourism and transaction of lawful business. Other activities are considered to regulate, permit or prohibit depending on activities.		(Protection) Act 1972 Notification from Ministry of Environment & Forests
	Eco-Sensitive zone (10km distance around the National parks and Sanctuaries)	Erection of electrical cables is regulated and underground cabling is recommended.	Permission from the Commissioner of the gov. of MP	Guideline for declaration of Eco-Sensitive zone around national parks and wildlife sanctuaries Certificate from Ministry of Environment & Forests, Wildlife Introduction of Ministry of Environment & Forests
	Un-designated area around the NP/Sanctuary	-	-	-
PROTECTED FORESTS		Prohibited activities are the quarrying of stone, or the burning of lime or charcoal, or the collection or subjection to any manufacturing process, or removal of, any forest-produce in any such forest, and the breaking up or clearing for cultivation, for building, for herding cattle or for any other purpose, of any land in any such forest.	Forest Clearance	Indian Forest Act 1927

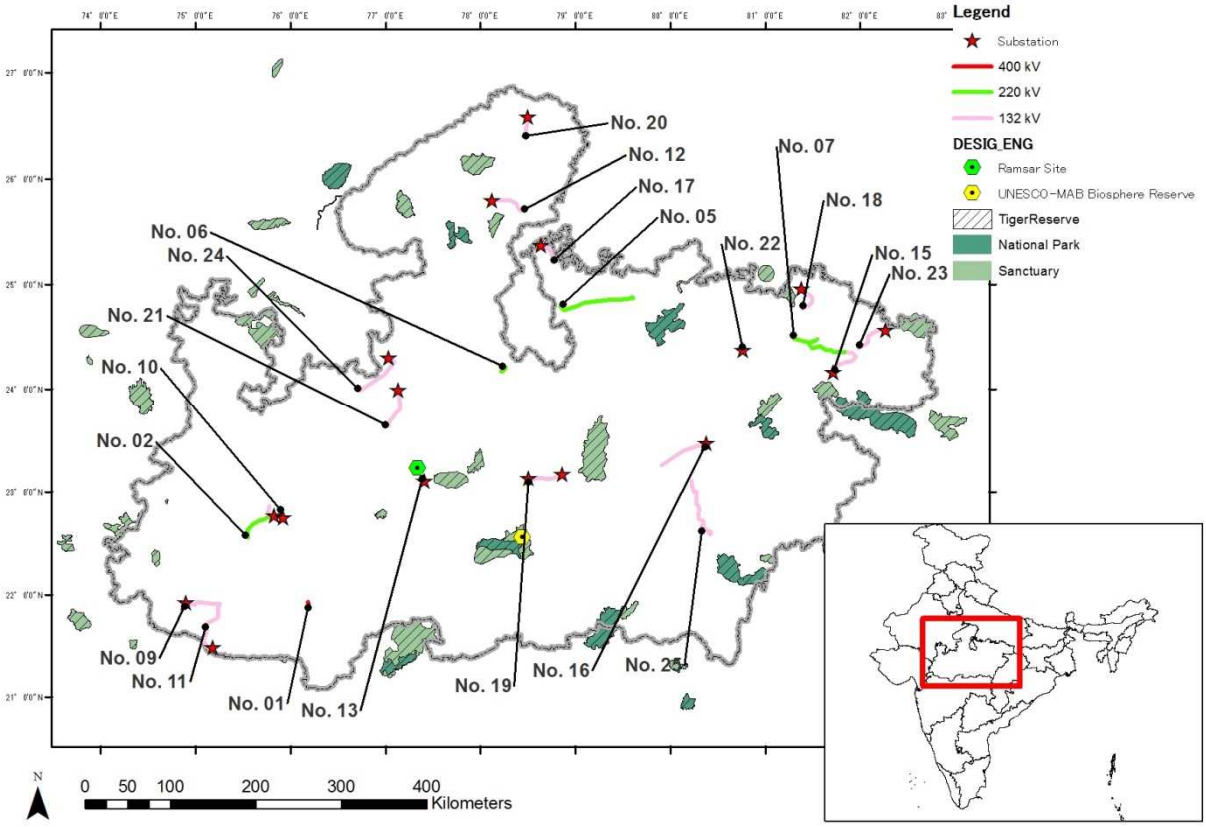
There are 9 National Parks, 25 Sanctuaries, 6 Tiger reserves and two International protected areas (UNESCO-MAB Biosphere Reserve and Ramsar site) in Madhya Pradesh State (see Table 6-2 and Figure 6-5).

Table 6-2 Protected Areas in Madhya Pradesh State

Type	Name	Tiger Reserves	International importance
National Park	1. Kanha	1. Kanha	
	2. Bandhavgarh	2. Bandhavgarh	
	3. Panna	4. Panna	
	4. Pench	3. Pench	
	5. Satpura	5. Satpura	Pachmarhi UNESCO-MAB Biosphere Reserve
	6. Sanjay	6. Sanjay	
	7. Madhav		
	8. Vanvihar		Bhoj Ramsar Wetland
	9. Fossil		
Sanctuary	1. Bori	5. Satpura	
	2. Bagdara		
	3. Phen		
	4. Ghatigaon		
	5. Gandhisagar		
	6. Karera		

	7. Ken Ghariyal		
	8. Kheoni		
	9. Narsinghgarh		
	10. N. Chambal		
	11. Nauradehi		
	12. Pachmari	5. Satpura	
	13. Panpatha	2. Bandhavgarh	
	14. Kuno		
	15. Pench	3. Pench	
	16. Ratapani		
	17. Sanjay Dubri	6. Sanjay	
	18. Singhori		
	19. Son Ghariyal		
	20. Sardarpur		
	21. Sailana		
	22. Ralamandal		
	23. Orchha		
	24. Gangau	4. Panna	
	25. V. Durgawati		

Source: Protected Planet (www.protectedplanet.net)



Source: Forest Department

Figure 6-5 Protected Areas

6.2.3 Protected Species

According to IUCN, 1,333 species are tagged as India in the IUCN red list. 136 species are Critically Endangered, 353 species are Endangered, 496 species are Vulnerable and 348 species are Near Threatened (see Table 6-3). Among them, three (3) plants,

fourteen (14) mammals, two (2) reptiles, eight (8) turtles, one (1) Anuras, seventeen (17) fish and one (1) Odonata are known to exist in Madhya Pradesh state (see Table 6-4). The habitats of three (3) species out of forty six (46) protected species are limited in the state as shown in Figure 6-6.

Table 6-3 Number of IUCN Red list species in India

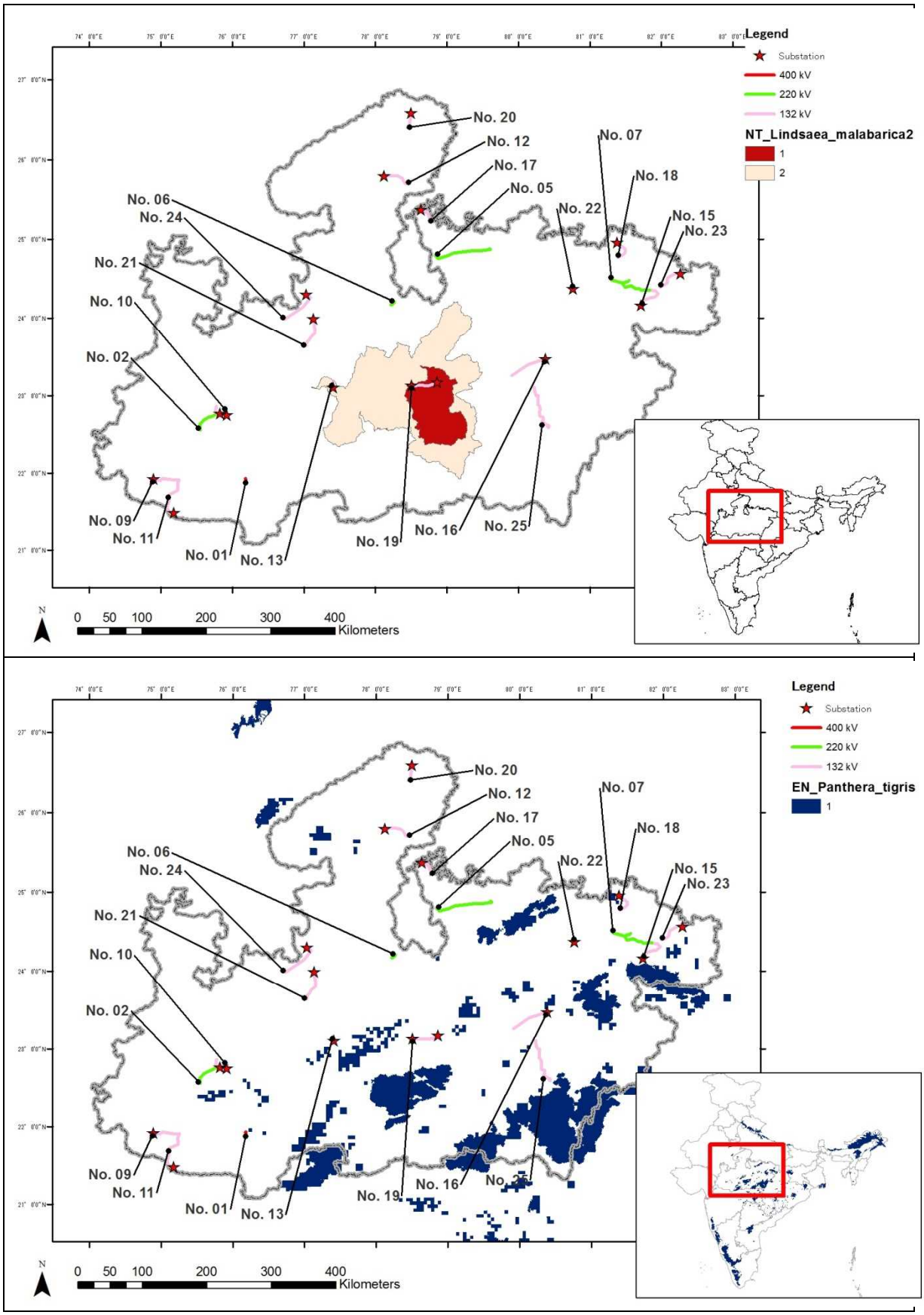
	Critically Endangered (CR)	Endangered (EN)	Vulnerable (VU)	Near Threatened (NT)	Total*
ANIMALIA	75	202	376	326	979
ARTHROPODA	3	7	31	19	60
CHORDATA	71	184	263	199	717
ACTINOPTERYGII	14	69	88	52	223
AMPHIBIA	20	32	22	9	83
AVES	16	16	50	75	157
CHONDRICHTHYES	3	9	30	28	70
MAMMALIA	11	40	45	24	120
REPTILIA	7	18	28	11	64
CNIDARIA	1	4	73	107	185
ECHINODERMATA		4	5		9
MOLLUSCA		3	4	1	8
PLANTAE	61	151	120	22	354
BRYOPHYTA	1	1	1		3
MARCHANTIOPHYTA		3	1		4
TRACHEOPHYTA	60	147	118	22	347
Total	136	353	496	348	1333

*: Least Concern (LC) and Data Deficient (DD) are excluded.

Table 6-4 IUCN Red List Species Known in Madhya Pradesh

	Scientific Name	Common Name	IUCN Red List category
Plants	Ammannia nagpurensis		EN
	Lindsaea malabarica		NT
	Utricularia praeterita		NT
Mammals	Cuon alpinus	Indian Wild Dog	EN
	Hipposideros durgadasi	Durga Das's Leaf-nosed Bat	EN
	Manis crassicaudata	Indian Pangolin	EN
	Panthera tigris	Tiger	EN
	Bos gaurus	Indian Bison	VU
	Lutrogale perspicillata	Indian Smooth-coated Otter	VU
	Melursus ursinus	Sloth Bear	VU
	Prionailurus rubiginosus	Rusty-spotted Cat	VU
	Rucervus duvaucelii	Barasingha, Swamp Deer	VU
	Rusa unicolor	Sambar Deer	VU
	Tetracerus quadricornis	Four-horned Antelope	VU
	Antilope cervicapra	Blackbuck	NT
	Hyaena hyaena	Striped Hyena	NT
	Panthera pardus	Leopard	NT
Reptiles	Gavialis gangeticus	Indian Gharial	CR
	Crocodylus palustris	Mugger	VU

	Scientific Name	Common Name	IUCN Red List category
Turtles	Batagur dhongoka	Three-striped Roofed Turtle	EN
	Chitra indica	Indian Narrow-headed Softshell Turtle	EN
	Batagur kachuga	Bengal Roof Turtle	CR
	Nilssonia gangetica	Indian Softshell Turtle	VU
	Hardella thurjii	Crowned River Turtle	VU
	Geoclemys hamiltonii	Black Pond Turtle	VU
	Nilssonia hurum	Indian Peacock Softshell Turtle	VU
	Nilssonia leithii	Leith's Softshell Turtle	VU
Anura	Philautus sanctisilvaticus	Sacred Grove Bushfrog	CR
Fish	Tor khudree	Black Mahseer	EN
	Thynnichthys sandkhol	Sandkhol Carp	EN
	Silonia childreni		EN
	Clarias magur	Wagur	EN
	Amblyceps arunchalensis		EN
	Ailia coila	Gangetic ailia	NT
	Anguilla bengalensis	Indian Mottled Eel	NT
	Anguilla bicolor	Shortfin Eel	NT
	Bagarius bagarius		NT
	Bagarius yarrelli		NT
	Chitala chitala		NT
	Labeo pangusia	Pangusia labeo	NT
	Microphis deocata		NT
	Ompok bimaculatus		NT
	Ompok pabo		NT
	Parambassis lala	Highfin Glassy Perchlet	NT
	Wallago attu		NT
Odonata	Indothemis carnatica		NT


Legend
Substation
400 kV
220 kV
132 kV
NT_Lindsaea_malabarica2
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Kilometers
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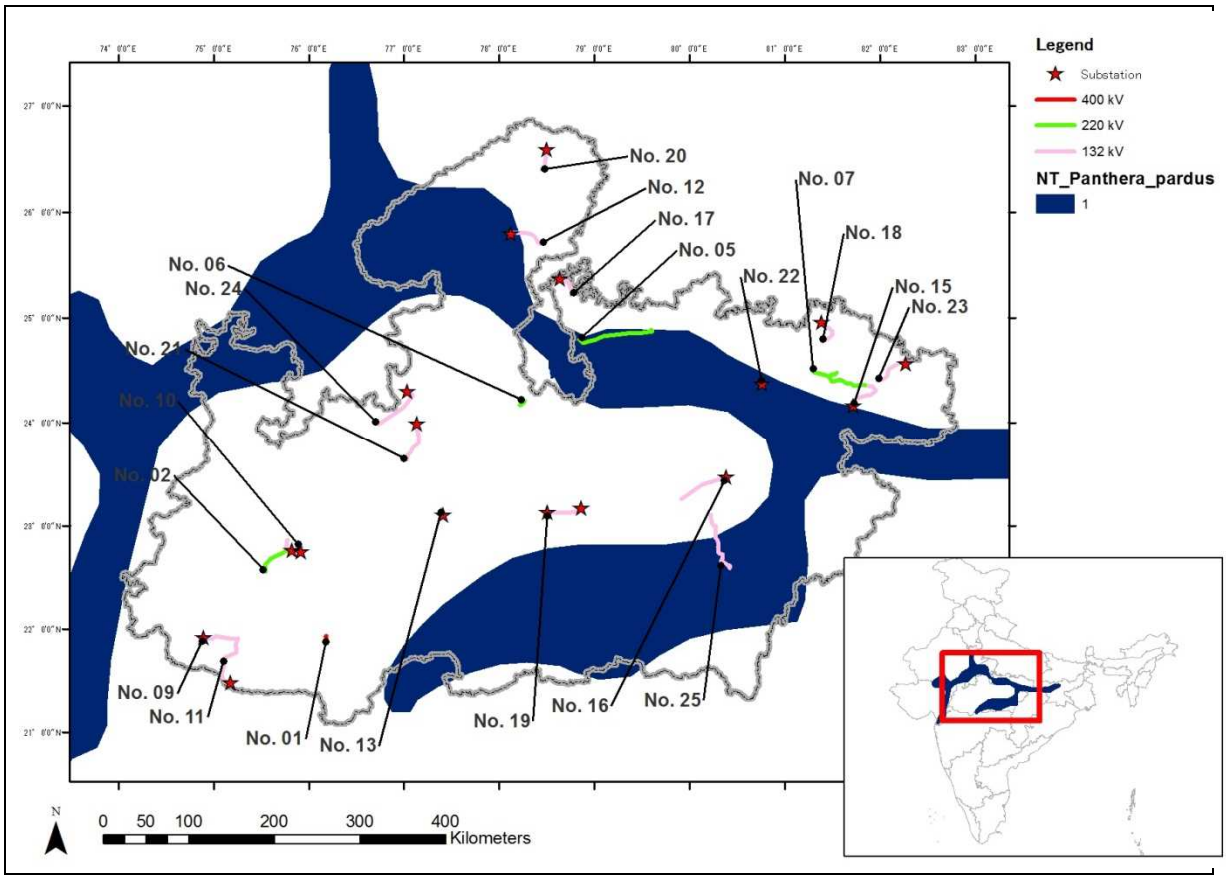


Figure 6-6 Limited habitat species of protected species

6.3 Social Environment

6.3.1 Administrative Boundaries

There are 45 districts in Madhya Pradesh state. The proposed sub-stations and TMLs are located in 26 districts.

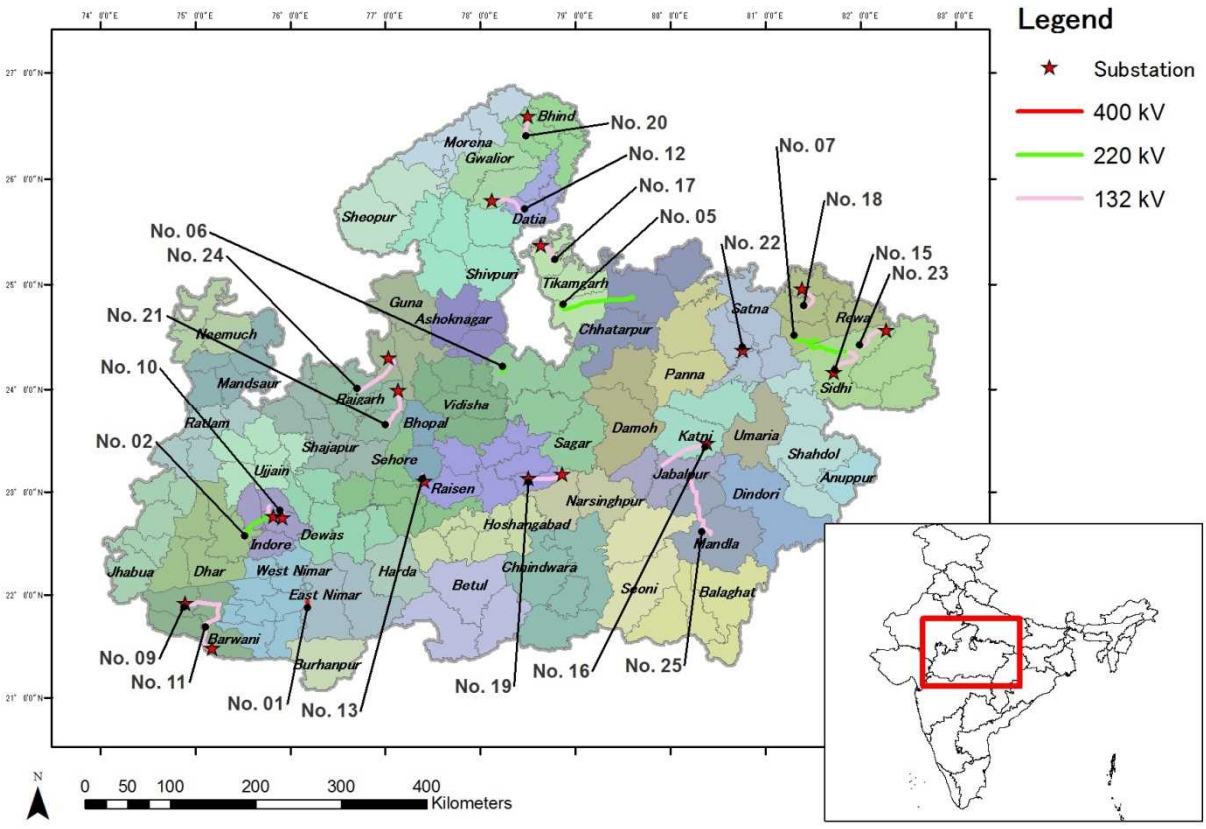


Figure 6-7 District Map

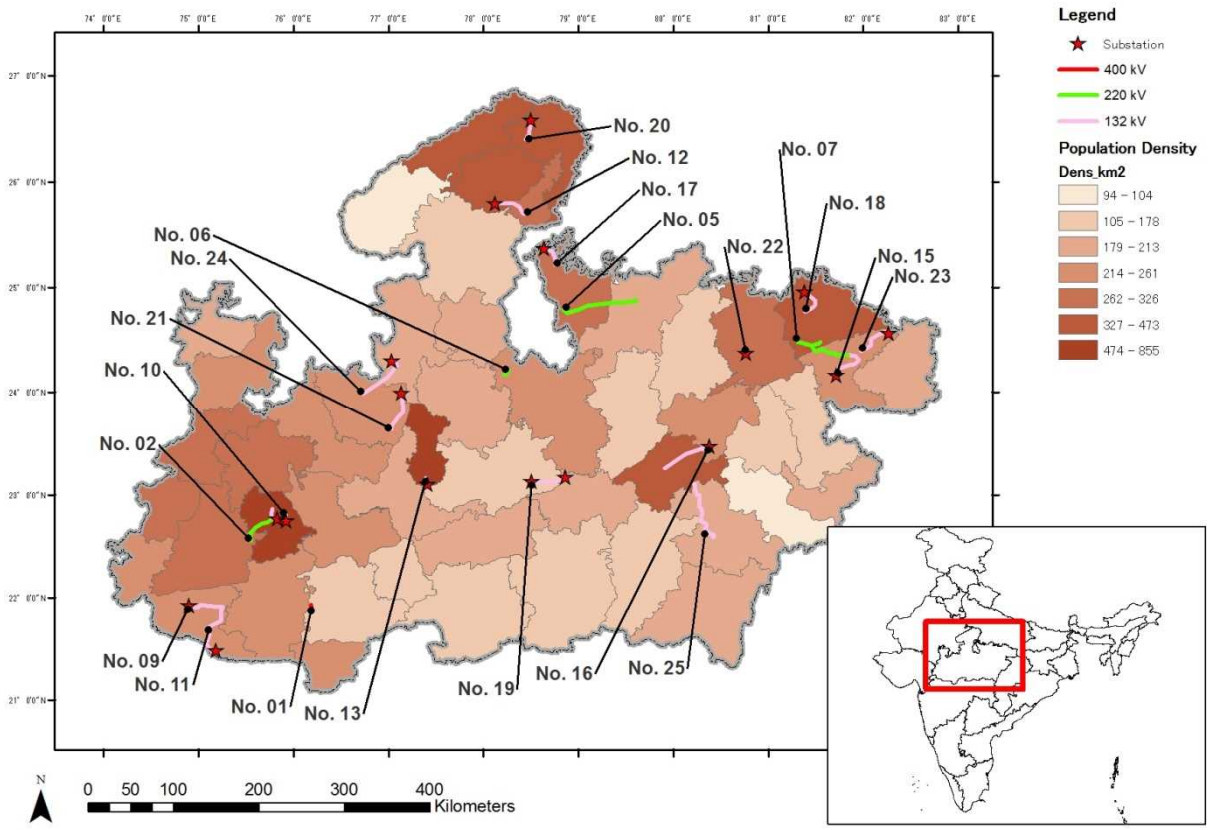
6.3.2 Population

According to the 2011 census, around 72.6 million people are living in Madhya Pradesh state. Rural population is 44.4 million (61%) and urban population is 16.0 million (22%). Working population is 25.8 million (36%) including marginal working population. Cultivators are 11.0 million (15%). The highest population district is Indore and the highest population density is Bhopal, which is 855 persons/km2. The highest population growth rate is 32.88 %, Indore district.

Table 6-5 Population, Growth rate and Population density by District

No	District Name	Population (2011)	Population Growth Rate	Area (km2)	Population Density (persons/km2)	Project number
1	Indore	3,276,697	32.88%	3,898	841	2, 10
2	Jabalpur	2,463,289	14.51%	5,211	473	16
3	Sagar	2,378,458	17.63%	10,252	232	6
4	Bhopal	2,371,061	28.62%	2,772	855	13
5	Rewa	2,365,106	19.86%	6,314	375	7, 18
6	Satna	2,228,935	19.19%	7,502	297	22
7	Dhar	2,185,793	25.60%	8,153	268	2
8	Chhindwara	2,090,922	13.07%	11,815	177	
9	Gwalior	2,032,036	24.50%	4,560	446	12
10	Ujjain	1,986,864	16.12%	6,091	326	
11	Morena	1,965,970	23.44%	4,989	394	3
12	West Nimar	1,873,046	22.85%	8,025	233	1
13	Chhattarpur	1,762,375	19.51%	8,687	203	5
14	Shivpuri	1,726,050	22.76%	10,066	171	12
15	Bhind	1,703,005	19.21%	4,459	382	20
16	Balaghat	1,701,698	13.60%	9,229	184	

No	District Name	Population (2011)	Population Growth Rate	Area (km2)	Population Density (persons/km2)	Project number
17	Betul	1,575,362	12.92%	10,043	157	
18	Dewas	1,563,715	19.53%	7,020	223	
19	Rajgarh	1,545,814	23.26%	6,153	251	21, 24
20	Shajapur	1,512,681	17.20%	6,195	244	
21	Vidisha	1,458,875	20.09%	7,371	198	6
22	Ratlam	1,455,069	19.72%	4,861	299	
23	Tikamgarh	1,445,166	20.13%	5,048	286	5, 17
24	Barwani	1,385,881	27.57%	5,427	255	9, 11
25	Seoni	1,379,131	18.22%	8,758	157	
26	Mandsaur	1,340,411	13.24%	5,535	242	
27	Raisen	1,331,597	18.35%	8,466	157	4, 19
28	Sehore	1,311,332	21.54%	6,578	199	
29	East Nimar	1,310,061	21.50%	7,352	178	1
30	Katni	1,292,042	21.41%	4,950	261	16
31	Damoh	1,264,219	16.63%	7,306	173	
32	Guna	1,241,519	26.97%	6,390	194	24
33	Hoshangabad	1,241,350	14.49%	6,703	185	
34	Singrauli	1,178,273	28.05%	5,675	208	
35	Sidhi	1,127,033	23.72%	4,851	232	7, 15, 23
36	Narsimhapur	1,091,854	14.01%	5,133	213	19
37	Shahdol	1,066,063	17.39%	6,205	172	
38	Mandla	1,054,905	17.97%	5,800	182	25
39	Jhabua	1,025,048	30.70%	3,600	285	
40	Panna	1,016,520	18.67%	7,135	142	
41	Ashoknagar	845,071	22.66%	4,674	181	
42	Neemuch	826,067	13.77%	4,256	194	
43	Datia	786,754	18.46%	2,902	271	12
44	Burhanpur	757,847	19.37%	3,427	221	
45	Anuppur	749,237	12.30%	3,747	200	
46	Alirajpur	728,999	19.45%	3,182	229	
47	Dindori	704,524	21.32%	7,470	94	
48	Sheopur	687,861	22.94%	6,606	104	
49	Umaria	644,758	24.96%	4,076	158	
50	Harda	570,465	20.25%	3,334	171	



Source: The Office of Registrar General and Census Commissioner of India

Figure 6-8 Population Density in Madhya Pradesh State

6.3.3 Poverty

According to the 2004 census, the number of people below the poverty line is 25,029,390 and the poverty rate of the state is 38%. The district with the highest poverty rate is Dindori (80.11%); the lowest is Neemuch (7.26%).

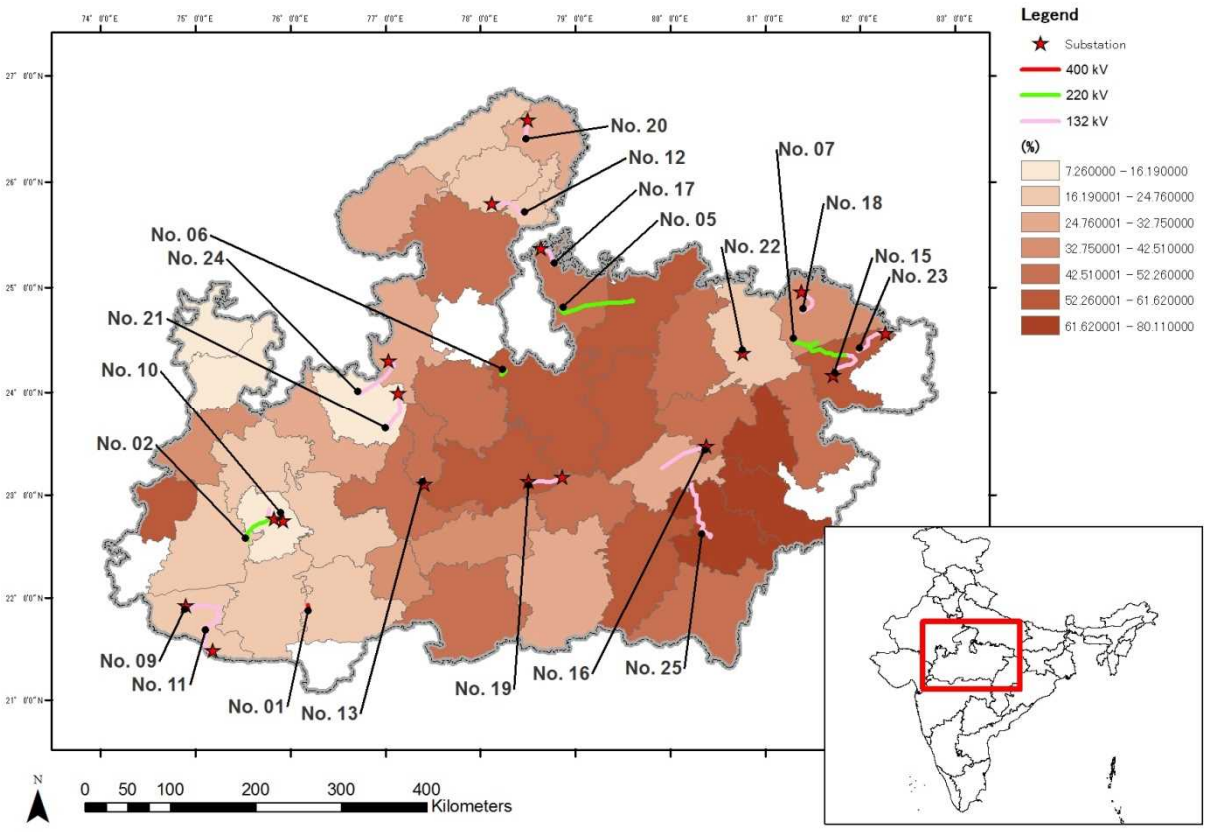


Figure 6-9 Poverty rate by district

Source: Census 2004

6.3.4 Ethnic Groups

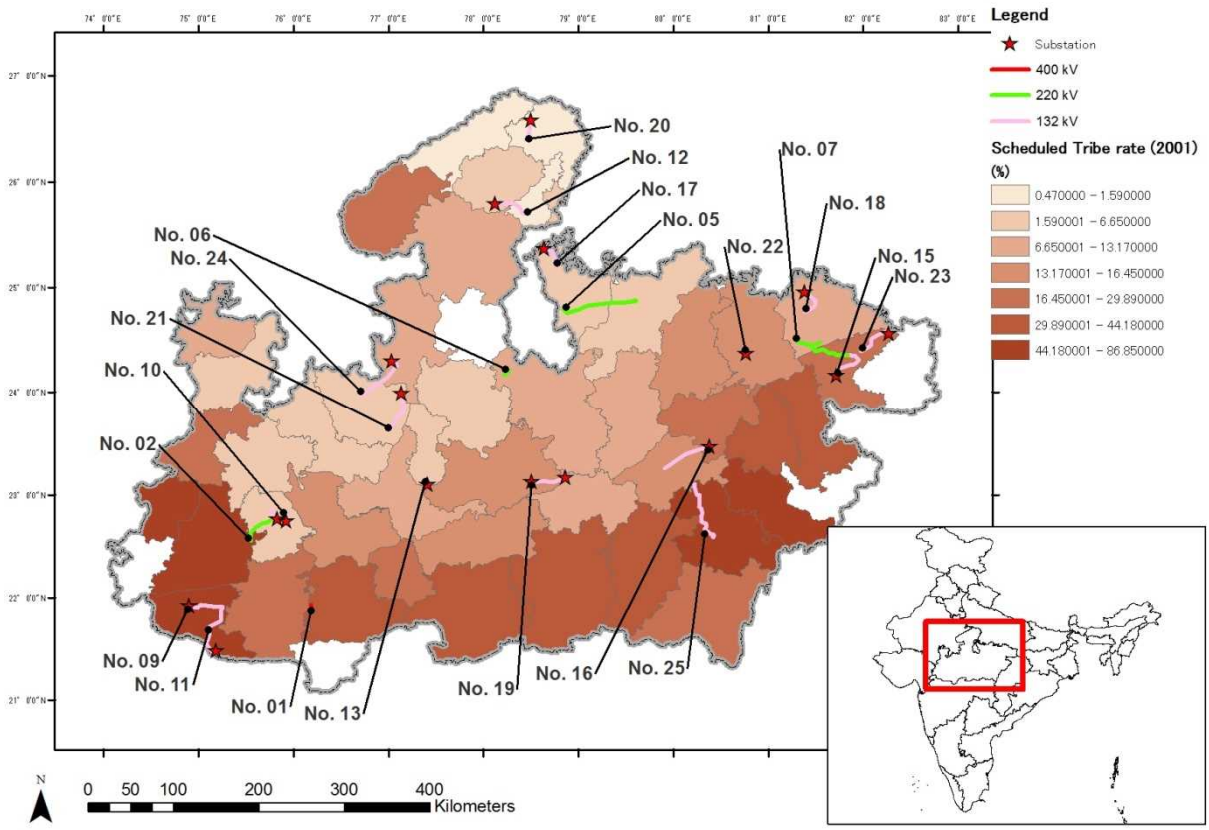
Scheduled Tribes in Madhya Pradesh state are notified as per the Scheduled Castes and Scheduled Tribes Order, 2001 as amended by List of the Scheduled Tribes and Castes in Madhya Pradesh State. According to the list, 46 tribes are in Madhya Pradesh state (see Table 6-6).

Table 6-6 Scheduled Tribes in Madhya Pradesh State

No.	Scheduled Tribes
1.	Agariya
2.	Andh
3.	Baiga
4.	Bhaina
5.	Bharia Bhumia, Bhuinhar Bhumia,Bhumiya, Bharia, Paliha, Pando
6.	Bhattra
7.	Bhil, Bhilala, Barela, Patelia
8.	Bhil Mina
9.	Bhunjia
10.	Biar, Biyar
11.	Binjhwar
12.	Birhul, Birhor
13.	Damor, Damaria
14.	Dhanwar
15.	Gadaba, Gadba
16.	Gond, Arakh, Arrakh, Agaria, Asur, Badi Maria, Bada Maria, Bhatola, Bhimma, Bhuta,

No.	Scheduled Tribes
	Koilabhuta,Koilabhuti, Bhar, Bisonhom Maria, Chota Maria, Dandami Maria, Dhuru, Dhurwa, Dhoba, Dhulia, Dorla,Gaiki, Gatta, Gatti, Gaita, Gond Gowari, Hill Maria, Kandra, Kalanga, Koitar, Koya, Khirwar, Khirwara, Kucha Maria, Kuchaki Maria, Madia, Maria, Mana, Mannewar, Moghya, Mogia, Monghya, Mudia, Muria, Nagarchi, Nagwanshi, Ojha, Raj, Sonjhari Jhareka, Thatia, Thotya, Wade Maria, Vade Maria, Daroi
17.	Halba,Halbi
18.	Kamar
19.	Karku
20.	Kawar, Kanwar, Kaur, Cherwa, Rathia, Tanwar, Chattri
21.	(Omitted)
22.	Khairwar, Kondar
23.	Kharia
24.	Kondh, Khond, Kandh
25.	Kol
26.	Kolam
27.	Korku, Bopchi, Mouasi, Nihal, Nahul Bondhi, Bondeya
28.	Korwa, Kondaku
29.	Majhi
30.	Majhwar
31.	Mawasi
32.	Omitted
33.	Munda
34.	Nagesia, Nagasia
35.	Oraon, Dhanka, Dhangad
36.	Panika Chhatarpur, Panna, Rewa, Satna, Shahdol, Umaria, Sidhi and Tikamgarh districts, And Sevda and Datia tehsils of Datia district
37.	Pao
38.	Pardhan, Pathari, Saroti
39.	Omitted
40.	Pardhi, Bahelia, Bahellia, Chita Pardhi, Langoli Pardhi, Phans Pardhi, Shikari, Takankar, Takia [In (i) Chhindwara, Mandla, Dindon and Seoni districts, (ii) Baihar Tahsil of Balaghat District, (iii) Betul, Bhainsdehi and Shahpur tahsils of Betul district, (iv) Patan tehsil and Sihora and Majholi blocks of Jabalpur district, (v) Katni (Murwara) and Vijaya Raghogarh tahsils and Bahoriband and Dhemerkheda blocks of Katni district, (vi) Hoshangabad, Babai, Sohagpur, Pipariya and Bankhedi tahsils and Kesla block of Hoshangabad district, (vii) Narsinghpur district, and (viii) Harsud Tahsil of Khandwa district
41.	Parja
42.	Sainariya, Saharia, Seharia, Sehria, Sosia, Sor
43.	Saonta, Saunta
44.	Saur
45.	Sawar, Sawara
46.	Sonr

Source: ST & SC Development & Welfare Department, Madhya Pradesh Gov.



Source: ST & SC Development & Welfare Department, Madhya Pradesh Gov.

Figure 6-10 Percentage of Scheduled Tribe Population to Total Population

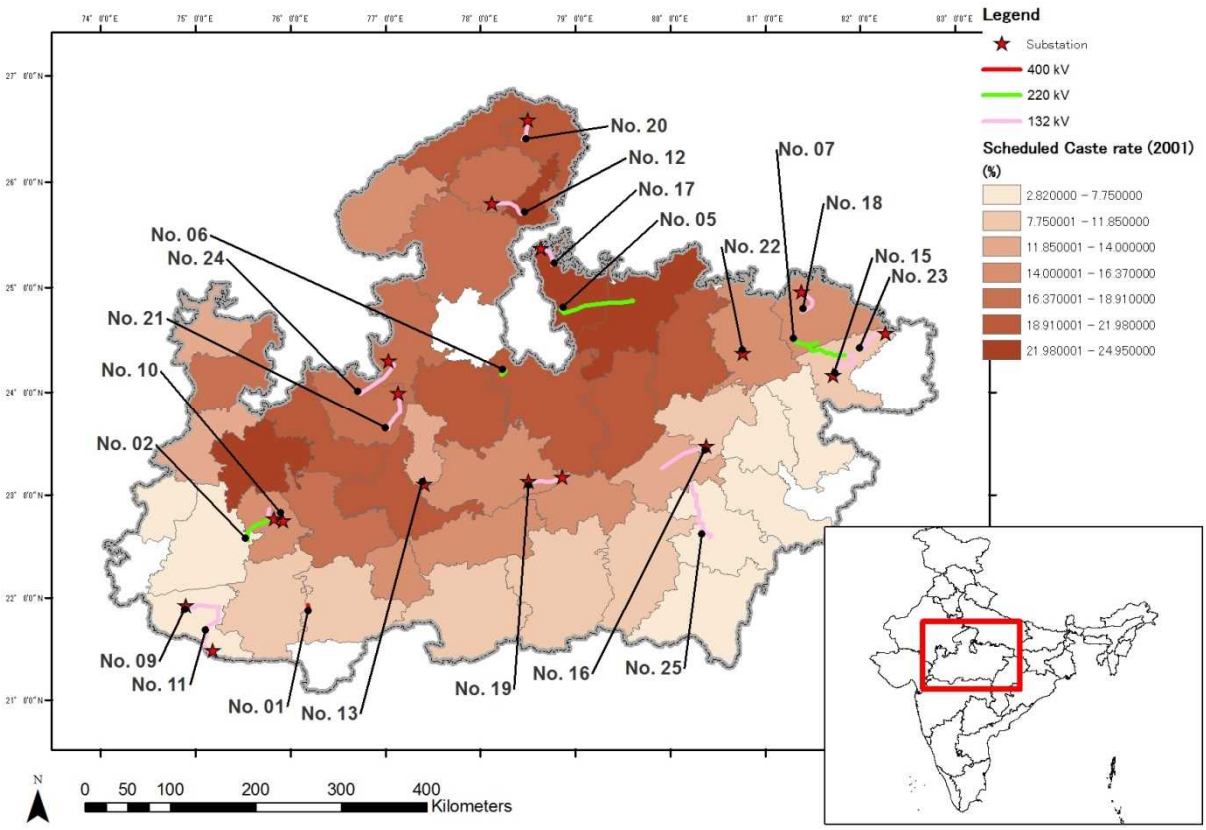
Scheduled Castes in Madhya Pradesh are notified as per the Constitution (Scheduled Castes) Order, 1950, as amended vide Modification Order 1956, Amendment Act, 1976 and the Constitution (Scheduled Castes) Order (Amendment) Act 2002 No. 25 dated 27.5.2002 of the Ministry of Law, Justice and Company Affairs, read with The Constitution (SCs) Order (Second Amendment) Act, 2002 No. 61 of 2002 dated 18.12.2002 of Ministry of Law & Justice republished vide Notification No. 7797-I- Legis-5/2002-L dated 7.6.2003 of Law Dept., Govt. of Orissa and, vide Gazette of India No.381dt.30.8.2007. According to the Order, 95 castes are listed in Madhya Pradesh state (see エラー! 参照元が見つかりません。).

Table 6-7 Scheduled Castes in Madhya Pradesh State

Sl.	Scheduled Castes
1.	Audhelia
2	Bagri, Bagdi (excluding Rajput, Thakur sub-castes among Bagri, Bagdi)
3.	Bahna, Bahana
4.	Balahi, Balai
5.	Banchada
6.	Barahar Basod
7.	Bargunda
8.	Basor, Burud, Bansor, Bansodi, Bansphor, Basar
9.	Bhanumati
10.	Beldar, Sunkar
11.	Bhangi, Mehtar, Balmiki, Lalbegi, Dharkar
12.	Bhanumati
13.	Chadar
14.	Chamar, Chamari, Bairwa, Bhambhi, Jatav, Mochi, Regar, Nona, Rohidas, Ramnami, Satnami, Surjyabanshi, surjyaramnami, Ahirwar, Chamar, Mangan, Raidas
15.	Chidar

Sl.	Scheduled Castes
16.	Chikwa, Chikvi
17.	Chitar
18.	Dahait, Dahayat, Dahat
19.	Dewar
20.	Dhanuh
21.	Dhed, Dher
22.	Dhobi(in Bhopal, Raisen and Sehore distirct)
23.	Dohor
24.	Dom, Dumar, Dome, Domar, Doris
25.	Ganda, Gandi
26.	Ghasi, Ghasia
27.	Holiya
28.	Kanjar
29.	Katia, Patharia
30.	Khatik
31.	Koli, Kori
32.	Kotwal (in Bhind, Dhar, Dewas, Guna, Gwalior, Indore, Jhabua, Khargone, Mandsaur, Morena, Rajgarh, Ratlam, Shajapur, Shivpuri Ujjain and Vidisha Districts)
33.	Khangar, Kanera, Mirdha
34.	Kuchbandhia
35.	Kumar (in Chhatarpur, Datia, Panna, Rewa, Satna, Shahdol, Sidhi and Tikamgarh districts)
36.	Mahar, Mehra, Mehar, Mahara
37.	Mang, Mang Garodi, Mang Garudi, Dankhani Mang, Mang Mahashi, Madari, Garudi, Radhe Mang
38.	Meghwal
39.	Moghia
40.	Muskhan
41.	Nat, Kalbelia, Sapera, Navdigar, Kubutar
42.	Pardhi (in Bhind, Dhar, Dewas, Guna, Gwalior, Indore, Jhabua, Khargone, Mandsaur, Morena, Rajgarh, Ratlam, Shajapur, Shivpuri, Ujjain and Vidisha)
43.	Pasi
44.	Rujjhar
45.	Sansi, Sansia
46.	Silawat
47.	Zamral
48.	Sargara

Source: ST & SC Development & Welfare Department, Madhya Pradesh Gov.

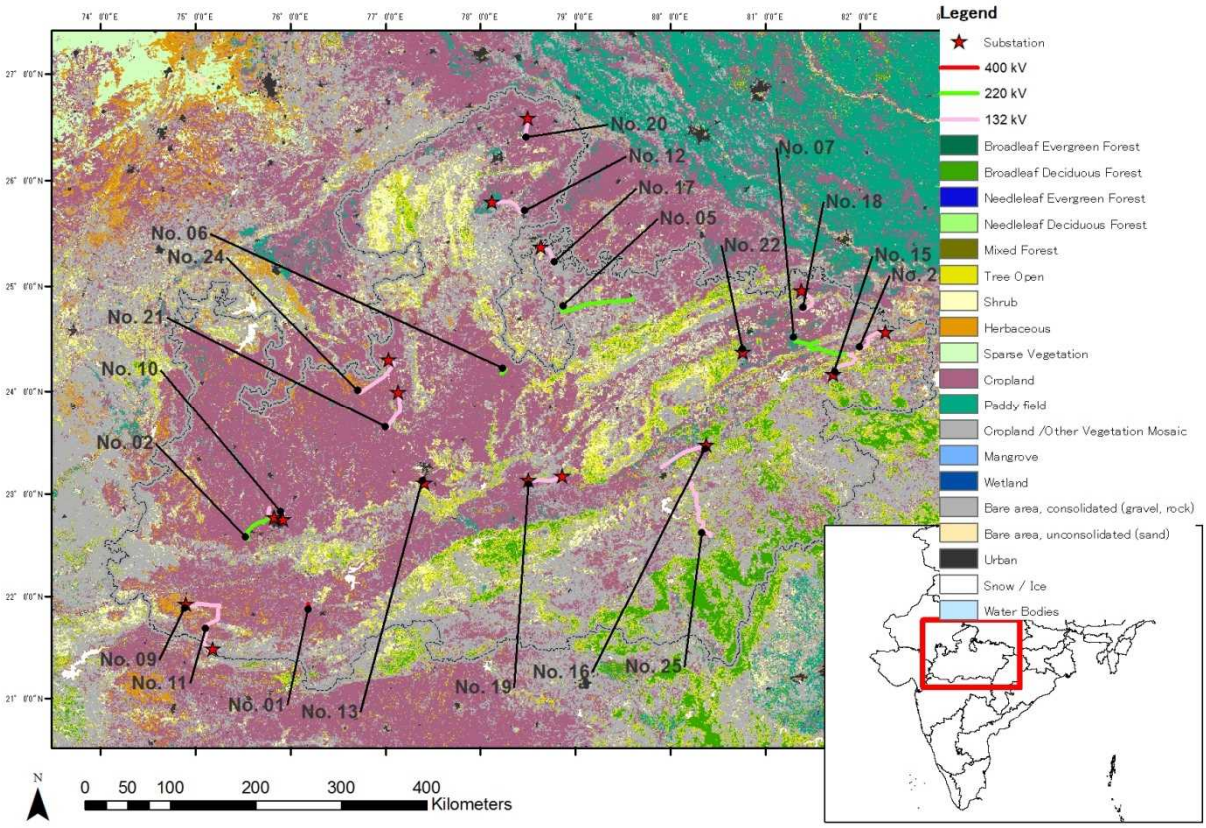


Source: ST & SC Development & Welfare Department, Madhya Pradesh Gov.

Figure 6-11 Percentage of Scheduled Caste Population to Total Population

6.3.5 Land Use

Land use in Madhya Pradesh state is a mixture of Cropland, Tree open and Needle leaf Deciduous Forest. Forests are located in the southern high mountainous area and most of the lower areas are used for agriculture (see Figure 6-12).



Source: Land use map, International Steering Committee for Global Mapping (ISCGM)

Figure 6-12 Land use in Madhya Pradesh state

7 Environmental Impacts

7.1 Physical Environmental Impact

7.1.1 Air Pollution

Construction Stage: Vehicle exhaust from construction vehicles might cause air pollution. The dust caused by transportation vehicles might affect the people along the access roads. The affected area would be limited to around the construction area and transportation route. The impact is limited to the construction period. The impact will not be serious because it is confined only to the construction period.

7.1.2 Global Warming

Operation Stage: Global warming might be an issue of concern when sulfur hexafluoride (SF6)) is accidentally released from the GIS during maintenance. SF6 gas is a non-toxic, odorless and harmless gas.

Four feeders of 220 kV GIS will be installed in the Super Corridor (Indore) 220kV Substation. The average volume of SF6 per GIS would be 13.27m3 (under 0.6 Mpa). Therefore, a total of approximately 53.08 m3 of SF6 shall be used in this Project. Usually the SF6 gas is completely enclosed in the GIS and there is hardly any leakage. However, the probability of leakage of SF6 gas would be slightly higher during the gas treatment work at the time of maintenance. If the gas can be gathered in the specific way recommended by the manufacturer, then the amount of SF6 released into the atmosphere will be very low. The maintenance is performed annually per one GIS.

7.1.3 Water Pollution

Construction Stage: Water might become turbid at the tower area during construction if towers are located in steep and/or soft soil areas which are not managed adequately. 3,029 towers are planned in the Project, but their exact locations are not fixed yet. Therefore, the exact impact cannot be anticipated.

Operation Stage: Human sewage from substations might cause water pollution. All of the domestic waste water from the 16 new substations will be treated by septic tank or sewage system, so it will not cause serious problems.

7.1.4 Soil Erosion and Landslides

Construction Stage: Slope failures or landslides at the construction site might be caused at the tower points of the transmission lines, if towers are located in unstable steep areas. In the case that the design and construction methods are not suitable for the land, 3,289 tower points which are planned in the Project might be affected. Because the locations are not exactly fixed at this stage, the high risk locations are not clearly known.

7.1.5 Waste

Construction Stage: Cleared vegetation and domestic waste from workers will be produced at the project sites during construction. The removed plants and domestic waste will be treated by a contractor. The impact will not be serious if proper measures are taken.

Operation Stage: Damaged parts from substations and transmission lines might become industrial waste during the operation stage. The main materials would be iron, copper, ceramics, and plastic. None of them are toxic to human health. The volume would be 2kg/year per one substation and 136 kg/km of transmission line per year. This industrial waste will be carried out of the substation following Indian waste management rules (S.O No. 1035 (E), [12/05/2011] - E-waste Management and Handling Rules 2011) for all domestic and industrial waste including hazardous waste.

7.1.6 Noise and Vibration

Construction Stage: Construction vehicles might cause noise impacts on the people and wildlife around 100m from the construction site. The affected areas are not clear but the impact would not be serious because most of the locations would be in rural areas and these impacts would be temporary. MPPTCL's safety rules stipulated at the construction site will prevent serious impact.

Operation Stage: Sometimes, cooling fans and transformers in substations might cause noise impacts on houses around the substations. The impact area of the fans and transformers would be 100m around the facilities. The number of affected houses is not clear. Because locations would be in rural areas, the number of the affected houses would not be high.

7.1.7 Electromagnetic Waves

Operation Stage: Electromagnetic waves will be released from transformers, beakers and transmission lines. The estimated level of electromagnetic waves under the transmission line would be less than 20μT and electromagnetic waves at the boundary of the substation would be less than 4μT. Therefore, there will be no impact on the persons who are living near the facilities.

7.1.8 Radio Interference

Operation Stage: Radio interference might happen around the transmission lines and substations. The possible affected area would be 100-300m around the facilities. The number of affected houses cannot be identified at this stage. If mitigation measures are taken, the impact will be compensated for.

7.2 Natural Environmental Impact

7.2.1 Protected Areas

Construction Stage: Indian Forest Act 1927 does not allow any activities in the Reserved Forests (National Park, Sanctuary, and Eco-Sensitive zone) except for the permitted activities. All the sub-projects which affect protected areas are excluded from the proposed project.

7.2.2 Protected Species and Ecosystem

Some project locations fall in the known habitats of IUCN red-list species. In terms of Mammals, the habitats of two Endangered species, six Vulnerable species and three Near Threatened species are covered in some project locations. All the sub-projects are located outside of the known Tiger habitats but some of them, such as No.15, 16, 18, and 25, are near the habitats. The sub-projects might not affect the habitat seriously but the ROWs might be used by Tigers. If important corridors are fragmented, the gene level biodiversity will be lowered and the risk of regional extinction will be higher. If the important hunting areas are decreased, the number of individuals will be lowered. If the project cause expansion of the human habitat towered the wildlife habitat, the conflict between people and rare species will be increased. If the ROW make easier for the people to access the habitat, pouching risk will be increased.

Table 7-1 Protected species and project locations

No.	Name	EN	VU	NT

		Cuon alpinus*	Hipposideros durgadasi*	Manis crassicaudata	Panthera tigris*	Bos gaurus	Lutrogale perspicillata	Melursus ursinus	Prionailurus rubiginosus	Rucervus duvaucelii*	Rusa unicolor	Tetracerus quadricornis	Antilope cervicapra	Hyaena hyaena	Panthera pardus*
1	LILO of one circuit of 400kV Khandwa - Rajgarh PGCIL line at Chhegaon 400kV Substation (D/C)	1	-	1	-	-	1	2	1	-	1	1	1	1	-
	400kV Bus Reactor at Chhegaon 400kV S/S	1	-	1	-	-	1	2	1	-	1	1	1	1	-
2	Pithampur400-Super Corridor 220kV DCDS line	1	-	1	-	-	1	2	1	-	1	1	1	1	-
	LILO of One ckt of Indore (Jetpura) - Depalpur 132kV DCDS Line at Super Corridor (Indore) 220kV S/s. (D/C)	1	-	1	-	-	1	2	1	-	1	1	1	1	-
4	Charging/Upgradation of Chichli 220 - Udaipura DCDS line on 220kV level	1	-	1	-	-	1	2	1	-	1	1	1	1	-
5	Chhatarpur-Tikamgarh 220kV DCSS line	1	-	1	-	-	1	2	1	-	1	1	1	1	1
6	400/220kV Additional Transformer at Bina 400kV S/S	1	-	1	-	-	1	2	1	-	1	1	1	1	-
	LILO of Bina 220 - Ganjbasoda 220kV line at Bina (MPPTCL) 400kV S/s	1	-	1	-	-	1	2	1	-	1	1	1	1	-
7	Rewa 220 - Sidhi 220kV DCDS line through Rewa UMSP	1	-	1	-	-	1	2	-	-	1	1	1	1	-
9	Julwania 400 - Pati (Silawad) 132kV DCSS Line	-	-	1	-	-	1	2	1	-	1	1	1	1	-
10	Mangliya 220 - Mahalaxmi 132kV DCDS Line	1	-	1	-	-	1	2	1	-	1	1	1	1	-
11	Julwania 400 - Shahpura 132kV DCSS Line	-	-	1	-	-	1	2	1	-	1	1	1	1	-
12	Datia220 - Bhitarwar 132kV DCSS Line	-	-	1	-	-	1	2	1	-	1	1	1	1	1
13	MugaliaChhap 220 - Mahwadia 132kV DCDS Line	1	-	1	-	-	1	2	1	-	1	1	1	1	-
15	Sidhi 220 - Madwas 132kV DCSS Line	1	-	1	-	-	1	2	-	-	1	1	1	1	1
16	Panagar 220 - Dheemarkheda 132kV DCSS Line	1	-	1	-	-	1	2	1	-	1	1	1	1	-
17	Prithivipur-Orchha 132kV DCSS Line	1	-	1	-	-	1	2	1	-	1	1	1	1	-
18	Sirmour220 - Atraila 132kV DCSS line	1	-	1	-	-	1	2	-	-	1	1	1	1	-
19	Udaipura - Tendukheda 132kV DCSS line	1	-	1	-	-	1	2	1	-	1	1	1	1	-
20	Gohad - Gormi 132kV DCSS line	-	-	1	-	-	1	1	1	-	1	1	1	1	-
21	Narsinghgarh - Suthaliya 132kV DCSS line	1	-	1	-	-	1	2	1	-	1	1	1	1	-
22	LILO of Satna 220 - Kymore 132kV line at Unchhera 132kV S/s	1	-	1	-	-	1	2	1	-	1	1	1	1	1
23	LILO of one ckt of Sidhi 220 - Deosar 132kV line at Sinhawal 132kV S/s	1	-	1	-	-	1	2	-	-	1	1	1	1	-
24	2nd ckt of Rajgarh (B) - Raghogarh 132kV DCSS line up to Chachoda 132kV S/s	1	-	1	-	-	1	2	1	-	1	1	1	1	-
25	Maneri - Mandla 132kV DCSS line	1	-	1	-	-	1	2	1	-	1	1	1	1	1

*: The figures show the following conditions

Code	Origin
1	Extant

2	Probably Extant
3	Possibly Extant
4	Possibly Extinct
5	Extinct (Post 1500)
6	Presence Uncertain

Source: IUCN

7.2.3 Forest

All the substations are planned outside of forest areas. Total length of TML which passes through forest area is 24.2 km, 67.7 ha in total.

Table 7-2 Affected forest area by ROW

No	Project Name	Transmission line [km]	ROW [ha]
7	Rewa220 – Sidhi 220kV DCDS line through Rewa UMSP	3.0	10.5
9	Julwania400 – Pati (Silawad) 132kV DCSS Line	0.5	1.4
11	Julwania400 – Shahpura 132kV DCSS Line	6.0	16.2
13	MugaliaChhap 220 - Mahwadia 132kV DCDS Line	1.5	4.1
15	Sidhi 220 - Madwas 132kV DCSS Line	0.2	0.5
17	Prithivipur-Orchha 132kV DCSS Line	2.0	5.4
18	Sirmour220 - Atraila 132kV DCSS line	1.0	2.7
23	Sidhi 220 - Sinhawal 132kV DCSS line	1.0	2.7
25	Maneri - Mandla 132kV DCSS line	9.0	24.3
	Total	24.2	67.7

7.3 Social Environmental Impact

7.3.1 Resettlement and Land acquisition

Construction Stage: The locations of TML routes and SS will be carefully selected to avoid residential places, including illegal settlements, so there is very little possibility of resettlements. But it has not been completely confirmed that all the squatters are avoided, because the routes are still tentative and no site surveys are conducted. MPPTCL has no experience of resettlement over 20 years. MPPTCL doesn't need to acquire the land under the ROW. The land for the SSs will not require expropriation of private land, because all the areas will be allocated by the government.

7.3.2 Land use restriction

Construction Stage: Some agricultural activities under the ROW will be stopped during construction.

Operation Stage: In order to keep clearance between land and transmission lines, land use in the ROW will be restricted. Construction of houses, structures more than 4 m, and tree planting higher than 4 m will not be allowed. But as long as the clearance is kept the area can be used as agricultural land and grazing ground. Natural tree sprouts should be cleared by MPPTCL on a regular basis to keep clearance between ground and lines. The number of affected land owners and peasants has not been cleared yet.

7.3.3 Local Heritage

Construction Stage: Local heritage, including buried cultural property, in the project site will not be allowed by the Site Selection Committee, so there is very little possibility of their being affected by the project.

7.3.4 Landscape

Construction Stage: Most of the sub-projects are more than 10 km from National parks and sanctuaries. Sub-project No.13 (MugaliaChhap 220 - Mahwadia 132kV DCDS Line) is located less than 10 km away but it is 6.5km away from the Vanvihar National Park. Therefore, no serious landscape impact is predicted.

7.3.5 Ethnic Minorities and Indigenous People

Construction Stage: Ethnic minorities and indigenous people might be affected by land acquisition/resettlement. Exact locations and numbers are not clear at this stage.

7.3.6 Public Health

Construction Stage: Infectious diseases such as HIV/AIDS might be brought in by workers during the construction stage. The number of workers during the construction period would be 10 persons for 14 days per TML tower and 15 persons for 180 days per SS. Total man-days would be 45,059. The risk is not so high because they are not staying in one location for a long time like with hydropower plant construction, highway construction or mining activities. MPPTCL has never experienced HIV/AIDS problems so far.

7.3.7 Accidents

Operation Stage: Tower failures and electrification might happen when too strong wind comes or people touch high voltage facilities. The risk would be lower if adequate mitigation measures are taken. According to past MPPTCL experience, 3 fatal accidents and 4 non-fatal accidents have been recorded in two years. Therefore, one or two accidents per year is estimated.

Table 7-3 Accidents in the MPPTCL areas (2013-2015)

Date of accident	Fatal/Non-Fatal	Name of the lines
13-May-2013	-	132kV Southzone-Satyasai
25-Feb-2014	Fatal	132kV Southzone-Chambal line
14-Feb-2014	Fatal	132kV Southzone-Mangaliya line
4-Oct-2014	-	132kV Chambal-Satyasai line

7.3.8 Working Safety

Construction Stage: Worker accidents such as car accidents, falling etc. might happen during construction. MPPTCL has experienced some accidents so far. An average of two fatal accidents happened per 1,000 km of TML construction. Therefore, one accident is estimated for 932 km of TML construction.

Operation Stage: Workers' accidents such as electrification, falling etc. might happen during operation. MPPTCL has had no experience of worker injury at substations so far. Therefore, the possibility of workers' accidents would be very low.

Table 7-4 Accidents in the MPPTCL areas (2013-2015)

Date of accident	Fatal/Non-Fatal	Name of the lines
16-Jun-2014	-	220kV S/s Nayagaon-Jabalpur line
20-Jun-2014	Fatal	220kV Bhopal-Sukhisevaniya line
21-May-2015	-	220kV Satna-SGTPS Birsinghpur line

8 Analysis of Alternatives

The main alternative designs have been examined before project proposal. Some of the projects were excluded because of impacts on forest or protected areas. Other alternative routes will be selected to minimize resettlements and the impact on forest during the detailed design stage too. For example first design was designed without consideration the protected areas and forests but after checking the locations of the protected areas and forest area, the routes are changed and cancelled to minimize the forest area. Then the affected forest length was reduced from 86.6 km to 24.2 km.

Table 8-1 Changed and cancelled routes

Project No	Voltage	Previous Plan			Revised Plan			Remarks
		Protected Area	Forest	Total	Protected Area	Forest	Total	

		(km)	(km)	(km)	(km)	(km)	(km)	
3	220	0.0	55.0	55.0	0.0	0.0	0.0	Cancelled
	132	2.5	10.0	12.5	0.0	0.0	0.0	Cancelled
7	220	0.0	1.0	1.0	0.0	3.0	3.0	
8	132	7.0	0.0	7.0	0.0	0.0	0.0	Cancelled
9	132	0.0		0.0	0.0	0.5	0.5	
11	132	0.0	6.0	6.0	0.0	6.0	6.0	
13	132	0.0	0.0	0.0	0.0	1.5	1.5	
14	132	0.0	0.0	0.0	0.0	0.0	0.0	Cancelled
15	132	0.0	1.0	1.0	0.0	0.2	0.2	
17	132	0.0	0.0	0.0	0.0	2.0	2.0	
18	132	0.0	1.5	1.5	0.0	1.0	1.0	
23	132	0.0		0.0	0.0	1.0	1.0	
25	132	0.0	12.0	12.0	0.0	9.0	9.0	
Total		9.5	86.5	96.0	0.0	24.2	24.2	

9 Environmental Management Plan

9.1 Mitigation Plan

9.1.1 Physical Environment

9.1.1.1 Global Warming

Operation Stage: GIS is a very hermetically-sealed system, so less than 0.5 % of the sealed SF6 gas per year might be released. In order to check the GIS, all the SF6 gas should be removed and the GIS opened every 12 years. More than 80% of the SF6 gas will be collected and it will be reused after maintenance. The maintenance cost would be 148,688 Rs. per one GIS. Therefore, a total of 594,751 Rs./year is required for the mitigation. This will be covered by operation costs.

9.1.1.2 Water Pollution

Construction Stage: MPPTCL will strictly follow the construction rules to minimize turbid water. The rules are as follows.

- Slope areas of more than 10 degrees should not be selected as locations of TML towers.
- Sedimentation ponds should be settled if turbid water is anticipated.

9.1.1.3 Soil Erosion and Landslides

Construction Stage: MPPTCL will strictly follow the construction rules to minimize erosion and landslides. The rules are as follows. By adhering to them, the risk of landslides and slope failures will be avoided.

- Slope areas of more than 10 degrees should not be selected as locations of TML towers.
- Geological boring exploration should be done before detailed design.
- High risk landslide areas should be avoided for TML towers.
- Erosion prevention techniques should be adopted for slope areas.
- After construction, bare ground should be covered by vegetation.

9.1.1.4 Waste

Construction Stage: MPPTCL will manage construction waste properly. The following rules will be adopted for all the subprojects.

- Cleared trees and vegetation should be given to the land owners.
- Demolition waste should be taken to an industrial waste dumping site.
- Portable toilets and separated garbage boxes should be installed at the project site.
- No domestic garbage is allowed to be thrown out at the construction site.

The cost for the mitigation will be included in the construction cost.

Operation Stage: MPPTCL has the following waste management rules and they will be adopted at all the substations. Therefore, the impact will be totally minimized.

- Damaged parts should be divided by type (metal, glass, plastic, and flammable) and collected in a waste storage place.
- The waste should be sold to a registered waste collection company.

- Produced waste should be recorded by date, type, volume, and price.

9.1.1.5 Noise and Vibration

Construction Stage: In order to minimize the noise and vibration impact, the following measures will be taken.

- Noise source in the substation should be located more than 30m from residential areas.
- The substation should be designed to reduce the noise at the boundary of the compound to adhere to the noise standards of India (Noise Pollution (Regulation and Control) Rules, 2000).
- If residents around the substation complain about the noise, soundproof covers or sound insulation walls should be examined.

Mitigation cost will be managed by operation costs.

9.1.1.6 Radio Interference

Construction Stage: Radio interference will be completely mitigated by the following compensation rules.

- MPPTCL will inform neighboring communities about the project.
- MPPTCL will establish a special client liaison.
- If MPPTCL receives any complaints about radio interference, it will check the conditions and install community reception antennae.

The mitigation cost would be managed by operation costs.

9.1.2 Natural Environment

9.1.2.1 Protected Species and Ecosystem

Construction Stage: MPPTCL has already selected the routes to avoid the forest areas. But there are some sub-projects which locations are near to the Tiger reserve (No.15, 16, 18, and 25) and distribution areas of leopard. Sub-project No.19 and No. 4 is in the area of *Lindsaea malabarica*. In order to avoid fragmentation of the corridors or extinction by invasive species, careful considerations are required. Then before the routes would be finalized, MPPTCL will discuss with Wildlife Department and Forest Department about the routes and vegetation management under the ROW. Possible mitigation measures are as follows.

During planning

- Based on the biological survey result, change the TML route
- Change the height of the towers to keep higher the vegetation
- Planning compensation planting to protect the habitat

During construction

- Consider construction time schedule to keep corridor to the affected species

Operation Stage: If the Wildlife Department gives any instructions, MPPTCL should follow them adequately. The possible mitigation might be vegetation control under the right of way, installation of the access rules, conducting poaching patrol and so on.

9.1.2.2 Forest

Construction Stage: Forest areas affected by substations and the ROW must be compensated for based on the Forest (Conservation) Act, 1980, amended 1988. Trees cut by the project should be planted at a 1:10 rate. Compensation for plantation will be charged by the Forest Department after site survey. The estimated compensation cost would be 216 million Rs (see Table 9-1). Forest department will plant trees in order to mitigate the cleared forest.

Table 9-1 Forest compensation cost

No.	Name	Forest [km]	ROW [ha]	Cost As per Estimate [INR]
7	Rewa (UMSP) - Sidhi 220 DCDS line	3.0	10.5	33,495,000
9	Julwania 400 - Pati (Silawad) 132kV DCSS Line	0.5	1.4	4,466,000
11	Julwania 400 - Shahpura 132kV DCSS Line	6.0	16.2	51,678,000
13	MugaliaChhap 220 - Mahwadia 132kV DCDS Line	1.4	4.1	13,079,000
15	Sidhi 220 - Madwas 132kV DCSS Line	0.2	0.6	1,914,000
17	Prithivipur-Orchha 132kV DCSS Line	2.0	5.4	17,226,000
18	Sirmour 220 - Atraila 132kV DCSS line	1.0	2.7	8,613,000
23	Sidhi 220 - Sinhawal 132kV DCSS line	1.0	2.7	8,613,000
25	Maneri - Mandla 132kV DCSS line	9.0	24.3	77,517,000

Total	24.1	67.9	216,601,000

Source: MPPTCL

9.1.3 Social Environment

9.1.3.1 Resettlement

Construction Stage: Most resettlement will be avoided during the design stage. But if any resettlement issues happen, MPPTCL will follow the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.

9.1.3.2 Land Use

Construction Stage: In terms of Sub-stations MPPTCL does not need to purchase private land because all of the lands will be government land, directly from the land owner. In terms of ROW, MPPTCL will not need to purchase the land but MPPTCL has to pay compensation for the agricultural crops during construction. Estimated affected crop lands would be 2,736.9 ha and the compensation cost would be 183 million Rs.

Table 9-2 Land compensation cost

No.	Name	Length [km]	ROW [ha]	Unit Cost*1 [INR/ha]	Cost As per Estimate [INR]
1	LILO of one circuit of 400kV Khandwa - Rajgarh PGCIL line at Chhegaon 400kV Substation (D/C) 400kV Bus Reactor at Chhegaon 400kV S/S	5.0	26.0	40,192	1,045,000
2	Pithampur 400-Super Corridor 220kV DCDS line LILO of One ckt of Indore (Jetpura) - Depalpur 132kV DCDS Line at Super Corridor (Indore) 220kV S/s. (D/C)	63.0	210.1	60,995	12,815,000
5	Chhatarpur-Tikamgarh 220kV DCSS line	110.0	385.0	56,000	21,560,000
6	400/220kV Additional Transformer at Bina 400kV S/S LILO of Bina 220 - Ganjbasoda 220kV line at Bina (MPPTCL) 400kV S/s	10.0	35.0	64,429	2,255,000
7	Rewa 220 - Sidhi 220kV DCDS line through Rewa UMSP	90.0	315.0	58,342	18,378,000
9	Julwania 400 - Pati (Silawad) 132kV DCSS Line	40.0	108.0	72,199	7,798,000
10	LILO of Mangliya 220 –Indore 132kV Line at Mahalaxmi	3.0	8.1	74,691	605,000
11	Julwania 400 - Shahpura 132kV DCSS Line	65.0	175.5	78,374	13,755,000
12	Datia 220 - Bhitarwar 132kV DCSS Line	40.0	108.0	72,315	7,810,000
13	MugaliaChhap 220 - Mahwadia 132kV DCDS Line	10.0	27.0	83,878	2,265,000
15	Sidhi 220 - Madwas 132kV DCSS Line	50.0	135.0	73,219	9,885,000
16	Panagar 220 - Dheemarkheda	65.0	175.5	72,707	12,760,000

	132kV DCSS Line				
17	Prithivipur-Orchha 132kV DCSS Line	30.0	81.0	83,664	6,777,000
18	Sirmour 220 - Atraila 132kV DCSS line	35.0	94.5	74,292	7,021,000
19	Udaipura - Tendukheda 132kV DCSS line	45.0	121.5	71,523	8,690,000
20	Gohad - Gormi 132kV DCSS line	25.0	67.5	74,963	5,060,000
21	Narsinghgarh - Suthaliya 132kV DCSS line	50.0	135.0	72,111	9,735,000
22	LILO of Satna 220 - Kymore 132kV line at Unchhera 132kV S/s	5.0	13.5	89,630	1,210,000
23	Sidhi 220 - Sinhawal 132kV DCSS line 132kV	50.0	135.0	74,414	10,046,000
24	2nd ckt of Rajgarh (B) - Raghogarh 132kV DCSS line up to Chachoda 132kV S/s	61.0	164.7	40,540	6,677,000
25	Maneri - Mandla 132kV DCSS line	80.0	216.0	80,334	17,353,000
total		932.0	2,736.9	1,468,810	183,497,000

Note *1: Unit Cost is calculated based on Cost as per estimate from MPPTCL.

Source: MPPTCL

Operation Stage: The land use will be restricted for building construction and tree or crop planting over 4 m. There will be no compensation for this impact based on .

Table 9-3 Entitlement Matrix of Land Use compensation

Item No.	Type of loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation Package)	Implementation issues/Guidelines	Responsible Organization
1.	Stop cropping (during construction)	The land owners and peasants under the right of way	Crop compensations	Values estimated by Revenue Department	Revenue Department
2.	Restrict construction buildings (during operation)	The land owners under the right of way	Nothing	Nothing/ Indian Electricity Act-2003	MPPTCL
3.	Restrict planting (During operation)	The land owners and peasants under the right of way	Nothing	Nothing/ Indian Electricity Act-2003	MPPTCL

9.1.3.3 Local Heritage

Construction Stage: Impacts on local heritage, including temples, holy trees, historical rocks, or local cemeteries, might be revealed at the site survey by the Revenue Department. If any serious impacts are expected, MPPTCL should follow the instructions from the Revenue Department.

9.1.3.4 Ethnic Minorities and Indigenous People

Construction Stage: If impacts on ethnic minorities and indigenous people are identified during the detailed design stage, compensation must be provided based on the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.

9.1.3.5 Public Health

Construction Stage: Even if the risk of infectious diseases is not high, MPPTCL will provide a public health program for all the workers before construction. The program includes:

- Education on the propagation mechanisms of infectious diseases including HIV/AIDS
- Instruction on precautions for infectious diseases
- Instruction on examination for infectious diseases, and
- Instruction on handling methods for infectious diseases.

The program preparation cost would be around USD 3,000. The training will be provided at the same time as the safety program.

9.1.3.6 Accidents

Operation Stage: As long as towers are accessible by the public, the risk of accidents cannot be avoided. In order to lower the risk, danger plates shall be applied to all the transmission towers. The plates should be of durable material and should be well illustrated so that even children who cannot read can understand them. The plates cost would be 3,029,000 Rs. (1,000 Rs. x 3,029 towers).

9.1.3.7 Working Safety

Construction Stage: The Safety Department will prepare a safety training program for construction, and educate the workers before construction. The training cost will be managed by the operation costs of the Safety Department.

Operation Stage: The Safety Department will prepare a safety training program for operation and educate the workers periodically. The training cost will be managed by the operation costs of the Safety Department.

Table 9-4 Mitigation cost

No.	Impacts	Proposed mitigation	Implementing Organization	Responsible Organization	Cost
Construction					
1	Water pollution	• Slope areas of more than 10 degrees should not be selected as locations of TML towers. • Sedimentation ponds should be settled if turbid water is anticipated.	MPPTCL	MPPTCL	Unknown (Included in construction cost)
2	Soil erosion and landslides	• Slope areas of more than 10 degrees should not be selected as locations of TML towers. • Geological boring exploration should be done before detailed design. • High risk landslide areas should be avoided for TML towers. • Erosion prevention techniques should be adopted for slope areas. • After construction, bare ground should be covered by vegetation.	MPPTCL	MPPTCL	Unknown (Included in construction cost)
3	Waste	• Cleared trees and vegetation should be given to the land owners. • Demolition waste should be taken to an industrial waste dumping site. • Portable toilets and separated garbage boxes should be installed at the project site. • No domestic garbage is allowed to be thrown out at the construction site.	MPPTCL	MPPTCL	Unknown (Included in construction cost)
4	Noise	• Noise source in the substation should be located more than 30m from residential areas. • The substation should be designed to reduce the noise at the boundary of the compound to adhere to the noise standards of India (Noise Pollution (Regulation and Control) Rules, 2000). • If residents around the substation complain about the noise, soundproof covers or sound insulation walls should be examined.	MPPTCL	MPPTCL	Unknown (Included in construction cost)
5	Radio Interference	• MPPTCL will inform neighboring communities about the project. • MPPTCL will establish a special client liaison. • If MPPTCL receives	MPPTCL	MPPTCL	Unknown (Included in construction cost)

6	Protected Species and Ecosystem	Before the routes would be finalized, MPPTCL will discuss with Wildlife Department and Forest Department about the routes and vegetation management under the ROW.	MPPTCL	MPPTCL	Unknown (Included in construction cost)
7	Forest	Tree plantation	Department of Forest	Department of Forest	216,601,000 INR
8	Resettlement	MPPTCL will follow the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	MPPTCL	Revenue Department	Unknown
9	Land use	MPPTCL has to pay compensation for the agricultural crops during construction	MPPTCL	Revenue Department	183 million Rs.
10	Local Heritage	If any serious impacts are expected, MPPTCL should follow the instructions from the Revenue Department.	MPPTCL	Revenue Department	Unknown
11	Ethnic Minorities and Indigenous People	If impacts on ethnic minorities and indigenous people are identified during the detailed design stage, compensation must be provided based on the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.	MPPTCL	Revenue Department	Unknown
12	Public Health	The program includes: • Education on the propagation mechanisms of infectious diseases including HIV/AIDS • Instruction on precautions for infectious diseases • Instruction on examination for infectious diseases, and • Instruction on handling methods for infectious diseases.	MPPTCL	MPPTCL	USD 3,000
13	Working Safety	The Safety Department will prepare a safety training program for construction, and educate the workers before construction.	MPPTCL	MPPTCL	Unknown (operation cost of the Safety Department)
Operation					
1	Global warming	Careful maintenance to collect 80% of thesealed SF6 in every 12 years	MPPTCL	MPPTCL	594,751 Rs./year (Included in operation cost)
2	Waste	• Damaged parts should be divided by type (metal, glass, plastic, and flammable) and collected in a waste storage place. • The waste should be sold to a registered waste collection company. • Produced waste should be recorded by date, type, volume, and price.	MPPTCL	MPPTCL	Unknown (Included in operation cost)
3	Protected species and Ecosystem	If the Wildlife Department gives any instructions, MPPTCL should follow them adequately.	MPPTCL	MPPTCL	Unknown (Included in operation cost)
4	Accidents	In order to lower the risk, danger plates shall be applied to all the transmission towers. The plates should be of durable material and should be well illustrated so that even children who cannot read can understand them.	MPPTCL	MPPTCL	3,029,000 Rs

5	Working Safety	The Safety Department will prepare a safety training program for operation and educate the workers periodically	MPPTCL	MPPTCL	Unknown (Included in operation cost)
Total cost					Unknown

9.2 Monitoring Plan

9.2.1 Impact Monitoring

Impact monitoring will be done based on the order by Forest Department. If Forest Department will not order any monitoring, no monitoring will be conducted. Possible items are as follows.

Table 9-5 Impact Monitoring

Items	Sub items	Location	Frequency	Responsible organizations
During construction				
Plant	Flora, Vegetation	33 subprojects	2 times a year	MPPTCL
Mammal	Fauna, protected species	33 subprojects	2 times a year	MPPTCL
Bird	Fauna, protected species	33 subprojects	2 times a year	
Reptile/ Amphibian	Fauna, protected species	33 subprojects	2 times a year	MPPTCL
Fish	Fauna, protected species	33 subprojects	2 times a year	MPPTCL
Operation				
Plant	Flora, Vegetation	33 subprojects	2 times a year	MPPTCL
Mammal	Fauna, protected species	33 subprojects	2 times a year	MPPTCL
Bird	Fauna, protected species	33 subprojects	2 times a year	MPPTCL
Reptile/ Amphibian	Fauna, protected species	33 subprojects	2 times a year	MPPTCL
Fish	Fauna, protected species	33 subprojects	2 times a year	MPPTCL

9.2.2 Compliance monitoring

The compliance monitoring should be conducted once a month by subprojects during detailed design and construction. If the mitigation does not work as planned, adequate mitigation measures should be planned. Impact monitoring will be considered based on the suggestions from the Forest Department and complaints from the people.

Table 9-6 Compliance Monitoring

Items	Sub items	Location	Frequency	Responsible organizations
During construction				
General	Institutional arrangement, Reporting and feedback	33 subprojects	Once a month	MPPTCL
Physical Environment	Water pollution, Soil erosion and landslides, Waste, Noise and vibration, Radio interference	33 subprojects	Once a month	MPPTCL
Natural Environment	Protected species and ecosystem, Forest	33 subprojects	Once a month	MPPTCL
Social Environment	Information disclosure, Land use, Local heritage, Ethnic	33 subprojects	Once a month	MPPTCL

	minorities and Indigenous people, Public Health, Accidents, Working safety, Resettlement			
During Operation				
General	Institutional arrangement, Reporting and feedback	33 subprojects	Once a month	MPPTCL
Physical Environment	Water pollution, Global warming, Soil erosion and landslides, Waste, Noise and vibration, Radio interference	33 subprojects	Once a month	MPPTCL
Natural Environment	Protected species and ecosystem	33 subprojects	Once a month	MPPTCL
Social Environment	Information disclosure, Land use, Ethnic minorities and Indigenous people, Accidents, Working safety, Resettlement	33 subprojects	Once a month	MPPTCL

Table 9-7 Compliance Monitoring check sheet for design and construction period

Compliance Monitoring check sheet		
Date: _____	Subproject Name: _____	Person: _____
Location: _____		

General				
Institutional arrangement	• MPPTCL should assign a person in charge of compliance monitoring.		□ Satisfied	□ Unsatisfied
	• MPPTCL should hire or assign a person who has enough knowledge about the environment for monitoring.		□ Satisfied	□ Unsatisfied
Reporting and feedback	• MPPTCL should have submitted the monitoring check sheet to JICA last month.		□ Satisfied	□ Unsatisfied
	• MPPTCL should take action on the suggestions from previous monitoring.		□ Satisfied	□ Unsatisfied

Physical Environment				
Water pollution	• Slope areas of more than 10 degrees should not be selected as locations of TML towers.	□ Not applicable	□ Satisfied	□ Unsatisfied
	• Sedimentation ponds should be settled if turbid water is anticipated.	□ Not applicable	□ Satisfied	□ Unsatisfied
Soil erosion and landslides	• Slope areas of more than 10 degrees should not be selected as locations of TML towers.	□ Not applicable	□ Satisfied	□ Unsatisfied
	• Geological boring exploration should be done before detailed design.	□ Not applicable	□ Satisfied	□ Unsatisfied
	• High risk landslide areas should be avoided for TML towers.	□ Not applicable	□ Satisfied	□ Unsatisfied
	• Erosion prevention techniques should be adopted for slope areas.	□ Not applicable	□ Satisfied	□ Unsatisfied
	• After construction, bare ground should be covered by vegetation.		□ Satisfied	□ Unsatisfied
Waste	• Cleared trees and vegetation should be given to the land owners.		□ Satisfied	□ Unsatisfied
	• Demolition waste should be taken to an industrial waste dumping site.		□ Satisfied	□ Unsatisfied
	• Portable toilets and separated garbage boxes should be installed at the project site.		□ Satisfied	□ Unsatisfied
	• No domestic garbage is allowed to be thrown out at the construction site.		□ Satisfied	□ Unsatisfied
Noise and vibration	• Noise source in the substation should be located more than 30m from residential areas.		□ Satisfied	□ Unsatisfied

	• The substation should be designed to reduce the noise at the boundary of the compound to adhere to the noise standards of India (Noise Pollution (Regulation and Control) Rules, 2000).		□ Satisfied	□ Unsatisfied
	• If residents around the substation complain about the noise, soundproof covers or sound insulation walls should be examined.	□ Not applicable	□ Satisfied	□ Unsatisfied
	• Construction noise should be lower than the national standard noise level at the residential area and it should be during the designated time.		□ Satisfied	□ Unsatisfied
Radio interference	• MPPTCL should inform the neighboring communities about the project's radio interference risk.		□ Satisfied	□ Unsatisfied

Natural Environment				
Protected Species and ecosystem	• Before finalizing the locations, MPPTCL should discuss with the Wildlife Department about important habitats for protected species such as Tiger and Leopard.		□ Satisfied	□ Unsatisfied
	• MPPTCL should strictly follow the instructions from the Wildlife Department, if any instructions are given.	□ Not applicable	□ Satisfied	□ Unsatisfied
Forest	• MPPTCL should get Forest clearance if there are any forest areas in the planned route.	□ Not applicable	□ Satisfied	□ Unsatisfied

Social Environment				
Information disclosure	The project design, possible impact, compensation plans, and grievance mechanism are fully explained to all the affected people before the designs are fixed. The design should not be fixed before communication with the people.		□ Satisfied	□ Unsatisfied
	The project is announced in newspapers before construction.		□ Satisfied	□ Unsatisfied
	When MPPTCL receives opinions or suggestions from the affected people, MPPTCL should take them into account for designs or compensation.	□ Not applicable	□ Satisfied	□ Unsatisfied
Land use	MPPTCL should follow crop compensation procedures and pay compensation costs to the Revenue Department.		□ Satisfied	□ Unsatisfied
Local heritage	If any sites of cultural importance, such as temples, holy trees, historical rocks, or local cemeteries are found by the site survey, MPPTCL should follow the instructions from the Revenue Department.	□ Not applicable	□ Satisfied	□ Unsatisfied
Ethnic minorities and Indigenous people	If impacts on ethnic minorities and indigenous people are identified during detailed design, compensation must be provided to them.	□ Not applicable	□ Satisfied	□ Unsatisfied
Public Health	MPPTCL should conduct a public health program for all the workers before construction.		□ Satisfied	□ Unsatisfied
Accidents	MPPTCL should explain the risk of electrification to the local people and install warning sign on all the		□ Satisfied	□ Unsatisfied

	towers.			
Working safety	The Safety Department will prepare a safety training program for construction and educate the workers before construction.		□ Satisfied	□ Unsatisfied
Resettlement	All resettlement is avoided, including illegal squatters.		□ Satisfied	□ Unsatisfied
	If some resettlements are not avoided, they should be compensated for based on "Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013".	□ Not applicable	□ Satisfied	□ Unsatisfied

Problems and the reasons (with the name of responsible party)

Suggestions for minimizing the impact

Table 9-8 Compliance Monitoring check sheet for Operation period

Compliance Monitoring check sheet		
Date: _____	Subproject Name: _____	Person: _____
Location: _____		

General

Institutional arrangement	• MPPTCL should assign a person in charge of compliance monitoring.		□ Satisfied	□ Unsatisfied
	• MPPTCL should hire or assign a person who has enough knowledge about the environment for monitoring.		□ Satisfied	□ Unsatisfied
Reporting and feedback	• MPPTCL should have submitted the monitoring check sheet to JICA last month.		□ Satisfied	□ Unsatisfied
	• MPPTCL should take action on the suggestions from previous monitoring.		□ Satisfied	□ Unsatisfied

Physical Environment				
Water pollution	• Domestic waste water is treated properly and does not cause any river/underground water pollution.		□ Satisfied	□ Unsatisfied
	• Industrial waste water is treated properly and does not cause any river/underground water pollution.		□ Satisfied	□ Unsatisfied
Global warming	SF6 gas should be collected properly during maintenance.	□ Not applicable	□ Satisfied	□ Unsatisfied
Soil erosion and landslides	• Slopes after construction do not cause landslides or erosion.	□ Not applicable	□ Satisfied	□ Unsatisfied
	• Planted vegetation is growing as planned.	□ Not applicable	□ Satisfied	□ Unsatisfied
Waste	• Domestic waste is properly collected and treated. No garbages are thrown out around the project site.		□ Satisfied	□ Unsatisfied
	• Industrial waste is properly collected and treated. It is not thrown out around the project site.		□ Satisfied	□ Unsatisfied
	• Sub-station areas are cleaned well and free from waste.		□ Satisfied	□ Unsatisfied
Noise and vibration	• Noise level at the nearest settlement is under the environmental standard (Noise Pollution (Regulation and Control) Rules, 2000). Residents are not complaining about the noise caused by the project.		□ Satisfied	□ Unsatisfied
	• If residents around the substation complain about the noise, soundproof covers or sound insulation walls should be examined.	□ Not applicable	□ Satisfied	□ Unsatisfied
Radio interference	• If MPPTCL receives any complaints about radio interference, take mitigation measures such as installing community reception antennae.	□ Not applicable	□ Satisfied	□ Unsatisfied

Natural Environment				
Protected Species and ecosystem	• If the Wildlife Department gives instructions for vegetation management etc., MPPTCL should follow the instructions.	□ Not applicable	□ Satisfied	□ Unsatisfied
	• If any important animals are found, MPPTCL should inform the Wildlife Department immediately.	□ Not applicable	□ Satisfied	□ Unsatisfied

Social Environment

Information disclosure	If MPPTCL gets any complaints about the project, MPPTCL should follow the grievance mechanism under the Indian Laws.	□ Not applicable	□ Satisfied	□ Unsatisfied
Land use	If any kind of damage to people's property is caused by the project, MPPTCL has to compensate for it. The living standards of the affected people should not be lowered by the project.	□ Not applicable	□ Satisfied	□ Unsatisfied
Ethnic minorities and Indigenous people	The living standards of the affected people should not be lowered by the project. If their living standards are lowered by the project, additional compensation should be considered.	□ Not applicable	□ Satisfied	□ Unsatisfied
Accidents	MPPTCL should replace the warning signs on the towers if they are broken.	□ Not applicable	□ Satisfied	□ Unsatisfied
Working safety	The Safety Department should implement a safety training program for the workers periodically.		□ Satisfied	□ Unsatisfied
Resettlement	If any resettlements happen, MPPTCL has to keep supporting the affected people so as not to lower their living standard or to upgrade them to higher than the poverty line.	□ Not applicable	□ Satisfied	□ Unsatisfied

Problems and the reasons (with the name of responsible party)

Suggestions for minimizing the impact

9.3 Implementation Arrangement

There is no Environmental Department in MPPTCL but the Construction Department and Land Department etc. will manage all the environmental and social issues. The PMU will manage all the Environmental and Social issues, cooperating with the following departments.

Table 9-9 Environmental Items and Department Responsible

Items	Department Responsible	Mitigation planning	Mitigation implementation	Impact Monitoring	Compliance Monitoring	Evaluation
Air, Noise	Construction Department, MPPTCL	Contractor	Contractor	-	Env. Consultant	JICA
Waste water	Construction Department, MPPTCL/Contractor	Contractor	Contractor	-	Env. Consultant	JICA
Soil Erosion	Construction Department, MPPTCL/Construction Contractor	Contractor	Contractor	-	Env. Consultant	JICA
Industrial waste	Operation & Maintenance Department, MPPTCL	Contractor	Contractor	-	Env. Consultant	JICA
Electromagnetic waves	Construction Department/Gov. of MP	Construction Department of MPPTCL	Construction Department of MPPTCL	-	Env. Consultant	JICA
Forest impact	Project Management Unit, MPPTCL	Forest Department	Forest Department	Env. Consultant	Env. Consultant	JICA
Protected species	Project Management Unit, MPPTCL	Wildlife Department	Wildlife Department	Env. Consultant	Env. Consultant	JICA
Land and resettlement	Land Department, MPPTCL	Revenue Department	Revenue Department	-	Env. Consultant	JICA
Ethnic Minorities	Land Department, MPPTCL	Revenue Department	Revenue Department	-	Env. Consultant	JICA
Cultural assets	Land Department, MPPTCL	Revenue Department	Revenue Department	-	Env. Consultant	JICA
Landscape	Construction Department, MPPTCL/Construction contractor	Revenue Department	Revenue Department	-	Env. Consultant	JICA
Public health	Health Department, MPPTCL	Health Department of MPPTCL	Health Department of MPPTCL	-	Env. Consultant	JICA
Accidents	Safety Department, MPPTCL	Safety Department of MPPTCL	Safety Department of MPPTCL	-	Env. Consultant	JICA
Work safety	Safety Department, MPPTCL	Safety Department of MPPTCL	Safety Department of MPPTCL	-	Env. Consultant	JICA

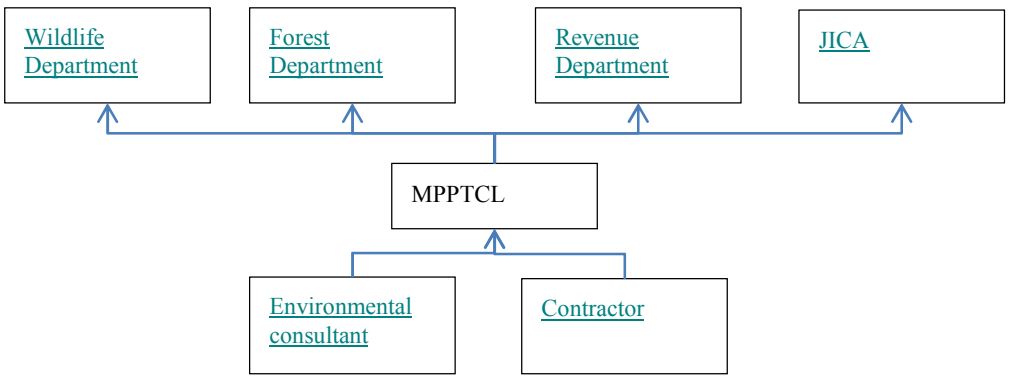


Figure 9-1 Implementation Arrangement of Mitigation and Monitoring

9.4 Reporting and Audit

To monitor and manage the environmental issues effectively, a monthly monitoring report must be prepared by MPPTCL. Based on the monthly reports, MPPTCL will summarize and submit a quarterly monitoring report during construction and semiannually monitoring report during operation to JICA. If Forest department or Wildlife Department order any report submission, MPPTCL will submit the monitoring report to them.

10 Public Consultation and Information Disclosure

The Project does not require an EIA or SIA. Therefore, public consultations and information disclosure related to EIA and SIA are not planned. But the project plan will be reported on in local newspapers before construction as per the Indian Electricity Act 2003. People can appeal to MPPTCL within 60 days and MPPTCL will manage the appeal.

11 Grievance Mechanism

MPPTCL and the Revenue Department of the Government of Madhya Pradesh ensure that all grievances and complaints regarding environmental and social impacts will be addressed in a timely and satisfactory manner. The Aps can make complaints or air their grievances regarding the project implementation in areas related to compensation, entitlement, compensation policy, rates, land acquisition, resettlement, allowance, income restoration and so on. The complaining APs will not be charged any fee during the resolution of their grievances and complaints. There are four (4) stages in the resolution of grievances and complaints under the Project. MPPTCL and the Revenue Department must explain the Grievance Mechanism to all the APs.

(i) First Stage: The APs can make a claim to the project complaints officers of MPPTCL and the Revenue Department.

(ii) Second Stage: Nyaya Panchayat - If the AP is not satisfied with the compensation suggested by the Revenue Department, the AP may submit the complaint to the Nyaya Panchayat, in written or verbal form. The cost of the consultation should be charged to MPPTCL and the Revenue Department. The Nyaya Panchayat will examine the complaint referring to the compensation rules, such as compensation unit cost, resettlement allowance etc., and seek a solution. The suggested solution should be recorded and opened to the public with its reasons.

(iii) Third Stage: District Legal Service Authority - If the AP does not accept the suggestions by Nyaya Panchayat, the AP may submit the complaint to the District Legal Service Authority in written form. The cost of the lawsuit should be charged to MPPTCL and the Revenue Department. The District Legal Service Authority should examine the case and give the decision of the court.

(iv) Fourth Stage: Madhya Pradesh Legal Service Authority – If the AP does not accept the decision of the court, the AP can appeal it to the Madhya Pradesh Legal Service Authority. The cost of the lawsuit should be charged to MPPTCL and the Revenue Department.

Environmental Screening Format

Name of Proposed Project: ***Transmission System Strengthening Works in Madhya Pradesh***
Project Executing Organization, Project Proponent or Investment Company: ***Madhya Pradesh Power Transmission Corporation Limited (MPPTCL)***
Name, Address, Organization, and Contact Point of a Responsible Officer:

Name: ***S.P. Gupta***
Address: ***Chief Engineer (Procurement)***
Organization: ***MPPTCL***
Tel: ***0761-2702134***
Fax***: 0761-2665593***
E-Mail:
Date***:*** _____

Signature***:*** _____

Check Items

Please write "to be advised (TBA)" when the details of a project are yet to be determined.

Question 1:
Address of project site

35 projects are located in various districts (See table 1). 12 of them are just installing equipment into existing Substations. Excepting these upgrading projects other projects locates in 26 districts in Madhya Pradesh.

Table 1 Names of the district by Substations

No.	*Project description*	*District*
1	*LILO of one circuit of 400kV Khandwa - Rajgarh PGCIL line at Chhegaon 400kV Substation (D/C)* *400kV Bus Reactor at Chhegaon 400kV S/S*	*East Nimar*
2	*Pithampur400-Super Corridor 220kV DCDS line* *LILO of One ckt of Indore(Jetpura) - Depalpur 132kV DCDS Line at Super Corridor (Indore) 220kV S/s.(D/C)*	*Indore, Dhar*
4	*Charging/Upgradation of Chichli220 - Udaipura DCDS line on 220kV level*	*Raisen*
5	*Chhatarpur-Tikamgarh 220kV DCSS line*	*Chhattarpur, Tikamgarh*
6	*400/220kV Additional Transformer at Bina 400kV S/S* *LILO of Bina220 - Ganjbasoda 220kV line at Bina(MPPTCL) 400kV S/s*	*Sagar*
7	*Rewa220 - Sidhi 220kV DCDS line through Rewa UMSP*	*Rewa, Sidhi*
9	*Julwania400 - Pati(Silawad) 132kV DCSS Line*	*Barwani*
10	*LILO of Mangliya220 –Indore 132kV Line at Mahalaxmi*	*Indore*
11	*Julwania400 - Shahpura 132kV DCSS Line*	*Barwani*
12	*Datia220 - Bhitarwar 132kV DCSS Line*	*Gwalior, Datia*
13	*MugaliaChhap220 - Mahwadia 132kV DCDS Line*	*Bhopal*

No.	Project description	District
15	Sidhi220 - Madwas 132kV DCSS Line	Sidhi
16	Panagar220 - Dheemarkheda 132kV DCSS Line	Jabalpur, Katni
17	Prithivipur-Orchha 132kV DCSS Line	Tikamgarh
18	Sirmour220 - Atraila 132kV DCSS line	Rewa
19	Udaipura - Tendukheda 132kV DCSS line	Raisen, Narsimhapur
20	Gohad - Gormi 132kV DCSS line	Bhind
21	Narsinghgarh - Suthaliya 132kV DCSS line	Rajgarh
22	LILO of Satna220 - Kymore 132kV line at Unchhera 132kV S/s	Satna
23	Sidhi220 - Sinhawal 132kV DCSS line 132kV	Sidhi
24	2nd ckt of Rajgarh(B) - Raghogarh 132kV DCSS line up to Chachoda 132kV S/s	Rajgarh, Guna
25	Maneri - Mandla 132kV DCSS line	Mandla
26	Sukha (Jabalpur)	Jabalpur
27	Hoshangabad 220kV (2nd)	Hoshangabad
28	Barwaha 220kV (3rd)	West Nimar
29	Betma 132kV	Indore
30	Khirkiya 132kV	Harda
31	Amla 132kV	Betul
32	Tejgarh 132kV	Damoh
33	Satwas 132kV	Harda
34	Sitamau 132kV	Mandsaur
35	Baroda 132kV	Shajapur
36	Amrawadkhurd 132kV	Bhopal

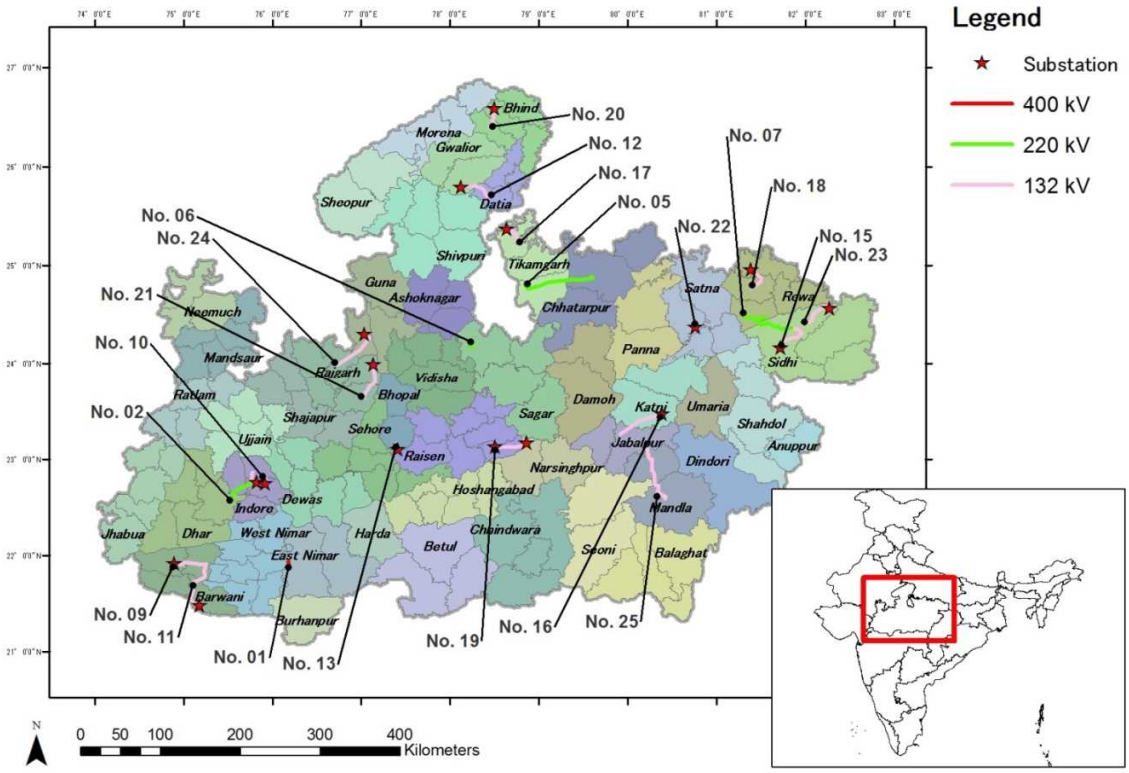


Figure 1 Location of the subprojects

Question 2:

Scale and contents of the project (approximate area, facilities area, production, electricity generated, etc.)

2-1. Project profile (scale and contents)

21 TML, 15 new Substations, and 13 Additional Transformers are planned in 33 sub-projects.

Table 2 Project profile

No.	*Project description*	*TML (km)*			*Substation*		*Additional Transformer*
		400 kV	*220 kV*	*132 kV*	*Name*	*Required Area (ha)*	
1	*LILO of one circuit of 400kV Khandwa - Rajgarh PGCIL line at Chhegaon 400kV Substation (D/C) 400kV Bus Reactor at Chhegaon 400kV S/S*	*5*	*-*	*-*	*-*	*-*	*1x125 MVAR*
2	*Pithampur400-Super Corridor 220kV DCDS line LILO of One ckt of Indore(Jetpura) - Depalpur 132kV DCDS Line at Super Corridor (Indore) 220kV S/s.(D/C)*	*-*	*50*	*13*	*Super Corridor (Indore)*	*3.27*	
4	*Charging/Upgradation of Chichli220 - Udaipura DCDS line on 220kV level*	*-*	*-*	*-*	*Udaipura*	*-*	
5	*Chhatarpur-Tikamgarh 220kV DCSS line*	*-*	*110*	*-*	*-*	*-*	
6	*400/220kV Additional Transformer at Bina 400kV S/S LILO of Bina220 - Ganjbasoda 220kV line at Bina(MPPTCL) 400kV S/s*	*-*	*10*	*-*	*-*	*-*	*1x315 MVA*
7	*Rewa220 - Sidhi 220kV DCDS line through Rewa UMSP*	*-*	*90*	*-*	*-*	*-*	
9	*Julwania400 - Pati(Silawad) 132kV DCSS Line*	*-*	*-*	*40*	*Pati(Silawad)*	*4.00*	
10	*LILO of Mangliya220 –Indore 132kV Line at Mahalaxmi*	*-*	*-*	*3*	*Mahalaxmi*	*unknown*	
11	*Julwania400 - Shahpura 132kV DCSS Line*	*-*	*-*	*65*	*Shahpura*	*2.25*	
12	*Datia220 - Bhitarwar 132kV DCSS Line*	*-*	*-*	*40*	*Bhitarwar*	*2.25*	
13	*MugaliaChhap220 - Mahwadia 132kV DCDS Line*	*-*	*-*	*10*	*Mahwadia*	*5.00*	
15	*Sidhi220 - Madwas 132kV DCSS Line*	*-*	*-*	*50*	*Madwas*	*3.30*	
16	*Panagar220 - Dheemarkheda 132kV DCSS Line*	*-*	*-*	*65*	*Dheemarkheda*	*2.25*	
17	*Prithivipur-Orchha 132kV DCSS Line*	*-*	*-*	*30*	*Orchha*	*3.00*	
18	*Sirmour220 - Atraila 132kV DCSS line*	*-*	*-*	*35*	*Atraila*	*4.00*	
19	*Udaipura - Tendukheda 132kV DCSS line*	*-*	*-*	*45*	*Tendukheda*	*3.82*	
20	*Gohad - Gormi 132kV DCSS line*	*-*	*-*	*25*	*Gormi*	*2.25*	
21	*Narsinghgarh - Suthaliya 132kV DCSS line*	*-*	*-*	*50*	*Suthaliya*	*3.28*	
22	*LILO of Satna220 - Kymore 132kV line at Unchhera 132kV S/s*	*-*	*-*	*5*	*Unchhera*	*6.25*	
23	*Sidhi220 - Sinhawal 132kV DCSS line 132kV*	*-*	*-*	*50*	*Sinhawal*	*unknown*	

No.	*Project description*	*TML (km)*			*Substation*		*Additional Transformer*
		400 kV	*220 kV*	*132 kV*	*Name*	*Required Area (ha)*	
24	*2nd ckt of Rajgarh(B) - Raghogarh 132kV DCSS line up to Chachoda 132kV S/s*	*-*	*-*	*61*	*Chachoda*	*unknown*	
25	*Maneri - Mandla 132kV DCSS line*	*-*	*-*	*80*	*-*	*-*	
26	*Sukha (Jabalpur)*	*-*	*-*	*-*	*-*	*-*	*+ 2x50 MVA*
27	*Hoshangabad 220kV (2nd)*	*-*	*-*	*-*	*-*	*-*	*+ 1x160 MVA*
28	*Barwaha 220kV (3rd)*	*-*	*-*	*-*	*-*	*-*	*+ 1x160 MVA*
29	*Betma 132kV*	*-*	*-*	*-*	*-*	*-*	*+ 50 MVA*
30	*Khirkiya 132kV*	*-*	*-*	*-*	*-*	*-*	*+ 50 MVA*
31	*Amla 132kV*	*-*	*-*	*-*	*-*	*-*	*+ 50 MVA*
32	*Tejgarh 132kV*	*-*	*-*	*-*	*-*	*-*	*+ 50 MVA*
33	*Satwas 132kV*	*-*	*-*	*-*	*-*	*-*	*+ 50 MVA*
34	*Sitamau 132kV*	*-*	*-*	*-*	*-*	*-*	*+ 50 MVA*
35	*Baroda 132kV*	*-*	*-*	*-*	*-*	*-*	*+ 50 MVA*
36	*Amrawadkhurd 132kV*	*-*	*-*	*-*	*-*	*-*	*+ 50 MVA*

2-2. How was the necessity of the project confirmed?
Is the project consistent with the higher program/policy?
☑YES: Please describe the higher program/policy.
（*13th Five year Plan (2018-2023)* ）
□NO

2-3. Did the proponent consider alternatives before this request?
☑YES: Please describe outline of the alternatives
（***Many alternative TML routes of first design were changed to avoid protected area, forest area, and residential area.***）
□NO

2-4. Did the proponent implement meetings with the related stakeholders before this request?
□Implemented ☑Not implemented
If implemented, please mark the following stakeholders.
□Administrative body
□Local residents
□NGO
□Others（ ）

Question 3:

Is the project a new one or an ongoing one? In the case of an ongoing project, have you received strong complaints or other comments from local residents?

☑New ☐Ongoing (with complaints) ☐Ongoing (without complaints)
☐Other ( )

Question 4:

Is an Environmental Impact Assessment (EIA), including an Initial Environmental Examination (IEE) Is, required for the project according to a law or guidelines of a host country? If yes, is EIA implemented or planned? If necessary, please fill in the reason why EIA is required.

☐Necessity (☐Implemented ☐Ongoing/planning)
(Reason why EIA is required:)
☑Not necessary
☐Other (please explain)

Question 5:

In the case that steps were taken for an EIA, was the EIA approved by the relevant laws of the host country? If yes, please note the date of approval and the competent authority.

☐Approved without a supplementary condition	☐Approved with a supplementary condition	☐Under appraisal

(Date of approval: Competent authority:)
☐Under implementation
☐Appraisal process not yet started
☐Other ( )

Question 6:

If the project requires a certificate regarding the environment and society other than an EIA, please indicate the title of said certificate. Was it approved?

☐Already certified
Title of the certificate: ( )
☑Requires a certificate but not yet approved
(Forest Clearances are required for 67.7 ha for 9 sub-projects. They will be taken in a year.)

☐Not required

☐Other ( )

Question 7:

Are any of the following areas present either inside or surrounding the project site?
☑Yes ☐No

If yes, please mark the corresponding items.

☐National parks, protection areas designated by the government (coastline, wetlands, reserved area for

ethnic or indigenous people, cultural heritage)

☐Primeval forests, tropical natural forests

☐Ecologically important habitats (coral reefs, mangrove wetlands, tidal flats, etc.)

☑Habitats of endangered species for which protection is required under local laws and/or international treaties

(All the Tiger reserves and known tiger habitat are avoided. Some sub-projects (No. 15, 16, 18, 25) are near the habitat of Tiger (See Figure 2). MPPTCL will strictly follow all the instructions of Forest Department.)

☐Areas that run the risk of a large scale increase in soil salinity or soil erosion

☐Remarkable desertification areas

☐Areas with special values from an archaeological, historical, and/or cultural points of view

☑Habitats of minorities, indigenous people, or nomadic people with a traditional lifestyle, or areas with special social value

(Some of the lands of scheduled tribe and scheduled caste might be affected by ROW. They will be compensated based on government rules.)

Question 8:

Does the project include any of the following items?

☑Yes ☐No

If yes, please mark the appropriate items.

☑Involuntary resettlement (It might happen involuntary resettlement but the scale is not clear now.)

☐Groundwater pumping (scale: m3/year)

☑Land reclamation, land development, and/or land-clearing

(scale: Around 44.92 + x hectors of government land will be developed for the new Sub-stations. No private land will be affected by Sub-stations (See table 3). In terms of TML 2,669 hectors of crop land or wood land might come under the ROW (See table 4). The land under the ROW/Tower is not need expropriation and land owners can use the land up to 4.5m for agricultural purposes.)

Table 3 Required Government Areas for the new Sub-stations

No.	*SS Name*	*Required Area (ha)*
2	*Super Corridor (Indore)*	*3.27*
9	*Pati(Silawad)*	*4.00*
10	*Mahalaxmi*	*unknown*
11	*Shahpura*	*2.25*
12	*Bhitarwar*	*2.25*
13	*Mahwadia*	*5.00*
15	*Madwas*	*3.30*
16	*Dheemarkheda*	*2.25*
17	*Orchha*	*3.00*
18	*Atraila*	*4.00*
19	*Tendukheda*	*3.82*
20	*Gormi*	*2.25*
21	*Suthaliya*	*3.28*

22	***Unchhera***	***6.25***
23	***Sinhawal***	***unknown***
24	***Chachoda***	***unknown***
Total		***44.92+ x***

Table 4 Estimated affected crop/tree areas for compensation

No.	400 kV				220 kV			
	Length (km)	ROW (ha)	Length (km)	ROW (ha)	Length (km)	ROW (ha)	Length (km)	ROW (ha)
1	5.0	26.0	-	-	-	-	5.0	26.0
2	-	-	50.0	175.0	13.0	35.1	63.0	210.1
5	-	-	110.0	385.0	-	-	110.0	385.0
6	-	-	10.0	35.0	-	-	10.0	35.0
7	-	-	90.0	315.0	-	-	90.0	315.0
9	-	-	-	-	40.0	108.0	40.0	108.0
10	-	-	-	-	3.0	8.1	3.0	8.1
11	-	-	-	-	65.0	175.5	65.0	175.5
12	-	-	-	-	40.0	108.0	40.0	108.0
13	-	-	-	-	10.0	27.0	10.0	27.0
15	-	-	-	-	50.0	135.0	50.0	135.0
16	-	-	-	-	65.0	175.5	65.0	175.5
17	-	-	-	-	30.0	81.0	30.0	81.0
18	-	-	-	-	35.0	94.5	35.0	94.5
19	-	-	-	-	45.0	121.5	45.0	121.5
20	-	-	-	-	25.0	67.5	25.0	67.5
21	-	-	-	-	50.0	135.0	50.0	135.0
22	-	-	-	-	5.0	13.5	5.0	13.5
23	-	-	-	-	50.0	135.0	50.0	135.0
24	-	-	-	-	61.0	164.7	61.0	164.7
25	-	-	-	-	80.0	216.0	80.0	216.0
Total	5.0	26.0	260.0	910.0	667.0	1,800.9	932.0	2,736.9

☑Logging (scale: ***67.7 hectors of forest land should be claimed for Forest Clearance***)

Table 5 Affected forest areas

No	***Project Name***	***Voltage***	***Forest (km)***	
			Length (km)	***RoW (ha)***
7	***Rewa220 - Sidhi 220kV DCDS line through Rewa UMSP***	***220***	***3.0***	***10.5***
9	***Julwania400 - Pati(Silawad) 132kV DCSS Line***	***132***	***0.5***	***1.4***
10	***Mangliya220 - Mahalaxmi 132kV DCDS Line***	***132***	***-***	***-***
11	***Julwania400 - Shahpura 132kV DCSS Line***	***132***	***6.0***	***16.2***
12	***Datia220 - Bhitarwar 132kV DCSS Line***	***132***	***-***	***-***
13	***MugaliaChhap220 - Mahwadia 132kV DCDS Line***	***132***	***1.5***	***4.1***
15	***Sidhi220 - Madwas 132kV DCSS Line***	***132***	***0.2***	***0.5***
17	***Prithivipur-Orchha 132kV DCSS Line***	***132***	***2.0***	***5.4***

18	*Sirmour220 - Atraila 132kV DCSS line*	*132*	*1.0*	*2.7*
23	*LILO of one ckt of Sidhi220 - Deosar 132kV line at Sinhawal 132kV S/s*	*132*	*1.0*	*2.7*
25	*Maneri - Mandla 132kV DCSS line*	*132*	*9.0*	*24.3*
Total			*24.2*	*67.7*

Question 9:

Please mark related adverse environmental and social impacts, and describe their outlines.

☐Air pollution
☐Water pollution
☐Soil pollution
☐Waste
☐Noise and vibrations
☐Ground subsidence
☐Offensive odors
☐Geographical features
☐Bottom sediment
☑Biota and ecosystems
☐Water usage
☑Accidents
☐Global warming

☑Involuntary resettlement
☐Local economies, such as employment, livelihood, etc.
☑Land use and utilization of local resources
☐Social institutions such as social infrastructure and local decision-making institutions
☐Existing social infrastructures and services
☑Poor, indigenous, or ethnic people
☐Misdistribution of benefits and damages
☐Local conflicts of interest
☐Gender
☐Children's rights
☐Cultural heritage
☐Infectious diseases such as HIV/AIDS
☐Other ( )

Outline of related impact:

Tige habitat might be affected by some sob-projects. It might cause habitat fragmentation and make the risk of regional extinction higher. And some activities might cause poarching.

Question 10:

In the case of a loan project such as a two-step loan or a sector loan, can sub-projects be specified at the present time?

☑Yes ☐No

Question 11:

Regarding information disclosure and meetings with stakeholders, if JICA's environmental and social considerations are required, does the proponent agree to information disclosure and meetings with stakeholders through these guidelines?

☐Yes ☑No

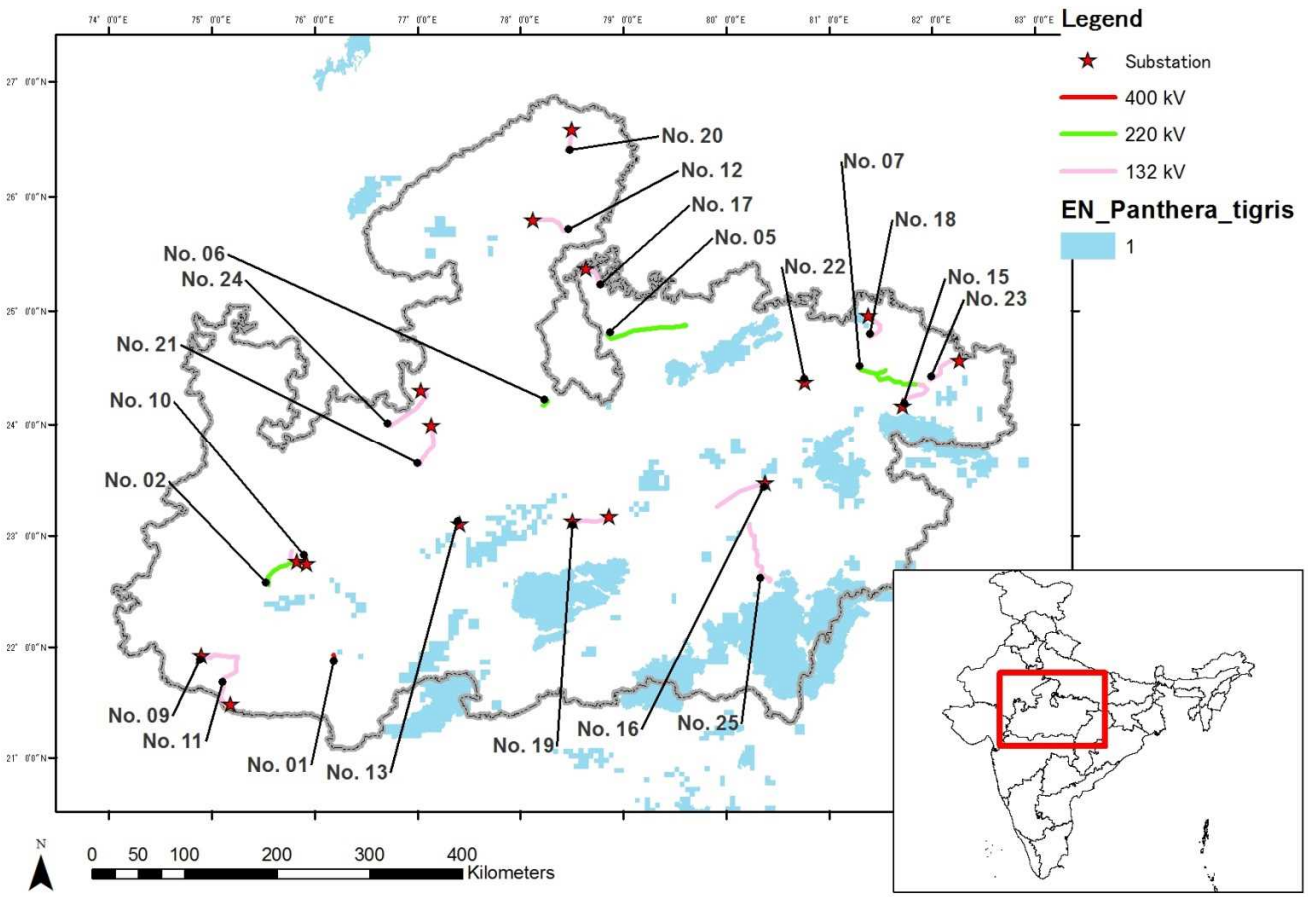


Figure 2: Habitat of Tiger (IUCN: EN)

Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports already been prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N/A (b) N/A (c) N/A (d) N	(a) EIA reports are not required. (b) EIA reports are not required. (c) EIA reports are not required. (d) Forest clearances are required for 9 subprojects. One of them has already been acquired.
	(2) Explanation to the Local Stakeholders	(a) Have the contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Has understanding been obtained from the Local stakeholders? (b) Have the comments from the stakeholders (such as local residents) been reflected in the project design?	(a) N (b) N	(a) No information has been given to the local stakeholders. It will be given before construction. (b) No comments have been taken.
	(3) Examination of Alternatives	(a) Have alternative plans for the project been examined taking into account social and environmental considerations?	(a) Y	(a) Many alternative routes have been considered so far. Two sub-projects are cancelled due to impact on protected areas and the length of passing through the forest was reduced from 86.5 km to 24.2 km by changing the routes.
2 Pollution Control	(1) Water Quality	(a) Is there any possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling, will cause water quality degradation in downstream water areas? If water quality degradation is anticipated, have adequate measures been considered?	(a) ?	(a) There might be some possibility of runoff if the towers are located in mountainous areas. EMP provides some precautions for runoff (See 9.1.1.3 of IEE) such as “Erosion prevention techniques should be adopted for slope areas” and “After construction, bare ground should be covered by vegetation”.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country’s laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) All the sub-projects are located outside of the National parks and Sanctuaries designated by the Indian Government.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, or ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country’s laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, have adequate protection measures been taken to reduce the impacts on the ecosystem? (d) Have adequate measures been taken to prevent disruption of migration routes and habitat fragmentation of wildlife or livestock? (e) Is there any possibility that the project will cause negative impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, or disturbance of ecosystem due to introduction of exotic (non-native invasive) species or pests? Have adequate measures for preventing such impacts been considered?	(a) N (b) N (c) Y (d) ? (e) Y (f) N	(a) Most of the primeval forest in the protected areas has been avoided, but it is not clear whether it has all been completely avoided or not because of the lack of a site survey. (b) All the designated Tiger reserves are outside of the project location. (c) It is not clear whether there will be significant ecological impact or not because of the lack of a biological site survey. Some sub-projects might be located in undesignated Tiger corridors. The possible impact would be increasing regional extinction risk of Tiger by habitat fragmentation, decreasing number of individuals by shrinking habitats, and increasing

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		(f) In cases where the project site is located in undeveloped areas, is there any possibility that the new development will result in extensive loss of natural environments?		human conflict caused by human habitat expansion. EMP mentioned that MPPTCL will discuss with the Wildlife Department and follow all the instructions. (d) It is not clear which kind of instructions will be given by the Wildlife Department to maintain migration routes. Possible instruction would be detail survey during detail design, increasing the tower height to preserve vegetation under the ROW, installation of access rules to the habitat and so on. (e) There is a small possibility that the project causes negative impacts. Clearing vegetation under the ROW might make access to the forest easier. It might cause illegal logging and introduction of exotic species. EMP mentioned that MPPTCL will discuss with the Wildlife Department and follow all the instructions. (f) There is no possibility that the project will result in extensive loss of natural environments. The loss of forest has been carefully avoided during route identification and minimized up to 67.7 ha, which is only 2.7 % of the total ROW.
3 Natural Environment	(3) Topography and Geology	(a) Is there any soft ground on the route of power transmission and distribution lines that may cause slope failures or landslides? Have adequate measures been considered to prevent slope failures or landslides, where needed? (b) Is there any possibility that civil works, such as cutting and filling will cause slope failures or landslides? Have adequate measures been considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, or borrow sites? Have adequate measures been taken to prevent soil runoff?	(a) ? (b) ? (c) ?	(a) It is not clear because no detailed surveys have been done yet. EMP states that “Slope areas of more than 10 degrees should not be selected as locations of TML towers”, “Geological boring exploration should be done before detailed design” and “High risk landslide areas should be avoided for TML" towers” (See 9.1.1.3 of IEE). (b) It is not clear whether there is any possibility of slope failures or landslides because it is before the detailed survey. (c) It is not clear whether there is any possibility of slope failures or landslides because it is before the detailed survey.

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4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, have efforts been made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance to be given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensation going to be paid prior to the resettlement? (e) Are the compensation policies prepared in a document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people to be obtained prior to resettlement? (h) Is an organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Have any plans been developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) Y (b) Y (c) N/A (d) N/A (e) N/A (f) N/A (g) N/A (h) N/A (i) Y (j) Y	(a) It is not clear whether involuntary resettlement will be completely avoided or not because the designs are not fixed, but a large number of involuntary resettlements will not happen because MPPTCL has no experience of resettlement over 20 years. (b) EMP states that MPPTCL will follow the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (See 9.1.3.1 of IEE). (c) Resettlement is not confirmed at this stage. (d) Resettlement is not confirmed at this stage. (e) Resettlement is not confirmed at this stage. (f) Resettlement is not confirmed at this stage. (g) Resettlement is not confirmed at this stage. (h) Resettlement is not confirmed at this stage. (i) Compliance Monitoring check list in the EMP confirms resettlement issues (See 9.2 of IEE). (j) Grievance redress mechanism is mentioned in Section 9 of IEE.
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Have adequate measures been considered to reduce the impacts, if necessary? (b) Is there a possibility that diseases, including infectious diseases, such as HIV will be brought in due to immigration of workers associated with the project? Have adequate considerations been given to public health, if necessary? (c) Is there any possibility that installation of structures, such as power line towers, will cause radio interference? If any significant radio interference is anticipated, have adequate measures been considered? (d) Is the compensation for transmission wires given in accordance with the domestic law?	(a) Y (b) Y (c) Y (d) Y	(a) The project will reduce agricultural production in land which falls in the ROW during construction. Crop compensation will be paid to the farmers (See 9.1.3.2 of IEE). (b) There is a possibility that some diseases might be brought in by workers. A public health program is planned in EMP (See 9.1.3.5 of IEE). (c) It is not clear whether radio interference will happen or not, but MPPTCL will explain the risk to the local people and take precautionary measures if required (See 9.1.1.6 of IEE). (d) Crop compensation will be paid to the land owners based on the survey by the Revenue Department.
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, or religious heritage? Have adequate measures been considered to protect these sites in accordance with the country's laws?	(a) ?	(a) It is not clear whether damage to cultural assets will be completely avoided or not. It will be minimized during the site survey by the Revenue Department or discussion with the local people. If any serious impacts are expected, MPPTCL will follow

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				the instructions from the Revenue Department (See 9.1.3.3 of IEE).
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Have necessary measures been taken?	(a) ?	(a) It is not clear whether there is any possibility or not because no site survey has been conducted.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reducing impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) Y (b) Y	(a) Settlements of Ethnic Minorities are also avoided by the TML routes. Crop compensation will be given when crop lands of Ethnic Minorities are affected. (b) The rights of Scheduled Tribes and Scheduled Castes will be respected based on the Scheduled Caste and Scheduled Tribe (Prevention of Atrocities) Act, 1989 by MPPTCL.
	(6) Working Conditions	(a) Is the project proponent not violating any laws or ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Have appropriate measures been taken to ensure that security guards involved in the project do not violate the safety of other individuals involved, or local residents?	(a) N (b) Y (c) Y (d) N/A	(a) Project proponent will not be violating any laws. Safety Department of MPPTCL will implement safety training program for workers during both construction and operation (See 9.1.3.7 of IEE). (b) Safety equipment is present in existing Sub-stations. The same equipment will be installed in the planned Sub-stations too. (c) Safety Department of MPPTCL has implemented various precautions and conducting training for the workers so far. These activities will be implemented in this project too. (d) Such kinds of issues are not expected. MPPTCL has no experience of security guards violating the safety of individuals.
5 Others	(1) Impacts during Construction	(a) Have adequate measures been considered to reduce impacts during construction (e.g. noise, vibrations, turbid water, dust, exhaust gases, and waste)? (b) If construction activities adversely affect the natural environment (ecosystem), have adequate measures been considered to reduce the impacts? (c) If construction activities adversely affect the social environment, have adequate measures been considered to reduce the impacts?	(a) Y (b) Y (c) Y	(a) Water pollution, noise, and waste issues will be monitored by compliance monitoring (See 9.2 of IEE). (b) If any instructions are issued by the Wildlife Department, MPPTCL will follow the instructions. (c) If any instructions are issued by the Revenue Department, MPPTCL will follow the instructions.
	(2) Monitoring	(a) Does the proponent develop and implement a monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget) to sustain the monitoring framework? (d) Have any regulatory requirements pertaining to the monitoring report system been identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) ? (d) Y	(a) MPPTCL developed compliance monitoring. If impact monitoring is suggested by other agencies MPPTCL will follow the instructions. (b) The items cover Physical, Natural and Social environment. Checklist system is used. The frequency is once a month (See 9.2 of IEE). (c) There is no Environmental Department in MPPTCL. The related Department would be changed

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				depend on the issues (9.3 of IEE), but MPPTCL will assign a person who is in charge of Environment for this project. But the institutional and budget frameworks are not fixed yet. (d) The monitoring style is checklist. The results of the checklist will be combined and submitted to JICA annually.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Road checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities).	(a) N/A	(a) Most of the project location is near existing roads. There might be a few sub-projects which require construction of access roads but this is not clear at present.
	Note on Using Environmental Checklist	(a) If necessary, the impacts on transboundary or global issues should be confirmed, (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) Y	(a) One of the global warming gases, FX6, will be used for the GIS system. It will be carefully treated and collected during maintenance, which would be once in 20 years.

1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).

2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and area in which it is located.