

## TABLE OF CONTENTS

1. EXECUTIVE SUMMARY.....	9
2. INTRODUCTION.....	14
2.1. Background.....	14
2.2. Definition .....	15
2.3. Scope of Report.....	15
2.4. Risk Categories .....	15
2.5. Basis of Report.....	16
2.6. Disclaimer .....	16
3. TECHNICAL ASSESSMENT .....	18
3.1. General .....	18
3.2. Transmission System .....	18
3.3. Salient Technical Features.....	19
3.3.1. General	19
3.3.2. Service Conditions & System Parameters .....	19
3.3.3. Insulators .....	20
3.3.4. Conductor .....	21
3.3.5. Transmission Line Towers & Accessories.....	21
3.4. Codes and Standards.....	23
3.5. Type Testing of Towers and Major Equipment .....	23
3.6. Quality Assurance and Safety Aspects.....	24
3.6.1. Quality Control.....	24

3.6.2.	Safety Aspects .....	24
3.7.	Contract Packages & Schedules .....	24
3.8.	Availability .....	30
3.9.	Condition Assessment of Asset .....	30
3.9.1.	Review of Plant Design / Technical Details .....	30
3.9.2.	Current Status of Asset .....	31
3.9.3.	Material availability at stores .....	31
3.10.	Useful Life of Asset .....	32
3.11.	Technical Guarantee .....	32
3.12.	Availability of Transmission Lines .....	33
3.13.	Assessment of Technology Risk .....	33
4.	PROJECT MANAGEMENT ARRANGEMENT .....	34
4.1.	Project Organization .....	34
4.2.	O&M Organization Set-up & its adequacy .....	34
4.3.	Operation & Maintenance (O&M) Activities .....	36
4.3.1.	Routine Maintenance (Preventive Maintenance) .....	37
4.3.2.	Corrective Maintenance .....	40
4.3.3.	Emergency situations .....	40
4.4.	Standard Operating Procedures .....	41
4.5.	Implementation of the O&M Procedures .....	41
4.6.	O&M Technology .....	42
5.	ENVIRONMENTAL AND SOCIAL ASPECT .....	43
5.1.	Environmental Impacts and Mitigation Measures .....	43
5.2.	Environment, Health & Safety Assessment .....	43
5.2.1.	Mandatory Safety Requirement and Score System .....	43
5.2.2.	EHS Inspection Procedure .....	44
5.2.3.	Work Stoppage or EHS Non conformance Report (NCR) Procedure .....	45
5.2.4.	Review of the status of Environment, Health & Safety Aspects by IE .....	45
6.	PROJECT PERMITS AND CLEARANCES .....	46
6.1.	Permits and Clearances .....	46
6.2.	Summary of Findings .....	46



7. OVERALL STATUS.....47



## ACRONYM

AAAC	:	All Aluminium Alloy Conductors
ABG	:	Advance Bank Guarantee
ACSR	:	Aluminium Conductor Steel Reinforced
ACFs	:	Assistant Conservator of Forests
AP	:	Angle Point
BOOM	:	Build, Own, Operate & Maintain
BOCW	:	Building and Other Construction Workers
BOQ	:	Bill of Quantities
BSNL	:	Bharat Sanchar Nigam Limited
CTU	:	Central Transmission Utility
CEA	:	Central Electricity Authority
CERC	:	Central Electricity Regulatory Commission
COD	:	Commercial Operation Date
CST	:	Central Sales Tax
CPBG	:	Contract Performance Bank Guarantee
D/C	:	Double Circuit
DFO	:	Divisional Forest Officer
EA	:	Electricity Act
EAR	:	Erection All Risk
EPC	:	Engineering, Procurement & Construction
ESH	:	Environment, Health & Safety
FTTH	:	Fibre To The Home
FRA	:	Forest Rights Act
GOI	:	Government of India
GS	:	Galvanized Steel
IPTCs	:	Independent Power Transmission Companies
JB	:	765 kV S/C Jabalpur to Bina Transmission Line
JD	:	765 kV D/C Jabalpur to Dharamjaygarh Transmission Line
JTCL	:	Jabalpur Transmission Company Limited
kA	:	Kilo Ampere
kM	:	Kilometer

kV	:	Kilo Volt
IE	:	Independent Engineer
IMS	:	Integrated and Managed Services
ISV	:	Intermediary Safety Visit
LII	:	Lahmeyer International ( India) Ltd.
LC	:	Letter of Credit
LD	:	Liquidated Damages
LOA	:	Letter of Award
LTTC	:	Long Term Transmission Customer
MOEF	:	Ministry of Environment & Forest
MDCC	:	Material Dispatch Clearance Certification
MSRS	:	Mandatory Safety Requirement and Score
MP	:	Madhya Pradesh
NHAI	:	National Highway Authority of India
NR	:	Northern Region
NTP	:	Notice to Proceed
NCR	:	Non Conformance Report
NLDC	:	National Load Dispatch centre
O& M	:	Operation & Maintenance
OPGW	:	Optical Power Ground Wire
OF	:	Optical Fiber
OFC	:	Optical Fiber Cable
OSM	:	Owner Supplied Material
PBG	:	Performance Bank Guarantee
PCCF	:	Principal Chief Conservator of Forests
PFC	:	Power Finance Corporation
PTC	:	Power Transmission Conductors
PGCIL	:	Power Grid Corporation of India Ltd.
PSEB	:	Punjab State Electricity Board
PTCC	:	Power & Telecommunication Coordination Committee
PO	:	Purchase Order
QAP	:	Quality Assurance Plan
RFP	:	Request For Proposal
ROW	:	Right of Way

RLDC	:	Regional Load Dispatch Centre
S/C	:	Single Circuit
SEB	:	State Electricity Board
S/S	:	Substation
SGL	:	Sterlite Grid Ltd.
STL	:	Sterlite Technologies Ltd.
SOT	:	Safety Observation Tour
SPV	:	Special Purpose Vehicle
STU	:	State Transmission Utility
SLDC	:	State Load Dispatch Centre
TSA	:	Transmission Service Agreement
TSP	:	Transmission Service Provider
TL	:	Transmission Line
UTS	:	Ultimate Tensile Strength
UPTL	:	Unitech Power Transmission Limited
VAT	:	Value Added Tax
WR	:	Western Region
WCT	:	Works Contract Tax

## 1. EXECUTIVE SUMMARY

For evacuation of power from a large number of IPP generation projects in Chhattisgarh, Madhya Pradesh, Orissa, West Bengal and Jharkhand, a comprehensive transmission system has been evolved. While most of the transmission lines are being constructed by the Central Transmission Utility (CTU), some of the transmission elements have been planned to be implemented by Independent Power Transmission Companies (IPTCs).

Government of India, Ministry of Power, invited bids for selection of Transmission Service Provider (TSP) based on 'Tariff Based Competitive Bidding Guidelines for Transmission Services'. Sterlite Grid was selected as TSP for executing the Scheme for 'System Strengthening Common to WR & NR' consisting of 765 kV Transmission Lines through its SPV – Jabalpur Transmission Company Limited (JTCL). The Transmission System being executed by the SPV consists of:

1. Dharamjaygarh – Jabalpur 765 kV D/C (Hexa Zebra ACSR Conductor) Transmission Line (756.6 circuit kms). Hereinafter referred as JD Transmission Line
2. Jabalpur – Bina 765 kV S/C (Quad Bersimis ACSR Conductor) Transmission Line (235.194 circuit kms). Hereinafter referred as JB transmission Line.

The 765 kV D/C Dharamjaygarh – Jabalpur Transmission Line terminates one end at 765/400 kV Dharamjaygarh Pooling Station of M/s. PGCIL at Dharamjaygarh (Chhattisgarh) and other end at 765/400 kV Jabalpur Pooling Station of M/s. PGCIL at Jabalpur (Madhya Pradesh).

The 765 kV S/C Jabalpur – Bina Transmission Line is from 765/400 kV Jabalpur Pooling Station to 765/400 kV Bina Substation of M/s. PGCIL (Madhya Pradesh).

Jabalpur Transmission Company Limited (JTCL) facilitates strengthening of the Western and Northern Regions by providing open access to transmit power from independent power projects in the East. This project has the capacity to evacuate upto 5000 MW from East to the West and North, and shall offer relief by alleviating the current bottlenecks for power plants in the regions of Jharkhand, West Bengal and Orissa.

Sterlite Power Grid Ventures Limited ("SPGVL" or "the Project Company") is a holding company for all the transmission projects with each asset housed under a separate Special Purpose Vehicle (SPV).

Sterlite Power Grid Ventures Limited (SPGVL) through its wholly owned subsidiary Sterlite Grid 1 Limited (SGL) owns Jabalpur Transmission Company Limited (JTCL).

SPGVL owns ten (10) nos. projects consisting of 6767.702 circuit km power transmission lines and seven (7) nos. substations across 15 states in India. Sterlite have won these projects on Build Own Operate Maintain (BOOM) basis via tariff based competitive bidding process ran by Ministry of Power. Out of the total 10 nos. of project, four projects are operational and the construction is in progress for balance six nos. of project.

For all the 10 nos. of project, Sterlite has undertaken the designing, financing and construction & maintenance of the transmission systems for concession periods ranging from 25 to 35 years.

These transmission lines would help facilitate power evacuation and would be used for SEBs, Power GENCOs.

Lahmeyer International (India) Pvt. Ltd. has been appointed as Independent Engineer (IE) by SGL for Technical Due Diligence of the above Transmission Project being executed by the Project Company.

The Transmission Service Agreement (TSA) was signed between 5 nos. of Long Term Transmission Customers (LTTCS) and Jabalpur Transmission Company Limited (JTCL). The TSA covers the Allocated Project Capacity for each of the LTTCS for payment of the Transmission Charges. According to TSA, the scheduled COD of the Project was 36 months from the effective date of TSA which is 31<sup>st</sup> March 2011. Thus, the COD as per TSA was worked out to 31<sup>st</sup> March 2014.

Design and engineering of the Project was done in – house for all the four types of towers (A, B, C and D) to be used for 765 kV S/C line and 765 kV D/C line and prototype tested. The Project was implemented on multiple contract packages.

The transmission line towers have been designed as per IS: 802 Part 1 & 2 with a reliability factor of 1.0 which ensures the reliability period of the transmission line for 50 years. Additionally, Project Company is taking necessary life extension measures through preventive maintenance and condition monitoring to increase the useful life of the equipment.

Following contracts were awarded for JD Transmission Line (756.6 circuit kms):

1. Dharamjaygarh – Jabalpur 765 kV D/C transmission line (Package C1): from Dharamjaygarh Gantry of PGCIL Substation (Chhattisgarh) to Angle Point 73/0 (X: Co-ordinate 606779.336, Y: Co-ordinate 2458044.008 and elevation 294.097), awarded to M/s. Lanco Infratech Limited. The Owner has awarded three Split Contracts (Supply, Civil works and Erection) to the Contractor for the Works on a composite Engineering, Procurement and Construction responsibility basis.
2. Umbrella Contract for the above three (3) split contracts with M/s. Lanco Infratech Limited.
3. Package C2: to M/s. Unitech Power Transmission Limited, from Angle Point 73/0 (X: Co-ordinate 607596.076, Y: Co-ordinate 2457891.937 and elevation 294.079) (Chhattisgarh) to Angle Point 102/8 (X: Co-ordinate 531225.383, Y: Co-ordinate 2487375.335 and Elevation 878.916) (Chhattisgarh).

The Owner has awarded three Split Contracts (Supply, Civil works and Erection) to the Contractor for the Works on a Composite Engineering, Procurement and Construction (EPC) responsibility basis.

4. Umbrella Contract for the above three (3) split contracts with M/s. Unitech Power Transmission Limited.
5. Package M1 & M2: to M/s. Simplex Infrastructure Limited, from Angle Point 102/8 (X: Co-ordinate 531225.383, Y: Co-ordinate 2487375.335 and elevation 878.916) to Angle Point 130/0 (X: Co-ordinate 461144.1, Y: Co-ordinate 2542596.766 and elevation 653.664) (Madhya Pradesh), and M2 was from Jabalpur Gantry of Substation of PGCIL to Angle Point 130/0 (X: Co-ordinate 461144.1, Y: Co-ordinate 2542596.766 and Elevation 653.664) (Madhya Pradesh).
6. Umbrella Contract for the above three (3) split contracts with M/s. Simplex Infrastructure Limited

**Following contracts were awarded for JB transmission line (235.194 circuit kms):**

1. 765 kV S/C Transmission Line between Jabalpur and Bina (Gantry of Jabalpur S/S to AP 62/0) (Package A): Three separate split contracts for Supply of Tower materials, Civil and Erection Contracts to M/s. C&C Constructions Limited.
2. Umbrella contract for single source responsibility for the above split contracts between JTCL and C&C Constructions Limited.
3. 765 kV S/C Transmission Line between Jabalpur and Bina (Gantry of Bina S/S to AP 62/0) (Package B): Three separate split contracts for Supply of Tower materials, Civil and Erection Contracts to M/s. Unitech Power Transmission Limited.
4. Umbrella contract for single source responsibility for the above split contracts between JTCL and Unitech Power Transmission Limited.

Further, Conductors, Insulators, Insulator Hardware, GS Earthwire and its Hardware and Spacer Dampers were provided by the Owner to the Contractors as Owner Supplied Material (OSM). The contracts for Conductors, Insulators, GS Earth wire and Hardware Fittings & Spacer Dampers were awarded separately. Additionally, the Supply of Tower material including Stubs, Nuts & Bolts to the Contractor for package M1 & M2 was in the scope of the Owner.

Both the lines (765 kV S/C Jabalpur – Bina and 765 kV D/C Jabalpur – Dharamjaygarh transmission Line) are operational. The 400 kV S/C Jabalpur – Bina Transmission Line is the first 765 kV Transmission Line developed by a Private Sector entity in the Country.

JB Transmission Line – the approval for energisation from CEA was granted on 16<sup>th</sup> June, 2015 vide letter no. CEI/3/EI/RIO(W)/Insp/2015/748. The successful completion of 24 hrs trial run was achieved on 1<sup>st</sup> July, 2015 at 18:32 hrs as accorded by Power System Operation Corporation Limited (POSOCO) vide Certificate dated 16<sup>th</sup> July, 2015. The COD for the element was declared as 1<sup>st</sup> July, 2015.

JD Transmission Line – the approval for energisation from CEA was granted on 4<sup>th</sup> September, 2015 vide letter no. CEI/3/EI/RIO(W)/Insp./2015/1188. The successful completion of 24 hrs trial run was achieved on 14<sup>th</sup> September, 2015 at 00:04 hrs as accorded by POSOCO vide Certificate dated 30<sup>th</sup> September, 2015. The COD for the element was declared as 14<sup>th</sup> September, 2015, which also marks the Project COD.

For the project Operation and Maintenance activities the Project Company has outsourced the works to different agencies. However, supervision of the O&M activities is being done in – house by the Project Company. The Project Company has laid down Standard Operating Procedures (SOP) for effective O&M of the transmission lines. Additionally, regular trainings are being conducted to train the personnel on the latest techniques for effective maintenance of the transmission lines and safety measures are adopted during maintenance.

This Technical Due Diligence Report including the observations and recommendations of IE is based on the site visit undertaken by IE from 28.09.2016 to 29.09.2016, review of the Technical specifications, Material Quality Plan, Type Test Certificates, Field Quality Plan, Operation & Maintenance (O&M) Procedures, Environment, Health & Safety (EHS) Procedures. The Technical Due Diligence Report evaluates all aspects related to technical suitability, clearances, quality, maintenance, safety & environment and identifies risks, if any in operation of the project during its useful life. The report comprises of the following sections.

## **Section – 2: Introduction**

This section presents a brief introduction of the project and its sponsors including the scope of the work of the IE towards technical due diligence, the definitions of risk categories and the basis of the Report.

## **Section –3: Technical Assessment**

The salient technical features of the project have been reviewed based on the technical specifications and compliance to codes and standards. The Quality Assurance and Safety aspects being followed during execution of the project have also been reviewed.

The execution of the project by means of different contracts and packages is presented in this section. The Condition Assessment of the asset has been presented along with the current status of the project. Additionally, the useful life of the asset, technical guarantees and availability of transmission lines has been ascertained.

## **Section – 4: O&M Arrangement**

This section presents the O&M arrangement for Operation and Maintenance of the transmission lines. In this section, evaluation has been done regarding the adequacy of the O&M organization set-up, and the suitability of the O&M procedures.

## **Section – 5: Environmental and Social Aspects**

This section evaluates the impact of the project on the environment and social aspect. The practices adopted by the Project Company for maintaining Environment, Health & Safety (EHS) have also been evaluated in this section.



## **Section – 6: Project Permits and Clearances**

This section presents the status of the permits and clearances required for the execution and successful completion of the project.

## **Section – 7: Overall Status**

This section of the report gives a comprehensive summary of the findings of the Technical Due Diligence report including the strengths and risks, if any of the project.

The project was executed under the direct supervision of JTCL. As per the specification provided by the Project Company, the Transmission lines and Towers have been designed, installed and tested in accordance with International Standards and Indian Standards. The design has also met statutory requirements such as the Indian Electricity Rules, Indian Factory Act and Indian Electricity Grid Code etc. IE is of the opinion that considering the comprehensive Quality Assurance Plan being followed by the Project Company, the final design and specifications of equipment/ systems installed in the Transmission Lines are in line with the technical specification, drawings and documents reviewed and approved by the Project Company

IE reviewed the status of key permits and clearances. All major Permits and Clearances have been obtained by the Project Company.

IE is of the opinion that the Project Company had taken adequate measures for management of the complete project by allocating separate teams for supervision of the various EPC packages during the Project execution phase.

IE is of the opinion that the proposed O&M organization set-up is adequate and the O&M philosophy is effective in achieving the target availability.

IE reviewed the provisions of the Transmission Service Agreement (TSA) and found the same to be in order. The scheduled COD mentioned in the TSA has been delayed due to Force Majeure events and change in law.

SGL has implemented adequate procedures to ensure that the Environment, Health & Safety aspects are duly taken care of. Upon review of the various EHS documents received from the Project Company, IE is of the opinion that the Project Company is following the EHS Procedures to ensure that the aspects related to Environment, Health and Safety of the project are duly taken care of.

Based on the technical review of the project, IE has concluded that there are no risks associated with the project.

## 2. INTRODUCTION

### 2.1. Background

Jabalpur Transmission Company Limited (hereinafter referred as “JTCL or Project Company”) a subsidiary of SGL has set up 765 kV Transmission Project – System Strengthening common for Western & Northern Region – consisting of 765 kV D/C transmission line (756.6 circuit km in length) from Dharamjaygarh to Jabalpur and 765 kV S/C line from Jabalpur to Bina (235.194 circuit km) on Build, Own, Operate and Maintain (BOOM) basis. The two transmission lines have been connected to the 765/400 kV CTU substations at Dharamjaygarh, Jabalpur and Bina.

Lahmeyer International (India) Pvt. Ltd. has been appointed as Independent Engineer (henceforth referred to as IE); on behalf of SGL pursuant to contract via email dated 14.09.2016, to carry – out Technical Due Diligence of the Project.

#### **Sterlite Power Grid Ventures Limited**

Sterlite Power Grid Ventures Limited (“SPGVL” or “the Project Company”) is a holding company for all the transmission projects with each asset housed under a separate Special Purpose Vehicle (SPV).

Sterlite Power Grid Ventures Limited (SPGVL) through its wholly owned subsidiary Sterlite Grid 1 Limited (SGL) owns Jabalpur Transmission Company Limited (JTCL).

SPGVL owns ten (10) nos. projects consisting of 6767.702 circuit km power transmission lines and seven (7) nos. substations across 15 states in India. Sterlite have won these projects on Build Own Operate Maintain (BOOM) basis via tariff based competitive bidding process ran by Ministry of Power. Out of the total 10 nos. of project, four projects are operational and the construction is in progress for balance six nos. of project.

For all the 10 nos. of project, Sterlite has undertaken the designing, financing and construction & maintenance of the transmission systems for concession periods ranging from 25 to 35 years.

These transmission lines would help facilitate power evacuation and would be used for SEBs, Power GENCOs for which Sterlite would earn a fixed transmission tariff.

The Map in Fig 2.1 indicates the location of the JTCL transmission system

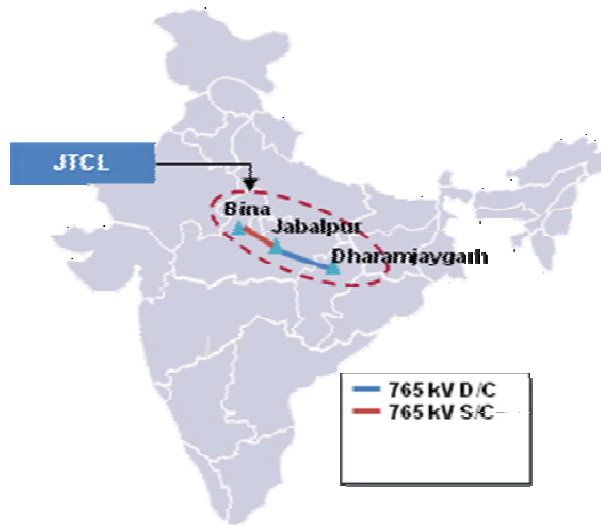


Figure 2.1: Map of JTCL Transmission System

## 2.2. Definition

Title	:	Definition
Project	:	System Strengthening common for Western & Northern Region – 765 kV Transmission System from Dharamjaygarh to Jabalpur and Jabalpur to Bina.
Project Company	:	Jabalpur Transmission Company Limited (JTCL)
Independent Engineer	:	Lahmeyer International (India) Pvt. Ltd. (LII).

## 2.3. Scope of Report

SGL has asked IE to carry out the Technical Due Diligence of the JTCL transmission line project. IE's review is based on documents furnished by the Project Company and the site visits undertaken by IE from 28<sup>th</sup> September to 29<sup>th</sup> September, 2016.

## 2.4. Risk Categories

Based on the detailed review of the technical documents/ information provided by JTCL, the IE proposes to identify in this Report, issues if any and the associated risks for the JTCL Transmission Line project. If such issues are highlighted by the IE, the same shall be addressed by JTCL for mitigation. The risks identified have been classified into three different categories as per the following table 2.1.

**Table 2.1 – Definition of Risk Categories**

<b>Risk Category A</b>	<b>Development Risk</b>	Matters which are dependent on external factors/ agencies and can affect the development/ schedule of the project.
<b>Risk Category B</b>	<b>Technology Risk</b>	Matters that are related to technical aspects of the project which can affect performance/ availability significantly.
<b>Risk Category C</b>	<b>Operational Risk</b>	Matters related to O&M which can lead to poor performance/ lower availability

## 2.5. Basis of Report

This Report has been prepared based on the discussions with the Project Company's representative and review of documents provided by the Project Company. Following documents have been received from the Project Company:

1. Technical specification
2. Contracts for supply & erection
3. Material Quality Plan
4. Field Quality Plan
5. Type Test Report of Towers
6. Permits and Clearances
7. O&M Procedures
8. Environment, Health and Safety (EHS) Procedures

## 2.6. Disclaimer

IE has made no search of any public records nor independently validated the information provided by Project Company with any external source, nor does IE have any responsibilities whatsoever with respect to such validation. Apart from the reviewed documents listed above, IE has not examined any other documents relating to the matters of the Project Company for the purpose of this Report, nor does IE have any responsibility whatsoever with respect to the examination of other documents.

Furthermore, IE has no responsibilities whatsoever with respect to the sufficiency or adequacy of the documents for the preparation of the Report.

IE's findings are strictly limited to the matters stated herein and are not to be read as extending by implication to any other matter. They are given as on the date of writing this Report solely for the benefit of the Client and may not be disclosed to or relied upon by anyone else without IE's prior consent, provided that, this opinion may be disclosed to the Auditors or any Professional Advisors of any of the Addressees or to any Regulatory Authority (as may be required by such Regulatory Authority) or otherwise pursuant to a court order or legal process.

IE disclaims all responsibility and liability (including, without limitation, for any direct or indirect, special, consequential or incidental damage, loss or costs or loss of profit, goodwill or business) arising from anything done or omitted to be done by any party in reliance, whether wholly or partially, on any of the information contained in this Report. Any use which a person makes of the Report or any reliance on or decisions to be made based on it, are the sole responsibility of such person. Decisions made or actions taken as a result of this Report shall be the sole responsibility of the parties directly involved in the decisions or actions.

## 3. TECHNICAL ASSESSMENT

### 3.1. General

Jabalpur Transmission Company Limited (JTCL) has set up one 765 kV Double Circuit line (Approximate 756.6 circuit km in length) from Dharamjaygarh (Chhattisgarh) to Jabalpur (Madhya Pradesh) and one 765 kV Single Circuit (Approximate 235.194 circuit km in length) transmission line from Jabalpur to Bina (Madhya Pradesh) under “System Strengthening Scheme common to WR & NR” on Build, Own, Operate and Maintain (BOOM) basis.

The Project consists of the following transmission lines:

1. Dharamjaygarh – Jabalpur (JD) 765 kV D/C transmission line with hexa ACSR ‘Zebra’ conductor (756.6 circuit km).
2. Jabalpur – Bina (JB) 765 kV S/C transmission line with quad ACSR ‘Bersimis’ conductor (235.194 circuit km).

### 3.2. Transmission System

Jabalpur Transmission Company Limited (JTCL) is facilitating the Western and Northern Regions by providing open access to transmit power from independent power projects in the East. This project has the capacity to evacuate upto 5000 MW from East to the West and North, and shall offer relief by alleviating the current bottlenecks for power plants in the regions of Jharkhand, West Bengal and Orissa. These corridors are crucial links, on the basis of which the Central Transmission Utility has entered long term open access agreements with several generation companies in the Eastern region.

The Transmission System covered in the Scheme facilitates evacuation of power from various IPP Generating Stations and pooled at pooling stations of Power Grid Corporation of India Ltd. (PGCIL) located at Jabalpur and Bina in Madhya Pradesh and at Dharamjaygarh in Chhattisgarh State to the beneficiaries in Western & Northern Region.

The 765 kV Dharamjaygarh – Jabalpur D/C line is used in transferring power from the Jharkhand and West Bengal IPP projects to NR/WR and is covered under the scheme “System Strengthening common for WR and NR” associated with IPP projects in Jharkhand and West Bengal Generation projects.

The 765 kV S/C Jabalpur – Bina line is under “System Strengthening common for WR and NR linked with Moser Baer IPP generation project.

JTCL has entered into a Transmission Service Agreement (TSA) with five (5) numbers Long Term Transmission Customers (LTTCS). The Transmission Service Agreement is valid for a period of thirty five (35) years.

### 3.3. Salient Technical Features

#### 3.3.1. General

IE has reviewed the Technical Specifications and system details made available by the Project Company for supply and construction of proposed Dharamjaygarh – Jabalpur 765 kV D/C (ACSR Zebra, Hexa Bundle) and Jabalpur – Bina, 765 kV S/C Line (ACSR Bersimis, Quad Bundle) transmission systems. The Insulators, Insulator Hardware, Conductor, Spacer Damper and OPGW have been supplied by the Project Company to the Contractor as 'Owner Supplied Material' (OSM). The Technical Specifications of the Insulators, conductor and Hardware Fittings have been reviewed. Project Company had completed all the design and engineering of towers and foundations of the Project in-house. IE found the design philosophy adopted for the transmission line system to be in order. The design and prototype of all types of towers for 765 kV S/C and 765 kV D/C towers was done successfully. IE is of the view that there are no principal design concerns.

The salient features of technical requirements/ parameters for various 765 kV D/C and S/C transmission line materials/ components have been described in the following paragraphs.

#### 3.3.2. Service Conditions & System Parameters

The Service Conditions of the Transmission Lines are given in Table 3.1 and System Parameters are given in Table 3.2 below.

**Table 3.1 – Service Conditions**

Parameters	Value
Maximum Ambient Temperature	50 °C
Minimum Ambient Temperature	0°C
Relative humidity – Range	10% -100%
Wind zone	2
Maximum wind velocity	39 m/sec
Maximum altitude above MSL	Up to 1000 m
Air Pollution	Moderately Polluted as per IEC 60815

**Table 3.2 – System parameters**

Parameters	Value
Nominal voltage	765 kV
Maximum system voltage	800 kV
Lightning Impulse withstand Voltage	2100 kV <sub>peak</sub> (BIL)
Power Frequency withstand Voltage	830 kV <sub>rms</sub> (dry)
Switching impulse withstand voltage (dry & wet)	1550 kV <sub>peak</sub> (BSL)
Minimum corona extinction Voltage	508 kV <sub>rms</sub> phase to earth (dry)

Parameters	Value
Radio Interference Voltage between 0.5 and 2 MHz at 508 kV rms	2500 micro volts max.
Maximum Conductor Temperature	85°C
Maximum Earthwire Temperature	53°C

IE observed that the above service conditions and system parameters were incorporated in the Bid Documents/ Technical Specifications. The above parameters are generally accepted for 765 kV transmission lines.

### 3.3.3. Insulators

Insulators are used to support the conductors and maintain clearances between circuits, tower and other conductors. It is designed to withstand both the normal operating voltage and surges due to switching and lightning. Insulators are broadly classified as either pin-type, which support the conductor above the structure, or suspension type, where the conductor hangs below the structure.

Insulators are usually made of wet-process porcelain or toughened glass, with increasing use of glass-reinforced polymer insulators.

As per the Technical Specifications for Insulator Package, Insulators used are composite Long Rod Insulators with the specified (as per RFP) electro – mechanical strength and total creepage. The insulators confirm to applicable IS & IEC Codes & Standards.

The size of long rod insulators, minimum creepage distance, the number to be used in different type of strings, their electro – mechanical strength and mechanical strength of insulator string along with Hardware fittings are given in table 3.3 below:

**Table 3.3 – Design Parameters – 765 kV line**

Type of String	Min. Creepage Distance (mm) Per Unit	Electro – Mechanical strength of Insulator Unit (kN)	Mechanical Strength of Insulator String along with Hardware Fittings (kN)
Single 'I' suspension Pilot, Towers B, C, D	16000	120	120
Double 'I' suspension Towers A	16000	120	240
Single 'V' suspension tower 'A'	16000	210	210

The long rod insulators are suitable for employment of hot line maintenance technique to allow usual hot line operation with ease, speed and safety and are designed to facilitate cleaning. The design and supply of Grading Rings are in the scope of Insulator supplier.

IE observed that the technical parameters stipulated in the specifications for insulators are suitable for use on 765 kV transmission systems.



### 3.3.4. Conductor

Conductors are current carrying element of the transmission lines which transmits electricity. The most common conductor in use for transmission today is aluminium conductor steel reinforced (ACSR). Aluminium is used because it has about half the weight of a comparable resistance copper cable. In order to increase efficiency of the transmission lines, typically EHV lines have bundled conductor arrangements. Bundle conductors consist of several parallel cables connected at intervals by spacers, often in a cylindrical configuration.

As per the technical specification, the Conductor used are Hexa ACSR Zebra and Quad ACSR Bersimis for JD and JB respectively type of Transmission line. The sub conductor spacing is 457 mm for 765 kV Transmission lines. The salient parameters of the conductors are given below in table 3.4 below:

**Table 3.4 – Design Parameters – Conductor**

Description	ACSR 'Zebra'	ACSR 'Bersimis'
Size of the conductor	54/3.18 mm Al +7/3.18 mm Steel	42/4.57 mm Al +7/2.54 mm Steel
Overall Diameter (mm)	28.62	35.04
Minimum UTS (kN)	130.32	154
Unit Mass (Kg/km)	1621	2181
Configuration	Vertical for D/C Line	Horizontal for S/C
Total sectional Area	428.9 sq. mm	689.5 sq. mm
Maximum Operating Temperature	85°C	85°C

The conductor offered has been subjected to Type Tests, Acceptance Tests and Routine Tests as per National/ International Standards as per the specifications.

### 3.3.5. Transmission Line Towers & Accessories

Transmission towers are the most visible component of the bulk power transmission system. Their function is to keep the high-voltage conductors separated from their surroundings and from each other. This requirement and the KV (voltage) define the basic physical dimensions of a tower, including its height, conductor spacing, and length of insulator required to mount the conductor.

The crucial design criteria for towers is to provide the structural strength necessary to maintain these distances under loading from the weight of the conductors, wind loads, ice loading, seismic loads, and possible impacts.

As specified in the technical specification, the JB line with quad conductor has Horizontal configuration of conductors and JD line with Hexa Conductor has vertical configuration. Various type of towers used are based on the final detailed survey carried out by JTCL and the soil investigation carried out by the erection contractor.

### a) Transmission Towers

Self – supporting hot dip galvanized lattice type bolted steel towers, designed to carry the line conductors with insulators, earth wires and fittings under all loading conditions have been used for the Project. The towers are fully galvanized using mild steel / high tensile steel sections. Bolts and nuts are provided with spring washers.

Following type of towers have been used on JB and JD lines.

**Table 3.5: Design Parameters – 765 kV/ 400kV Transmission Tower**

Type of Tower	Deviation Limit	Typical Use
DA	0° – 2°	To be used as tangent tower
DB	0° – 15°	To be used for line Angle deviation from 0 to 15 deg./ Section tower
DC	15° – 30°	To be used for line Angle deviation from 15 to 30 Deg./Section Tower/Transposition Tower
DD	30° – 60°	To be used for line Angle deviation from 30 to 60 Deg.
		Dead End with 0 degree to 15 degrees deviation both on line side and substation side 0 deg.
		Complete Dead End
		For river crossing anchoring with longer wind span with 0 deg. deviation on crossing span side and 0 to 30 deg. deviation on other side.
		Section tower for anti-cascading condition.

### b) Galvanised Earthwire

As per the Technical specification, the earth wire used is 7/3.66 mm galvanised steel wire, the parameters of which are given in the below table 3.6:

**Table 3.6: Major Parameters of GS Earthwire**

Parameters	Value
Number and Nominal Diameter of Strands (mm)	7/3.66 mm steel
Overall diameter	10.98 mm
Minimum UTS	68.4 KN
Unit Mass	583 kg/km
Resistance	2.5 ohms/km
Total sectional Area	73.6 sq. mm

### c) Hardware Fittings & Accessories

The Hardware Fittings are suitable for use with Disc/ Long Rod Composite insulators having ball and socket fittings. They are suitable for employment of hot line maintenance techniques so that usual hot line operations can be carried out with ease, speed and safety.

The accessories used are suitable for use with Quad ACSR 'Bersimis' and Hexa ACSR 'Zebra' Conductor as well as in GS Earthwire.

Provision exists for carrying out type test on complete insulator strings with hardware fittings, on suspension hardware fittings, on tension hardware fittings, spacer dampers as per National/ International standards.

#### d) Dimensions of Insulator strings along with Hardware fittings

The various limiting dimensions of the insulator strings along with Hardware fittings are as under:

**Table 3.7 – Dimensions of Insulator Strings along with Hardware Fittings**

Transmission Line	Type	Insulator length (mm)	String length (mm)
765 kV S/C	Double Suspension Insulator	5800	7150
	Quad Tension Insulator	5950	9800
765 kV D/C	Double Suspension Insulator	5800	7600
	Quad Tension Insulator	5950	10300

Other Technical specifications for conductor and Earthwire accessories, spacer dampers for Quad Bersimis and hexa Zebra have been reviewed and found to be in order.

### 3.4. Codes and Standards

The technical specifications for the project are in line with the Indian and international Codes and Standards. The Towers are designed based on the IS codes and Standards 802 (Part 1 Section 1 & Section 2 and Part 3) and CBIP Manual. The supply, erection and construction of the transmission line meets the requirements of the technical specifications and the relevant codes and standards thus ensuring the technical capability and quality of the transmission lines.

### 3.5. Type Testing of Towers and Major Equipment

The Technical specifications specify the requirement for Type testing of Towers and all Major Equipment in line with the relevant codes and standards. IE reviewed the type test certificates of the conductor ACSR Bersimis, hardware & fittings for ACSR Zebra, insulators and towers provided by the Project Company and the same were found to be in order.

## 3.6. Quality Assurance and Safety Aspects

### 3.6.1. Quality Control

The Project Company is adhering to the Quality Assurance Program which is in line with the industry standards and practices and is complying with the requirements of the Indian and International Standards. IE observed that, during execution of work, the Project Company has adopted appropriate measures to keep a strict vigil in implementing the Field Quality Plan & Material Quality Plans and in supervising the construction work.

The Material Quality Plans (MQP) of different components were reviewed by the IE and opines that the requisite tests and inspections were in line with Indian and International standards at various stages of the manufacturing process. This includes stringent quality control via Raw Material Inspection, in – process Inspection, Final Inspection and Testing and Checks conducted during Packing & Despatch. IE is satisfied with the QAP followed for implementation of the Project.

### 3.6.2. Safety Aspects

Safety practices have been followed by the Project Company as per their Safety Standards which is in line with the industry standards and practices. IE is of the opinion that the safety rules and norms are, by and large, being followed in the Project. All stores are being properly fenced and provided / being provided with adequate lights. Safety equipment / accessories are being used by site worker.

## 3.7. Contract Packages & Schedules

Sterlite Grid Limited on behalf of Jabalpur Transmission Company Limited had invited bids through International Competitive Bidding procedure.

The Project is being implemented on multiple contracts basis under the supervision of the JTCL.

For execution of Jabalpur – Bina 765 kV S/C Transmission Line, the entire line was divided into sections with respective two separate Contractors as mentioned below:

- i. From Jabalpur substation Gantry of PGCIL (Start Point) to Angle Point (AP) 62/0 (End Point): termed as Package A. Three split contracts for Supply of Tower materials, Civil works and Erection Contract with umbrella contract for a single source responsibility for the three split contracts was awarded to M/s. C&C Construction Limited.
- ii. From Bina substation Gantry of PGCIL (Start Point) to Angle Point (AP) 62/0 (End Point): termed as Package B. Three split contracts for Supply of Tower materials, Civil works and Erection Contract with umbrella contract for a single source responsibility for the three split contracts was awarded to M/s. Unitech Power Transmission Limited

For execution of Dharamjaygarh – Jabalpur 765 kV D/C Transmission Line, the entire stretch was divided into four packages (C1, C2 & M1 and M2) and awarded to three EPC contractors as mentioned below:

- i. Package C1: from Gantry of PGCIL substation at Dharamjaygarh to AP 73/0 – Contract awarded to M/s. Lanco Infratech Limited (3 split contracts for supply, civil works & erection works with umbrella contract for a single source responsibility for the three split contracts)
- ii. Package C2: from AP 73/0 to AP 102/8 – Unitech Power Transmission Limited (3 split contracts for supply, civil works & erection works with umbrella contract for a single source responsibility for the three split contracts)
- iii. Package M1 & M2: from AP 102/8 to 130/0 (Package M1) and AP 130/0 to Jabalpur PGCIL substation gantry (Package M2) – Simplex Infrastructure Limited (3 split contracts for supply, civil works & erection works with umbrella contract for a single source responsibility for each of the three split contracts)

Owner Supplied Materials (OSM) includes Insulators, Insulator Hardware, Conductor, Spacer Damper and Earthwire and its hardware fittings. Additionally, the supply of Tower material including stubs, Nuts & Bolts to the Contractor for Package M1 & M2 is in the scope of the Owner.

The brief Structure of the Contracts for Package A & B of 765 kV Jabalpur – Bina S/C Transmission Line and Package C1, C2, M1 & M2 of 765 kV Jabalpur – Dharamjaygarh Transmission Line is discussed in the table 3.8 below:

**Table 3.8 – Brief Structure of the contracts**

S. No.	Contract	Broad Scope of Work	Contractor
<b>765 kV S/C Transmission line, Package A – Jabalpur S/S Gantry (PGCIL) to Angle Point 62/0</b>			
1.	Supply Contract	Manufacturing, Inspection, Testing at manufacturer's works, loading and supply including transit insurance of all equipments except Conductor, Insulator, Insulator Hardware, Spacer Damper and Earthwire and its Hardware fittings ("Owner's Supplied Material") on FOR Project site basis.	M/s C&C Constructions Limited
2.	Erection Contract	Erection, Testing, Commissioning and Handing Over of the Facilities which shall be complete in all respect, arranging complete Right of Way and Statutory Approvals including Electrical Inspectorate, Railways, PTCC approvals for the same and Management for the Facility. The works also include loading/ unloading, safe storage, Inter – site/ stores transportation and erection of the Owner Supplied materials at site, Erection of Towers and terminating the line on the gantries of the 765 kV sub – station of PGCIL at Jabalpur.	
3.	Civil Work Contract	Civil work for construction as per requirement, site preparation including mobilization of manpower,	

S. No.	Contract	Broad Scope of Work	Contractor
		machineries, Labour, materials, consumables, tools and plants, as required for the construction of transmission lines of the size and scope of the Facility and handing over of the Facility which shall be complete in all respects, arranging complete ROW and Statutory Approvals, also other construction services and management for the Facility.	
4.	Umbrella Contract	Manufacturing, Procuring, Testing at manufacturer's works, loading and supply of all equipments/ material, loading/ unloading at site, safe storage (including that of Owner's Supplied Material which includes Insulator, Insulator Hardware, Conductor, Spacer Damper and Earthwire and its hardware fittings), Engineering, civil works and foundations, construction as per requirement, necessary site preparation including mobilization, ROW and Statutory Approvals if any, provision of labour, materials, consumables, tools and plants as required for the construction of transmission lines.	
<b>765 kV S/C Transmission line, Package B – Bina S/S Gantry (PGCIL) to Angle Point 62/0</b>			
1.	Supply Contract	Manufacturing, Inspection, Testing at manufacturer's works, loading and supply including transit insurance of all equipments except Conductor, Insulator, Insulator Hardware, Spacer Damper and Earthwire and its Hardware fittings ("Owner's Supplied Material") on FOR Project site basis.	M/s Unitech Power Transmission Limited.
2.	Erection Contract	Erection, Testing, Commissioning and Handing Over of the Facilities which shall be complete in all respect, arranging complete Right of Way and Statutory Approvals including Electrical Inspectorate, Railways, PTCC approvals for the same and Management for the Facility. The works also include loading/ unloading, safe storage, Inter – site/ stores transportation and erection of the Owner Supplied materials at site, Erection of Towers and terminating the line on the gantries of the 765 kV sub – station of PGCIL at Bina.	
3.	Civil work Contract	Civil work for construction as per requirement, necessary site preparation including mobilization of manpower, machineries, Labour, materials, consumables, tools and plants, as required for the construction of transmission lines of the size and scope of the Facility and handing over of the Facility which shall be complete in all respects arranging complete ROW and Statutory Approvals, if any, also other construction services and management for the Facility.	

S. No.	Contract	Broad Scope of Work	Contractor
4.	Umbrella Contract	Manufacturing, Procuring, Testing at manufacturer's works, loading and supply of all equipments/ material, loading/ unloading at site, safe storage (including that of Owner's Supplied Material which includes Insulator, Insulator Hardware, Conductor, Spacer Damper and Earthwire and its hardware fittings), Engineering, civil works and foundations, construction as per requirement, necessary site preparation including mobilization, ROW and Statutory Approvals if any, provision of labour, materials, consumables, tools and plants as required for the construction of transmission lines.	
<b>765 kV D/C Transmission line, Package C1 – Dharamjaygarh S/S Gantry (PGCIL) to Angle Point 73/0 (Chhattisgarh)</b>			
1.	Supply Contract	Manufacturing, Inspection, Testing at manufacturer's works, loading and supply including transit insurance of all equipments except Conductor, Insulator, Insulator Hardware, Spacer Damper and Earthwire and its Hardware fittings ("Owner's Supplied Material") on FOR Project site basis	M/s. Lanco Infratech Limited.
2.	Erection Contract	Erection, Testing, Commissioning and Handing Over of the Facilities which shall be complete in all respect, arranging complete Right of Way and Statutory Approvals including Electrical Inspectorate, Railways, PTCC approvals for the same and Management for the Facility. The works also include loading/ unloading, safe storage, Inter – site/ stores transportation and erection of the Owner Supplied materials at site, Erection of Towers and terminating the line on the gantries of the 765 kV sub – station of PGCIL at Dharamjaygarh.	
3.	Civil Contract	Civil work for construction as per requirement, necessary site preparation including mobilization of manpower, machineries, Labour, materials, consumables, tools and plants, as required for the construction of transmission lines of the size and scope of the Facility and handing over of the Facility which shall be complete in all respects, arranging complete ROW and Statutory Approvals, if any, also other construction services and management for the Facility.	
4.	Umbrella Contract	Manufacturing, Procuring, Testing at manufacturer's works, loading and supply of all equipments/ material, loading/ unloading at site, safe storage (including that of Owner's Supplied Material which includes Insulator, Insulator Hardware, Conductor, Spacer Damper and	



S. No.	Contract	Broad Scope of Work	Contractor
		Earthwire and its hardware fittings), Engineering, civil works and foundations, construction as per requirement, necessary site preparation including mobilization, ROW and Statutory Approvals if any, provision of labour, materials, consumables, tools and plants as required for the construction of transmission lines.	
<b>765 kV D/C Transmission line, Package C2 – Angle Point 73/0 to Angle Point 102/8 (Chhattisgarh).</b>			
1.	Supply Contract	Manufacturing, Inspection, Testing at manufacturer's works, loading and supply including transit insurance of all equipments except Conductor, Insulator, Insulator Hardware, Spacer Damper and Earthwire and its Hardware fittings ("Owner's Supplied Material") on FOR Project site basis.	M/s. Unitech Power Transmission Limited.
2.	Erection Contract	Erection, Testing, Commissioning and Handing Over of the Facilities which shall be complete in all respect, arranging complete Right of Way and Statutory Approvals including Electrical Inspectorate, Railways, PTCC approvals for the same and Management for the Facility. The works also include loading/ unloading, safe storage, Inter – site/ stores transportation and erection of the Owner Supplied materials at site, and Erection of Towers.	
3.	Civil Contract	Civil work for construction as per requirement, necessary site preparation including mobilization of manpower, machineries, Labour, materials, consumables, tools and plants, as required for the construction of transmission lines of the size and scope of the Facility and handing over of the Facility which shall be complete in all respects arranging complete ROW and Statutory Approvals, if any, also other construction services and management for the Facility.	
4.	Umbrella Contract	Manufacturing, Procuring, Testing at manufacturer's works, loading and supply of all equipments/ material, loading/ unloading at site, safe storage (including that of Owner's Supplied Material which includes Insulator, Insulator Hardware, Conductor, Spacer Damper and Earthwire and its hardware fittings), Engineering, civil works and foundations, construction as per requirement, necessary site preparation including mobilization, ROW and Statutory Approvals if any, provision of labour, materials, consumables, tools and plants as required for the construction of transmission lines.	

**765 kV D/C Transmission line, Package M1 & M2 – Angle Point 102/8 to Angle Point 130/0 and Jabalpur Gantry to Angle Point 130/0 (Madhya Pradesh).**



S. No.	Contract	Broad Scope of Work	Contractor
1.	Supply Contract	Manufacturing, Inspection, Testing at manufacturer's works, loading and supply including transit insurance of all equipments except Tower material including Stubs, Nuts & Bolts, Conductor, Insulator, Insulator Hardware, Spacer Damper and OPGW and its Hardware fittings ("Owner's Supplied Material") on FOR Project site basis.	M/s. Simplex Infrastructure Limited
2.	Erection Contract	Erection, Testing, Commissioning and Handing Over of the Facilities which shall be complete in all respect, arranging complete Right of Way and Statutory Approvals including Electrical Inspectorate, Railways, PTCC approvals for the same and Management for the Facility. The works also include loading/ unloading, safe storage, Inter – site/ stores transportation and erection of the Owner Supplied materials at site, and Erection of Towers.	
3.	Civil Contract	Civil work for construction as per requirement, necessary site preparation including mobilization of manpower, machineries, Labour, materials, consumables, tools and plants, as required for the construction of transmission lines of the size and scope of the Facility and handing over of the Facility which shall be complete in all respects arranging complete ROW and Statutory Approvals, if any, also other construction services and management for the Facility.	
4.	Umbrella Contract for M1 & M2	Manufacturing, Procuring, Testing at manufacturer's works, loading and supply of all equipments/ material, loading/ unloading at site, safe storage (including that of Owner's Supplied Material which includes Insulator, Insulator Hardware, Conductor, Spacer Damper and OPGW and its hardware fittings), Engineering, civil works and foundations, construction as per requirement, necessary site preparation including mobilization, ROW and Statutory Approvals if any, provision of labour, materials, consumables, tools and plants as required for the construction of transmission lines.	
<b>Contract for Supply of Insulators.</b>			
1.	Supply Contract	Design, manufacture, shop inspection, testing (routine, acceptance & type tests), seaworthy/ roadworthy packing and forwarding of Composite Long Rod Insulators (210 KN, 160 KN & 120 KN) with complete set of Corona Control Rings and delivery at CIF, Nava Sheva, Mumbai for 765 kV D/C and 765 kV S/C transmission lines.	Xian Electric Engineering Company Limited, China

**Contract for Supply of Conductor**

S. No.	Contract	Broad Scope of Work	Contractor
1.	Supply Contract	Design, engineering, manufacture, shop inspection, routine and acceptance tests including type testing, seaworthy/ roadworthy packing, forwarding and delivery of ACSR Conductor (Bersimis & Zebra) for 765 kV D/C & 765 kV S/C Transmission lines of Jabalpur Transmission Company Limited on FOR Destination (Project Sites – Champa, Mungeli, Dindori, Barela, Damoh, Sager) basis.	M/s Sterlite Power Transmission Ltd.
<b>Contract for Supply of Hardware Fittings and Spacer Dampers</b>			
1.	Supply Contract	Design, Engineering, manufacturing, inspection, testing, type testing, packing & forwarding and delivery of Hardware Fittings & Spacer Dampers for 765 kV S/C and 765 kV D/C transmission lines on FOR project sites basis.	Mosdorfer India Pvt. Limited, Mumbai.

Note: For Transmission Line contracts:

Design & Engineering of Towers and Foundations etc is in-house by the Project Company.

Conductor, Insulators & other Hardware Fittings etc. are free issue items provided by the Project Company.

Supply of Tower material including Stubs, Nuts & Bolts to the Contractor for package M1 & M2 was in the scope of the Owner

### 3.8. Availability

As per the TSA the Target Availability of the Project shall be 98%. Calculation of the Availability for the Element or the Project shall be as per the CERC (Terms & Conditions of Tariff) Regulations.

### 3.9. Condition Assessment of Asset

The JTCL Project is complete and both the elements (765 kV D/C and 765 kV S/C Transmission Lines) are commissioned and are operational. The COD for JB Transmission Line was declared on 1<sup>st</sup> July, 2015 and for JD Transmission Line was declared on 14<sup>th</sup> September, 2015.

#### 3.9.1. Review of Plant Design / Technical Details

As per the specification provided by the Project Company, the Transmission lines and Towers have been designed, installed and tested in accordance with International Standards and Indian Standards. The design has also met statutory requirements such as the Indian Electricity Rules, Indian Factory Act and Indian Electricity Grid Code etc. JTCL had carried out in – house Tower design and engineering of both 765 kV S/C and 765 kV D/C Transmission Lines. Type test of all the four (4) types of Towers (A, B, C and D) for S/C as well as D/C lines was also done.

### 3.9.2. Current Status of Asset

The COD for the project was envisaged as 31<sup>st</sup> March, 2014 as per the Transmission Service Agreement (TSA). However, the completion of both the lines got delayed due to Force Majeure events and Change in Law. Element wise the last element to successfully complete the Trial run test was Dharamjaygarh – Jabalpur (Ckt 4) on 14<sup>th</sup> September, 2015, which eventually marks the COD for the Project.

#### a) 765 kV S/C Jabalpur – Bina Line

765 kV S/C Jabalpur – Bina line comprising of 610 nos. towers and a line length of 235.194 circuit km is complete and is operational. The Approval for Energization of Jabalpur – Bina line from CEA has been received vide letter dated 16<sup>th</sup> June, 2015. The successful completion of 24 hrs trial run was achieved on 1<sup>st</sup> July, 2015 as accorded by the POSOCO Certificate vide letter dated 16<sup>th</sup> July, 2015.

#### b) 765 kV D/C Dharamjaygarh – Jabalpur Line

The 765 kV D/C Dharamjaygarh – Jabalpur line comprising of 991 nos. towers and a line length of 756.6 circuit kms is complete and is operational. The Approval for Energization from CEA was received on 4th September, 2015. The successful completion of 24 hrs trial run was achieved on 14th September, 2015 as accorded by the POSOCO Certificate vide letter dated 30th September, 2015.

### 3.9.3. Material availability at stores

The store material details for availability of different types of towers as furnished by the Project Company are mentioned under table below:-

Sl. No.	Material	Total weight in Kg
1.	DA Type BB Tower	87427.980
2.	A Type 0 Mtr. Extn. Tower	9475.200
3.	A Type +3 Mtr. Extn. Tower	6215.940
4.	A Type +6 Mtr. Extn. Tower	7412.93
5.	A Type +9 Mtr. Extn. Tower	20451.400
6.	DB Type BB Tower	70013.840
7.	B Type 0 Mtr. Extn. Tower	28238.010
8.	B Type +3 Mtr. Extn. Tower	8781.199
9.	B Type +6 Mtr. Extn. Tower	5615.639

10.	B Type +9 Mtr. Extn. Tower	10512.053
11.	B Type +18 Mtr. Extn. Tower	7159.938
12.	B Type +30 Mtr. Extn. Tower	8463.381
13.	DC Type BB Tower	51734.510
14.	C Type 0 Mtr. Extn. Tower	6101.860
15.	C Type +3 Mtr. Extn. Tower	794.020
16.	C Type +6 Mtr. Extn. Tower	22071.130
17.	C Type +9 Mtr. Extn. Tower	1695.380
18.	DD Type BB Tower	62499.29
19.	D Type 0 Mtr. Extn. Tower	8942.870
20.	D Type +3 Mtr. Extn. Tower	14810.060
21.	D Type +6 Mtr. Extn. Tower	783.660
22.	D Type +9 Mtr. Extn. Tower	6085.11
23.	D Type +18 Mtr. Extn. Tower	25184.912

### 3.10. Useful Life of Asset

The review of the Technical documents pertaining to the project by IE including the Technical Specifications, Type Test Certificates, MQPs and FQP confirm the quality of components and technical suitability of the transmission line.

The transmission line towers have been designed as per IS:802 Part 1 & 2 with a reliability factor of 1.0 which ensures the reliability period of the transmission line for 50 years. Additionally, Project Company is taking necessary life extension measures through preventive maintenance and condition monitoring to increase the useful life of the equipment.

Project Company is advised to continue with the prudent maintenance practice and follow the OEM recommendation to achieve the useful life.

### 3.11. Technical Guarantee

Typically contract for Transmission Project does not envisage any performance guarantee parameters. However, the project was implemented in line with the technical specifications with proper quality checks.

The certificate for Approval for Energisation of Jabalpur – Bina and Dharamjaygarh – Jabalpur Transmission lines has been issued by CEA vide letter dated 16<sup>th</sup> June, 2015 and 4<sup>th</sup> September, 2015 respectively. This certificate issued by CEA for both the lines ensures the completeness and technical acceptability of the transmission line.

### 3.12. Availability of Transmission Lines

Normative availability of each element has been considered as 98%. This is in line with CERC Notification. Also, the target availability of the project as per TSA is 98%.

IE observed that as per the O&M manual the target annual availability is 99%. The Project Company has submitted the monthly availability of transmission lines from Oct, 2015 till Dec, 2016 as indicated in the graph below:



IE observed that the Project Company has planned proper O&M procedures and an effective O&M organization set-up to maintain the availability of the lines. IE observed that the Availability is maintained more than 99%. IE is of the view that with prudent maintenance practices and deployment of skilled manpower, maintaining 98% availability is achievable.

### 3.13. Assessment of Technology Risk

Based on the technical assessment of the project, IE does not foresee any Technology risk.

## 4. PROJECT MANAGEMENT ARRANGEMENT

### 4.1. Project Organization

This section presents the Project Organization arrangement adapted during the execution of the project..

The Hub office of JTCL is located in Jabalpur with Project Head stationed there. The common services functions such as Accounts, Commercial, Safety, and Quality are catered from the Hub office.

#### 1. Dharamjaygarh – Jabalpur 765 kV D/C Transmission Line

The line is operational and was executed through three site offices along the line.

- a) **Bilaspur (Chhattisgarh):** This office had one Line Manager for package C1 & C2, one Section Manager and four Engineers and one forest Consultant. In addition, the out-sourced staff employed for package C1 & C2 were two supervisors, three technicians, two final checking staff and one safety supervisor. This team had been catering to approx. 181 kms of Chhattisgarh portion of the line.
- b) **Dindori (MP):** This office had been established for package M1. This office had one section Manager and one Engineer apart from out-sourced staff of two supervisors, three technicians, two final checking staff and one safety supervisor. The team had been catering to approx 100 kms section of the line.
- c) **Jabalpur (MP):** For execution of package M2, one Line Manager and two Engineers were posted. This was also the Hub office. One Line Manager and one Engineer were posted for the section of approx 100 kms long line.

#### 2. Jabalpur – Bina 765 kV S/C Transmission Line

The Jabalpur –Bina line is operational and was executed through two offices – located at Jabalpur & Sagar (MP).

The Line Manager is stationed at Jabalpur supported by two engineers in the Package – A (C&C). The Package – B (Unitech) was looked after from Sagar office wherein one Associate Manager and an Engineer are stationed.

IE is of the opinion that the Project Company has taken adequate measures for management of the complete project by allocating separate teams for supervision of the various EPC packages.

### 4.2. O&M Organization Set-up & its adequacy

The Head (O&M) of Sterlite Power Grid Ventures Ltd. shall be responsible for the Operation & Maintenance for JTCL and other projects of SPGVL.

The operation and maintenance of the transmission lines is done by the O&M contractor. Supervision of operation and maintenance work being carried out by the contractor is done by the SPGVL in-house team.

For trouble free operation and proper maintenance, SPGVL is taking up the following measures:

- a) Routine, Periodic, Preventive & Predictive maintenance shall be done by O&M contractor as per guide lines provided by SPGVL and under the supervision of SPGVL team.
- b) Close monitoring of agency, maintaining data and analysis to reduce down time shall be done by SPGVL Team.
- c) Mandatory spares shall be provided by SPGVL to the contractor. However, the contractor at his own cost, shall make provision of all other spares and consumables as may be required for O & M during the contract duration.
- d) Break down / Emergency shall be handled jointly by O&M contractor, SPGVL O&M & EHS (Environment, Health & Safety) Team.

JTCL has outsourced the maintenance works of 765 kV S/C Jabalpur – Bina Line to M/s. Telegence India vide letter dated 1<sup>st</sup> September, 2015, 765 kV D/C Jabalpur – Dharamjaygarh Line for 403.6 circuit kms to M/s. Telegence India vide letter dated 21<sup>st</sup> December, 2015 and the balance 354.4 circuit kms of Jabalpur – Dharamjaygarh line to M/s. JBS Enterprise Pvt. Ltd. vide letter dated 7<sup>th</sup> January, 2016.

The total work order Period is valid for 36 months i.e. 3 years from the date of successful commissioning of the respective lines.

The brief scope of the contractor includes:

- i. Routine patrolling and maintenance
- ii. T&P
- iii. Stores
- iv. Vehicles
- v. Transportation of material
- vi. Security of stores
- vii. Insulator cleaning
- viii. Corridor cleaning (vegetation), cutting of trees
- ix. Replacement of mission members
- x. Tightening of nuts and bolts
- xi. Visual inspection for hot spots
- xii. Breakdowns
- xiii. Inspection of foundations
- xiv. Strengthening of tower foundation and civil works
- xv. Night Patrolling
- xvi. Thermo vision once in six months
- xvii. Signature analysis as and when required
- xviii. Measurement of tower footing resistance
- xix. Mock drill
- xx. Thorough inspection of the corridor during pre monsoon and post monsoon
- xxi. Tree cutting if required
- xxii. Checking of foundation and ground clearance.



Incentive for increase in Availability over the target Annual Availability Value, limited to an overall Annual availability of 99.75 % and no incentive shall be paid over and above 99.75%. The Target Annual Availability shall not be less than 99.0%, during each Financial Year.

The 765kV Double circuit line from Dharamjaygarh to Jabalpur & 765kV Single circuit line from Jabalpur to Bina shall be managed by JTCL as follows:

To optimize costs, the contractor has deployed manpower and stores at four sections of Jabalpur. The gangs at this hub shall look after the maintenance of transmission lines in a circle of radius 100 kms. The contractor shall maintain manpower and stores at Sub – hubs wherever required to have optimum maintenance. Each section shall be taken care of by Section In- charge from the SPGVL In-house O&M team. The O&M contractor shall take care of all the O&M activities under the guide lines of the Section In- charge. To facilitate proper maintenance of the lines, the O&M personnel of the O&M contractor shall be assigned to four sections of the JTCL lines – Sagar, Bilaspur, Jabalpur, Dindori.

IE is of the opinion that the proposed O&M organization set-up is adequate. The division of responsibility of SPGVL O&M personnel for different line sections and the supervision of the O&M contractor by the SPGVL In-house team shall be effective in the smooth and trouble-free operation of the lines. Additionally, the proposal for providing mandatory spares by SPGVL to the contractor shall facilitate in reducing the down-time of the lines.

4.3. Operation & Maintenance (O&M) Activities

The Operation and Maintenance Activities have been classified under the following heads:

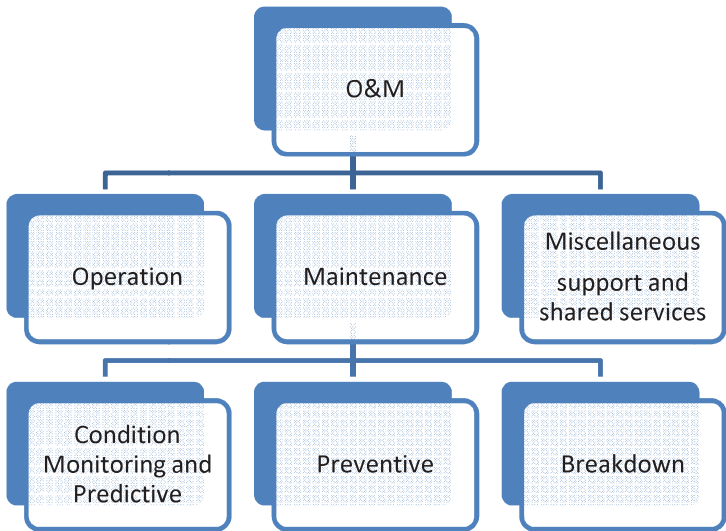


Figure4.1: Operation & Maintenance Activities

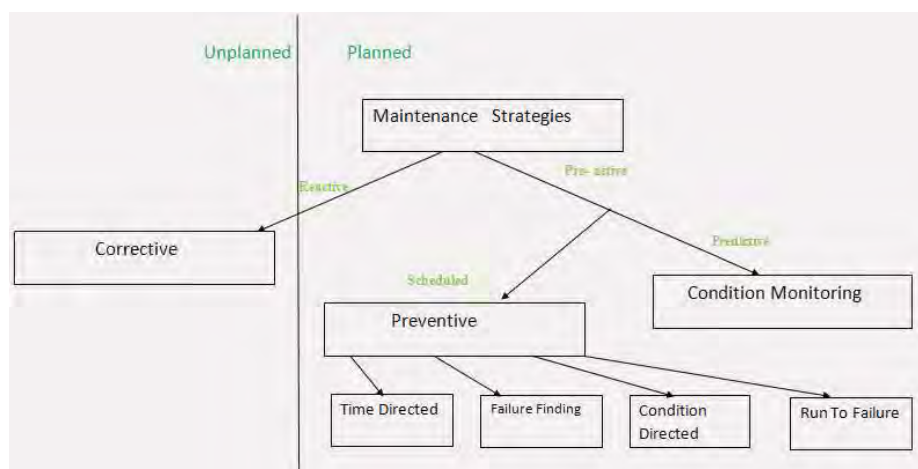
The day to day operation of the transmission systems is the primary responsibility of the Regional Load Dispatch Centre (RLDC). Consequently, the O&M strategy of JTCL will focus primarily on the maintenance aspect.



The objective of the O&M strategy of JTCL is:

- To achieve the system availability as specified in the TSA at the most economic cost,
- To carry out periodic 'preventive maintenance' so as to maximize the life of transmission lines
- To minimize the down time of the Transmission Lines/sub-stations for maintenance purpose

The maintenance activities are classified as follows to maximize the availability of the Transmission lines.



**Figure 4.2 – Maintenance Strategy**

#### 4.3.1. Routine Maintenance (Preventive Maintenance)

JTCL shall adopt proven practices such as regular patrolling of the lines, periodically removal of vegetation over growth, thermo-vision scanning, live line washing, on-line insulator failure detection and hot line maintenance techniques etc. JTCL plans to maintain a team of trained manpower along with adequate spares to swiftly attend to unforeseen eventualities/ natural calamities.

The patrolling frequency as followed by the Project Company is indicated below:

S. No.	Type of Patrolling	Visit Plan
1	Ground Patrolling	Monthly
2	Night Patrolling	45 Days
3	Monkey Patrolling	2 Month
4	Ground Patrolling (critical location)	Weekly
5	Emergency Patrolling	Immediate

JTCL shall carry out regular maintenance of each of the Transmission Lines suiting to the nature of terrain, environment, surroundings, etc so as to achieve the desired level of performance. The following are examples of routine maintenance activities:

- Routine ground patrols to inspect structural and conductor components. Such inspections generally require either an all-terrain vehicle (ATV) or pickup and possibly additional support vehicles travelling on access and service roads and may rely on either direct line-of-sight or binoculars. In some cases, the inspector may walk the ROW. Follow-up maintenance is scheduled depending on the severity of the problem either as soon as possible or as part of routine scheduled maintenance.
- Patrolling in normal terrain was completed on four monthly basis i.e., first patrolling cycle was completed in January to April , second patrolling cycle in May to August and third patrolling cycle in September to December. Patrolling sequence was such that each and every location was re patrolled in three to five months.
- Patrolling in vulnerable terrain was completed on quarterly basis i.e., first patrolling cycle was completed from January to March, second from April to June, third July to September and fourth from October to December. Patrolling sequence was such that each and every vulnerable location was re patrolled in two and half months to three and half months.
- Patrolling in most vulnerable terrain was completed on monthly basis. Patrolling sequence was such that each and every most vulnerable location was re patrolled in three to five weeks. Photographs of such location were taken using Digital Camera and Hard/Soft copies of the same were preserved to have the history of location.
- 100% Transmission Line towers and Spare were checked by concerned Lineman/ technician/ Engineer once in patrolling cycle. 20% Transmission Line Towers, spans in normal and vulnerable sections and all most vulnerable towers were checked by concerned Transmission Line Maintenance in Charge in each patrolling cycle of Three/four months.
- Climbing surveys may be necessary to inspect hardware or make repairs. Personnel generally access these structures by pickup, ATV, or on foot.
- Structure or conductor maintenance typically occurs manually. The maintenance vehicle may be located on or off a road, and no-to-minimal grading is necessary to create a safe work area.
- Cathodic protection surveys to check the integrity and functionality of the anodes and ground beds. These surveys typically require personnel to use an ATV or pickup and make brief stops.
- Routine cyclical vegetation clearing to trim or remove tall shrubs and trees to ensure adequate ground-to-conductor clearances. Vegetation clearing cycles vary from 3 to 5 years or as needed (dependent upon the vegetation present). Personnel generally access the area by pickup, ATV, or on foot; use chainsaws to clear the vegetation; and typically spend less than half a day in any one specific area. In some cases vegetation may be cleared using mechanical means.

- Removal of individual trees or snags (hazard trees) that pose a risk of falling into conductors or structures and causing outages or fires. Personnel generally access hazard trees by truck, ATV, or by foot from an access or service road, and cut them with a chainsaw or similar tool. Any felled trees or snags are left in place as sources of large woody debris or as previously directed by the land management agency. Felled green trees are limbed to reduce fire hazard.
- Rusting of tower parts: At some places, it was observed that rusting of tower parts/stubs have occurred due to direct contact of wet soil with tower parts. Therefore, it was ensured that the mandatory clearance from top of the coping of each leg and present ground level was maintained.
- Norms for tower top patrolling:- Tower top patrolling of the lines was carried out in case of repeated tripping/ autoreclosure (twice or more in same section/area) to find the untraceable faults during ground patrolling and in stretches having component failure history/ to examine pollution level on Insulators.
- Ground patrolling after line faults:- Emergency ground patrolling of the line was carried out for +/-5% towers both sides of the faulty tower indicated by online fault locator to trace the fault. In case of permanent faults, off-line fault locator were utilized by Maintenance Engineer to correlate the finding of on-line fault locator.
- Norms for Thermovision scanning:- Thermovision scanning of the lines was carried out after three month of the charging and noticed defects were attended on priority. Subsequent Thermovision scanning of high capacity lines (quadruple conductor) and highly loaded lines (90% or above of SIL rating) were carried out at every five year interval. Hotspots identified through Thermovision scanning were attended by HLM/ Earliest Opportunity.
- Norms for Punctured Insulator Detection:- PID scanning of Transmission lines having Insulator decapping incidents irrespective of age were carried out immediately to ascertain the healthiness of Insulators. However PID of Lines which are 15 years old were carried out irrespective of decapping incidents. Defective Insulators were replaced on priority.
- Condition Monitoring of Polymer insulators:- Condition monitoring of Polymer Insulators were carried out using Corona camera.
- Procedure for Transmission Line Patrolling:- Transmission Line maintenance Engineer prepares a program of transmission line patrolling/ Maintenance for the lines under his/her jurisdiction to complete patrolling cycle as per operation system norms and maintenance activities planned during the month and send copies to concerned employee and Delhi (O & M). Patrolling/ Maintenance of Transmission Line was carried out as per the plan.
- a) Checklist for Ground patrolling: Formats for the ground patrolling were filled up by the person who has patrolled the section immediately after patrolling and submitted to line In charge on daily basis. .

### 4.3.2. Corrective Maintenance

Corrective maintenance activities are relatively large-scale efforts that occur infrequently, may result in more extensive vegetation clearing or earth movement and associated activities. Such activities shall be scheduled in the Maintenance Schedule for Transmission Lines. The following are examples of corrective maintenance:

- a) Non-cyclical vegetation clearing to remove saplings or larger trees in the ROW.
- b) Structure or conductor maintenance in which earth must be moved, such as the creation of a landing pad for construction or maintenance equipment.
- c) Structure (e.g., cross-arm, insulator, structure) replacement.

### 4.3.3. Emergency situations

Most of the activities, such as routine patrols, inspections, or scheduled maintenance, are planned in advance as per the O&M procedures. However, there will be an occasional need for emergency response in cases where safety and property are threatened, to prevent imminent damage to the transmission line and ancillary facilities, or to restore service in the event of an outage. Such activities which need to be addressed immediately shall be identified in the Maintenance Schedule for Transmission Lines. The following are examples of Emergency situations:

- a) Failure of conductor splices.
- b) Damage to structures or conductors from wildfire, high winds, ice, or other weather related conditions.
- c) Line or system outages or fire hazards caused by trees falling into conductors.
- d) Breaking or imminent failure of cross-arms or insulators, which could, or does, cause conductor failure.
- e) Damage to structures or conductors from vandalism In the case of an emergency where life or substantial property is at risk or there is a potential or actual interruption in service, the Companies will promptly respond to the emergency and conduct any and all activities, including emergency repair requiring heavy equipment access to the structures or other ancillary facilities, needed to remedy the emergency and will implement feasible and practicable Environmental Protection Measures (EPMs).

#### **Maintenance Activities carried out on 765 kV Dharamjaygarh – Jabalpur Line is as follows –**

- i. Regular patrolling – all 478 tower attend in a month.
- ii. Revetment Work – no fresh revetment work done, only pending revetment from construction end completed.
- iii. Thermo vision scanning – incomplete due to low standard camera.
- iv. Aerial survey done for some tripped or auto re closer section.
- v. Tower Footing Resistance (TFR) checking under progress

## 4.4. Standard Operating Procedures

The Standard Operating Procedures (SOP) for Operation and Maintenance of the Transmission lines have been laid down by the Project Company. The Standard Operating Procedures elaborate the General Safety Precautions to be followed during the operation and maintenance of the transmission lines. It also includes the detailed procedure and working instructions for the following activities:

- a) Steps to be taken in case of Tower collapse
- b) Method employed to overcome failure of Jumpers
- c) Preventive Maintenance of Tower Foundation
- d) Maintenance Earthing of Transmission Lines
- e) Patrolling of Transmission Lines

The Standard Operating Procedures include the Maintenance Schedule of the Transmission lines and Checklist for Ground Patrolling. It also includes the various standard formats to be filled in during the operation and maintenance of the lines.

- a) Monthly Patrolling Programme
- b) Ground Patrolling report
- c) Tower Climbing Patrolling Report
- d) Log Book of Line Defects
- e) Emergency Patrolling Report on Tripping/ Auto re – closure of Transmission Lines
- f) Summary of Line Defects for the Month
- g) Shut Down Nature Defects
- h) Non-Shut down Nature Defects
- i) Details of Tree cutting
- j) Inspection Report for Major Maintenance/ Breakdown works
- k) Live Line Puncture Insulator Detection
- l) Thermovision scanning
- m) Insulator Washing/ cleaning

## 4.5. Implementation of the O&M Procedures

For proper implementation of the O&M Procedures, the following initiatives are being taken by the Project Company:

- a) Use of separate IT (Information Technology) based tool is being put in place for O&M, to computerize all the formats for the purpose of storage for easy access and for centralization of the information.
- b) To promote knowledge sharing within the team, a Knowledge management portal is already in place.
- c) Document management system in “WRENCH” software is already implemented for storage and retrieval of documents like engineering drawings, tower schedules, commissioning reports etc.
- d) Regular training programs are being held to train the personnel on the latest techniques for effective maintenance of the transmission lines and safety measures to be adopted during maintenance.

The O&M philosophy and methodology being adopted by the Project Company is in line with the widely accepted practices followed for similar projects. The Standard Operating Procedures laid down by the Project Company are comprehensive and include all major aspects required for effective operation and maintenance of the transmission lines.

## 4.6. O&M Technology

Project Company informed that they are planning to supervise their transmission assets with the drone based asset management technology developed by Sharper Shape Inc. This technology will enable to monitor the critical asset conditions and ensure full economic optimization of resource deployment in maintenance operations. The drone based asset management technology will improve the reliability, resilience and safety of the transmission lines. Long distance inspection will be provided through drone based technology. The use of drones will increase the uptime of the grid, and also save the environment by conducting preventive maintenance and reducing deforestation along the line corridors.

## 5. ENVIRONMENTAL AND SOCIAL ASPECT

### 5.1. Environmental Impacts and Mitigation Measures

The operation of the transmission line shall have no environment impact and hence, no clearance or mitigation measures are required.

### 5.2. Environment, Health & Safety Assessment

JTCL has implemented following procedures to ensure that the Environment, Health & Safety (EHS) aspects are duly taken care of.

#### 5.2.1. Mandatory Safety Requirement and Score System

The purpose of the Mandatory Safety Requirement and Score (MSRS) System is to be used by JTCL Employees and channel partners who may be concerned in any way with operation of work at site, property or premises.

The Intention of the Mandatory Safety Requirement & Score is to provide a means of:

- Implementation of MSRS system
- Analysis of Site Safety situation in terms of Percentage (0-100%)
- In case of repeated gaps, the gap is bridged
- Further partial changes and amendments to individual parts shall be routed for suggestions & comments

The Mandatory Safety Requirement & Score (maximum score of 100%) is evaluated based on the assessment of implementation of the following tools :

1. Organization of Empowerment
2. Induction & Training
3. Site & Work Place Access
4. Risk Assessment and prevention plan
5. Daily Survey, Safety Talk & Permit to Walk System
6. Work instruction survey for Excavation & Foundation, Material handling, Electrical Shut down.
7. Machine/ equipments/ T&P are the major sources of construction site & at the same time it is very hazardous. So the inspection/ certification is one of major preventive tools.
8. Vehicle & Traffic management
9. Site has following records & documentations;
  - Site organization
  - Emergency Plan
  - Training record
  - Project Plan (Project quality plan, project EHS plan, EHS site manual)
  - Contract with customer, contracts with subcontractors
  - Risk assessments and preventive plans
  - Safety tool box talk record



- EHS reports (Weekly, accidents, near-misses, etc.)
  - EHS plan follow up
  - Weekly EHS report
  - Routine self assessment check list
  - Fire extinguisher
  - Non conformity report
10. Internal & External Control

### 5.2.2. EHS Inspection Procedure

The EHS Inspection Procedure applies to the JTCL construction sites. The objective of this instruction is as follows:

- Demonstrate the involvement and commitment of middle managers in safety management
- Deploy common EHS managerial practices within all sites
- Promote the culture and to eradicate deviations and reach 100% compliance level

The EHS Inspection is achieved through

#### a) Safety Observation Tour (SOT) Process

This is a management process which is used to ensure the application of safety standards, instructions and practices/tools used in a given area. It is an inspection for the front line engineer & middle management. This is a safety observation visit. The SOT is conducted to check the application of the EHS rules and regulations in the area. The inspection format are filled by the Engineer & Manager involving channel partner & validated by EHS manager. During SOT, all points are checked in line with the Safety Tour Observation Check List which is provided as a part of the EHS Inspection Procedure. At the end of the SOT, a debrief between the SOT leader and the channel partner of the area visited takes place. All findings are reviewed and a commitment is taken by the channel partner to avoid new occurrences of the deviations found.

#### b) Intermediary Safety Visit (ISV)

It is a management process which should ensure the application of safety standards, instructions and practices/ tools used in a given area. It is an Intermediary Safety Visit Inspection for the Project Head, Commercial Head and Project Management & Business Head.

The objective of the ISV is to make management's commitment visible. Also, the ISV is used to make sure that all the risks are managed, i.e under control. It is used to verify that local standards (workshop, customer site) are respected and applied. It helps to identify deviations and unsafe practices. The ISV format is filled and at the end of the ISV, a debrief between the ISV leader and the Line / Station Manager of the area visited take place. All findings are reviewed and a commitment is taken by Line/ Station Manager to implement actions to avoid new occurrences of the deviations found. Any open non compliance follows up & closeout is responsibility of EHS manager through Project Head.



The Project Company submitted a summary of the Safety Observation Tours conducted during the execution of the project. Also, the Project Company submitted sample formats of the SOT reports. IE observed that Safety Observation Tours are being conducted regularly.

### 5.2.3. Work Stoppage or EHS Non conformance Report (NCR) Procedure

This procedure describes the methods for raising EHS non-conformances at the construction sites with subsequent corrective action. Non-Conformity is any circumstances, material or method within the operation of the construction of Transmission Line/ Substation which does not comply with the specified requirements contained within the Safe Working Procedure (SOP) and JTCL EHS manual. This procedure applies to across the Sterlite Grid limited construction site.

The responsibility to ensure that the procedure is followed, reported and appropriate records are maintained lies with the Project Head/ Line Manager/ EHS Lead. The responsibility to issue NCR / work stoppages to contractor Line Manager/ Project Manager, EHS Lead in case of any non-conformity, unsafe act/ unsafe condition and recommend corrective and preventive action. When the agreed remedial action is completed, the Engineer/ Line Manager/ Project Manager (JTCL) shall sign off the respective non-conformance report.

The Project Company has submitted the summary of the Non Conformance Reports reported during the execution of the project and the remedial actions implemented. IE observed that by this process, the Project Company has been taking adequate measures for ensuring safety at the site.

### 5.2.4. Review of the status of Environment, Health & Safety Aspects by IE

Upon review of the various EHS documents received from the Project Company, IE is of the opinion that the Project Company is following the EHS Procedures to ensure that the aspects related to Environment, Health and Safety of the project are duly taken care of.



## 6. PROJECT PERMITS AND CLEARANCES

### 6.1. Permits and Clearances

Following table 6.1 shows the latest status of various Permits and Clearances.

**Table 6.1: Status of key Permits & Licenses**

S. No.	Description	Authority	Present Status
1.	Transmission License	CERC	Obtained on 12.10.2011
2.	Company Registration	Registrar of Companies	Completed on 08.09.2009
3.	Forest Clearance	State Govt./ MoEF	Obtained
4.	Approval under Section 68 of Electricity Act, 2003	GOI, Ministry of Power	Obtained on 25.11.2010
5.	Approval under Section 164 of Electricity Act, 2003	GOI, Ministry of Power	Obtained on 10.06.2013
6.	Approval under Section 17(3)	CERC	Obtained on 12.09.2012
7.	Power & Telecommunication Coordination Committee Clearance (PTCC)	CEA / Ministry of Power	Approved
8.	Railway Crossing	Ministry of Railways	Approved
9.	River Crossing	Navigation Authority	No major river crossing is involved in any of the packages.
10.	Road Crossing	NHAI / State Road Department	Approved
11.	Power Line Crossings	Concerned State Power Utilities / PGCIL	Approved
12.	Aviation Clearance	Airport Authority of India	Approved.
13.	Defence Clearance	GOI, Ministry of Defense	Approved
14.	Transmission Service Agreement (TSA)	JTCL & LTTCs	Signed on 01.12.2010
15.	Approval for adoption of Tariff	CERC	CERC Order received on 28.10.2011

### 6.2. Summary of Findings

IE found that major permits and clearances including Transmission License, Approval under Section 68, Section 164 of Electricity Act 2003 and forest clearance have been received for the Project. The validity of all the permits and clearances as mentioned above for the transmission line are valid throughout the Project life.

## 7. OVERALL STATUS

Jabalpur Transmission Company Limited has set up 765 kV Transmission Project – System Strengthening common for Western & Northern Region – consisting of a 765 kV D/C transmission line (756.6 circuit km in length) from Dharamjaygarh to Jabalpur and 765 kV S/C line from Jabalpur to Bina (235.194 circuit km) on Build, Own, Operate and Maintain (BOOM) basis. The two transmission lines are connected to existing/ proposed 765/400 kV CTU substations at Dharamjaygarh, Jabalpur and Bina.

The Project consists of the following transmission lines:

- Dharamjaygarh – Jabalpur 765 kV D/C transmission line with hexa ACSR 'Zebra' conductor (756.6 circuit km).
- Jabalpur – Bina 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor (235.194 circuit km).

As per the specification provided by the Project Company, the Transmission lines and Towers are being designed, installed and tested in accordance with International Standards and Indian Standards. The design has also met statutory requirements such as the Indian Electricity Rules, Indian Factory Act and Indian Electricity Grid Code etc. IE reviewed the Technical Specifications and the same were found to be in order. The Project Company had carried out all the design and engineering of towers and foundations of the Project in-house. IE found the design philosophy adopted for the transmission line to be in order. The design and prototype of all types of towers for 765 kV S/C and 765 kV D/C towers was done successfully. IE reviewed the type test certificates of the conductor ACSR Bersimis, hardware & fittings for ACSR Zebra, insulators and towers provided by the Project Company and the same were found to be in order.

The Project Company is adhering to the Quality Assurance Program which is in line with the industry standards and practices and is complying with the requirements of the Indian and International Standards. IE observed that, during execution of work, the Project Company had adopted appropriate measures to keep a strict vigil in implementing the Field Quality Plan & Material Quality Plans and in supervising the construction work. The Material Quality Plans (MQP) of different components were reviewed by the IE and opines that the pre – requisite tests and inspections are in line with Indian and International standards at various stages of the manufacturing process.

The Project was executed under the supervision of JTCL. The Project was implemented on multiple contracts basis. Dharamjaygarh – Jabalpur 765 kV D/C Transmission Line had been divided into four packages (C1, C2 & M1 and M2) and awarded to three EPC contractors.

Package C1 was awarded to Lanco infra, Package C2 to Unitech Power Transmission Limited and Packages M1 & M2 were awarded to Simplex Infrastructure. OSM (Owner Supplied Materials) includes Tower Materials including stubs, nuts & bolts, Insulators, Insulator Hardware, Conductor, Spacer Damper and Earthwire and its hardware fittings. Additionally, the Supply of Tower material including Stubs, Nuts & Bolts to the Contractor for package M1 & M2 is in the scope of the Owner.

Jabalpur – Bina 765 kV S/C Transmission Line had been divided into two packages – Package A and Package B, awarded to two EPC Contractors. Package A was awarded to M/s. C&C Constructions Limited. Package B was awarded to Unitech Power Transmission Limited. OSM (Owner Supplied Materials) includes Insulators, Insulator Hardware, Conductor, Spacer Damper and Earthwire and its hardware fittings.

The Purchase Order for supply of ACSR Conductor (Bersimis & Zebra) for 765 kV D/C & 765 kV S/C Transmission lines was placed on M/s Sterlite Power Transmission Limited.

The Supply of Composite Long Rod Insulators (210 KN, 160 KN & 120 KN) with complete set of Corona Control Rings for 765 kV D/C and 765 kV S/C transmission lines was awarded to Xian Electric Engineering Co. Limited, China.

The Project Company had signed contract for supply of Hardware Fittings and Spacer Dampers for 765 kV S/C and 765 kV D/C transmission lines with Mosdorfer India Pvt. Limited, Mumbai.

JB Transmission Line – the approval for energisation from CEA was granted on 16<sup>th</sup> June, 2015 vide letter no. CEI/3/EI/RIO(W)/Insp/2015/748. The successful completion of 24 hrs trial run was achieved on 1<sup>st</sup> July, 2015 at 18:32 hrs as accorded by Power System Operation Corporation Limited (POSOCO) vide Certificate dated 16<sup>th</sup> July, 2015. The COD for the element was declared as 1<sup>st</sup> July, 2015.

JD Transmission Line – the approval for energisation from CEA was granted on 4<sup>th</sup> September, 2015 vide letter no. CEI/3/EI/RIO(W)/Insp./2015/1188. The successful completion of 24 hrs trial run was achieved on 14<sup>th</sup> September, 2015 at 00:04 hrs as accorded by POSOCO vide Certificate dated 30<sup>th</sup> September, 2015. The COD for the element was declared as 14<sup>th</sup> September, 2015, which also marks the Project COD.

The review of the Technical documents pertaining to the project by IE including the Technical Specifications, Type Test Certificates, MQPs and FQP confirm the quality of components and technical suitability of the transmission line. The transmission line towers have been designed as per IS: 802 Part 1 & 2 with a reliability factor of 1.0 which ensures the reliability period of transmission line for 50 years. Additionally, Project Company is taking necessary life extension measures through preventive maintenance and condition monitoring to increase the useful life of the equipment.

IE reviewed the Project Organization arrangement used for the execution of the project. IE is of the opinion that the Project Company had taken adequate measures for management of the complete project by allocating separate teams for supervision of the various EPC packages during the execution phase. Additionally, there was a Centralized PMO (Project Management Office) at corporate office of SPGVL, which is responsible for tracking the progress, reviewing the monthly and daily progress report received from the Contractors for all the transmission line packages, co-coordinating between the various agencies and facilitating the execution of the project

The O&M methodology and organization set-up was furnished by the Project Company. IE is of the opinion that the O&M organization set-up is adequate. The division of responsibility of O&M personnel for different line sections and the supervision of the O&M contractor by the SPGVL In-house team shall be effective in the smooth and trouble-free operation of the lines. Additionally, the procedure of providing mandatory spares by SPGVL to the contractor shall facilitate in reducing the down-time of the lines.

The O&M philosophy and methodology being adopted by the Project Company is in line with the widely accepted practices followed for similar projects. The Standard Operating Procedures laid down by the Project Company are comprehensive and include all the aspects required for effective operation and maintenance of the transmission lines. For proper implementation of O&M procedures, the Project Company has taken initiatives to computerize the various formats to be filled in during O&M of the transmission lines and has implemented the document management system in "WRENCH" software. Additionally, regular trainings have been planned to train the personnel on the latest techniques for effective maintenance of the transmission lines and safety measures to be adopted during maintenance.

The Project Company has taken appropriate measures to ensure the healthiness of the 765 kV long rod polymer insulators by including the appropriate conditions in the contract.

The operation of the transmission line shall have no environment impact and hence, no clearance or mitigation measures are required.

SPGVL has implemented adequate procedures to ensure that the Environment, Health & Safety aspects are duly taken care of. Upon review of the various EHS documents received from the Project Company, IE is of the opinion that the Project Company is following the EHS Procedures to ensure that the aspects related to Environment, Health and Safety of the project are duly taken care of.

The Project Company has submitted the summary of the Non Conformance Reports reported during the execution of the project and the remedial actions implemented. IE observed that by this process, the Project Company has been taking adequate measures for ensuring safety at the site.

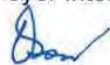
IE found that all major permits and consents including Transmission License, Approval under Section 68, Section 164 of Electricity Act 2003, PTCC clearance and forest clearances are well in place for the Project.

Based on the technical review of the project, IE has concluded that there are no risks associated with the project.

Prepared for and on behalf of

Lahmeyer International (India) Pvt. Ltd.

By



Name: Vaskar Basu

Title: Senior Consultant

Membership No. of Institute of Engineers (India): M 109154/3