TABLE OF CONTENTS

ACRONYM

AAAC	All Aluminum Alloy Conductors
ABG	Advance Bank Guarantee
ACSR	Aluminium Conductor Steel Reinforced
Areva	Areva T&D India Limited
ATV	All Terrain Vehicle
BOOM	Build, Own, Operate & Maintain
BDTCL	Bhopal-Dhule Transmission Company Limited
BSNL	Bharat Sanchar Nigam Limited
CTU	Central Transmission Utility
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
COD	Commercial Operation Date
CPG	Contract Performance Guarantee
CPBG	Contract Performance Bank Guarantee
D/C	Double Circuit
EA	Electricity Act
EPC	Engineering, Procurement & Construction
EHS	Environment, Health & Safety
FQP	Field Quality Plan
FTTH	Fibre To The Home
GOI	Government of India
GS	Galvanized Steel
HHI	Hyundai Heavy Industries Company Limited
IPTCs	Independent Power Transmission Companies
IEGC	Indian Electricity Grid Code
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
MQP	Material Quality Plan
MSRS	Mandatory Safety Requirement and Score
MP	Madhya Pradesh
MPPTCL	Madhya Pradesh Power Transmission Company Limited
MSL	Mean Sea Level
MSETCL	Maharashtra State Electricity Transmission Co. Ltd.
NTP	Notice to Proceed
NCR	Non Conformance Report
NLDC	National Load Dispatch centre
O& M	Operation & Maintenance
OEM	Original Equipment Manufacturer
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
PG	Performance Guarantee
PTC	Power Transmission Conductors
PGCIL	Power Grid Corporation of India Ltd.
PTCC	Power & Telecommunication Coordination Committee
QAP	Quality Assurance Plan
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
WR	Western Region

1. EXECUTIVE SUMMARY

For evacuation of power from large number of IPP generation projects in Chhattisgarh, Madhya Pradesh, Odisha 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 are being implemented by IPTCs.

Government of India, Ministry of Power, had invited bids for selection of Transmission Service Provider (TSP) based on 'Tariff Based Competitive Bidding Guidelines for Transmission Services'. Sterlite Grid Limited (erstwhile Sterlite Transmission Projects Limited) was selected as TSP for executing the 'System Strengthening Scheme for Western Region' consisting of 765 kV and 400 kV Transmission Lines and two numbers 765/400 kV Substations through its Special Purpose Vehicle (SPV) – Bhopal Dhule Transmission Company Limited (BDTCL). The BDTCL Transmission System consists of:

i. Jabalpur – Bhopal 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 259.693 circuit km. Hereinafter referred as BJ Transmission Line.
ii. Bhopal – Indore 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 175.75 circuit km. Hereinafter referred as BI Transmission Line.
iii. Bhopal (IPTC) – Bhopal (MPPTCL) 400 kV D/C transmission line with quad ACSR 'Moose' conductor, 17.362 circuit km. Hereinafter referred as BB Transmission Line.
iv. Aurangabad – Dhule 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 192.235 circuit km. Hereinafter referred as DA Transmission Line.
v. Dhule – Vadodara 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 262.90 circuit km. Hereinafter referred as DV Transmission Line.
vi. Dhule (IPTC) – Dhule (MSETCL) 400 kV D/C transmission line with quad ACSR 'Moose' conductor, 36.14 circuit km. Hereinafter referred as DD Transmission Line.

Substations

i. Bhopal (IPTC) Substation (2x1500 MVA, 765/400 kV)
ii. Dhule (IPTC) Substation (2x1500 MVA, 765/400 kV)

The transmission system is terminated at the gantry of Power Grid Corporation Limited (PGCIL) & State Transmission Utility (STU) 765/400 kV substations at Jabalpur, Indore, Aurangabad, Vadodara, Bhopal and Dhule. The Project was executed on Build, Own, Operate and Maintain (BOOM) basis.

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 Bhopal Dhule Transmission Company Limited (BDTCL).

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.

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

This Technical Due Diligence Report has been prepared based on the discussions with the officers of the Project Company, Project Site visit undertaken by IE from 27.09.2016 to 30.09.2016 and review of the documents provided by the Project Company.

The Transmission Service Agreement (TSA) has been signed between 22 nos. of Long Term Transmission Customers (LTTCs) and Bhopal Dhule Transmission Company Limited (BDTCL) on 7th Dec. 2010. 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 31st March 2011. Thus, the COD as per TSA was worked out to 31st March 2014.

The Project is complete and all the eight (8) nos. elements of the project have been commissioned and are fully operational. The COD of the last element which is the Dhule – Vadodara 765 kV S/C Transmission line has been declared on 13th June 2015. Considering the actual COD of the complete project as 13th June 2015, there has been a delay in the completion of the project with respect to the scheduled COD of 31st March 2014 specified in the Transmission Service Agreement.

The scheduled COD mentioned in the TSA has been delayed due to Force Majeure Events and change in law. .

Design and engineering of the Project was completed in – house for all the four types of towers (A, B, C and D) to be used for 765 kV S/C Transmission Lines and 400 kV D/C Transmission Lines and the prototype was tested. The Project was implemented on multiple contract packages. The contracts awarded are listed below:

i. 765/400 kV Transformers: Offshore Supply, Onshore Supply and Onshore Service (Supervision) Contracts to Hyundai Heavy Industries Company Limited, Seoul, Korea. This included supply of all the 14 nos. Transformers for both the 765/400 kV sub – stations at Bhopal and Dhule.
ii. 765 kV & 400 kV Reactors: Supply and Onshore Service (Supervision) Contract to Baoding Tianwei Baobian Electric Company Limited, China. This included supply of 22 nos. of 80 MVAr, single phase, 765 kV Reactors and one no. 125 MVAr, three phase, 400 kV Reactor including all accessories.

iii. 765/400 kV Substations at Bhopal and Dhule: Supply of all equipments except Transformers & Reactors, Civil and Erection contract was awarded to Areva T&D India Limited.
iv. 765 kV & 400 kV Transmission Lines: Supply of Tower materials, Civil and Erection Contracts to Simplex Infrastructures Limited (3 lines) and KEC International Limited (3 lines).
v. Insulators (120 KN, 160 KN & 210 KN): Supply Contract to Xian Electric Engineering Company Limited, China.
vi. Hardware Fittings & Spacer Dampers for 765 kV & 400 kV lines: Supply Contract awarded to Mosdorfer India Private Limited.
vii. Contracts for supply of Bersimis & Moose Conductor was awarded to Apar Industries Limited, Hind Aluminium Industries Limited and Sterlite Technologies Limited.

Element wise COD dates are mentioned below:

1. Jabalpur – Bhopal 765 kV S/C – COD was achieved on 9th June, 2015 and is operational.
2. Bhopal – Indore 765 kV S/C – COD was achieved on 19th November, 2014 and is operational.
3. Bhopal – Bhopal 400 kV D/C – COD was achieved on 12th August, 2014 and is operational.
4. 765/400 kV Bhopal Substation at Agaria – COD was achieved on 30th September, 2014 and is operational.
5. Dhule – Vadodara 765 kV S/C – COD was achieved on 13th June, 2015 and is operational.
6. Dhule – Aurangabad 765 kV S/C – COD was achieved on 5th December, 2014 and is operational.
7. Dhule – Dhule 400 kV D/C – COD was achieved on 6th December, 2014 and is operational.
8. 765/400 kV Dhule Substation – COD was achieved on 6th December, 2014 and is operational.

For Project Operation and Maintenance activities the Project Company has out – sourced the works to different agencies. However, supervision of the O&M activities is being done in – house by the Project Company.

For maintenance works of all the 765 kV S/C and 400 D/C Transmission Line in Dhule Section is accorded to M/s. JBS Enterprise Pvt. Ltd and for 765 kV S/c and 400 kV D/C Transmission Lines in Bhopal section the maintenance works are out sourced to M/s. Telegence India. For the operation of sub – station in Dhule and Bhopal the works are outsourced to M/s. Encotech Energy (India) Pvt. Ltd.

Project Company has laid down Standard Operating procedures 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 to be adopted during maintenance.

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. .

This Technical Due Diligence Report including the observations and recommendations of IE is based on the site visit undertaken by IE from 27th September, 2016 to 30th September, 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 the 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 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: Operation and Maintenance (O&M) Arrangement

This section presents the arrangement made by the company for the Operation and Maintenance of the substations and 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 aspects. 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 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.

As per the specification provided by the Project Company, the Substations, Transmission lines and Towers have been designed, installed and tested in accordance with International Standards and Indians 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 followed by the Project Company, the final design and specifications of equipment/ systems installed in the Transmission are in line with the technical specification and the drawings & documents reviewed and approved by the Project Company.

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 for transmission lines and substations laid down by the Project Company are comprehensive and include all the aspects required for effective operation and maintenance of the transmission lines.

IE is of the opinion that the O&M organization set-up envisaged for the O&M of the substations & transmission lines is adequate.

IE reviewed the provisions of the Transmission Service Agreement (TSA) and found the same to be in order.

IE reviewed the various supply and erection contracts for the project. IE is of the opinion that the warranties and Contract performance guarantees have been adequately covered in the various contracts and shall ensure the performance of the project.

IE found that all the major Permits/ Licenses like Transmission License, Approval under Section 68, Section 164 and Section 17 (3) of Electricity Act, 2003, forest clearance have already been obtained by the Project Company.

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.

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

Bhopal Dhule Transmission Company Limited (hereinafter referred as "BDTCL or Project Company") a subsidiary of SPGVL has set up four (4) nos. 765 kV Single Circuit (approximate 890.578 circuit km in length), Two (2) nos. 400 kV Double Circuit (approximate 53.502 circuit km in length) transmission lines and two nos. 765/400 kV Substations at Bhopal (Madhya Pradesh) and Dhule (Maharashtra) under "System Strengthening scheme for WR" on Build, Own, Operate and Maintain (BOOM) basis.

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

Sterlite 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 Bhopal Dhule Transmission Company Limited (BDTCL).

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 BDTCL transmission system

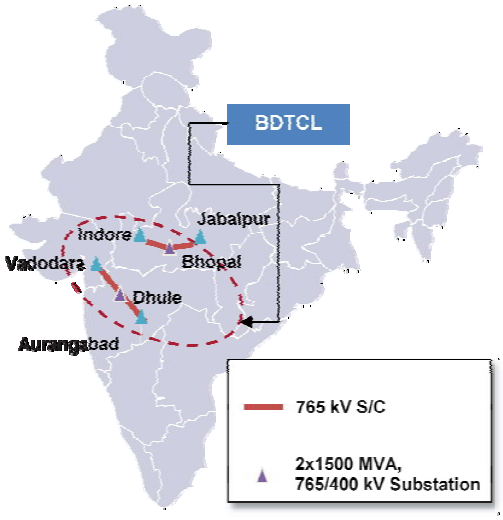


Figure 2.1: Map for BDTCL Transmission System

2.2 Definitions

Title	:	Definition
Project	:	System strengthening in Western region - 765 kV Transmission system from Jabalpur to Bhopal & Bhopal to Indore and Aurangabad to Dhule & Dhule to Vadodara and two nos.765/400 kV substations at Bhopal and Dhule.
Project Company	:	Bhopal Dhule Transmission Company Limited (BDTCL)
Independent Engineer	:	Lahmeyer International (India) Pvt. Ltd. (LII).

2.3 Scope of Report

SPGVL has asked IE to carry out the Technical Due Diligence of the BDTCL transmission project. IE's review is based on documents furnished by the Project Company and the site visits undertaken by IE from 27th to 30th September, 2016

2.4 Risk Categories

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

Table 2.1 – Definition of Risk Categories

Risk Category A	**Development Risk**	Matters which are dependent on external factors/ agencies and can affect the development/ schedule of the project.
Risk Category	**Technology Risk**	Matters that are related to technical aspects of the

B		project which can affect performance/ availability significantly.
Risk Category C	**Operational Risk**	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:

- Technical specification
- Contracts for supply & erection
- Material Quality Plan
- Field Quality Plan
- Type Test Reports
- Type Test Report of Towers
- Permits and Clearances
- O&M Manual for BDTCL
- O&M Organization Chart
- Environment, Health and Safety (EHS) Procedures
- CEA approval certificates for energization
- POSOCO certificates for completion of trial operation.
- Transmission line Operational Performance

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

Bhopal Dhule Transmission Company Limited (hereinafter referred as "BDTCL or Project Company") a subsidiary of SPGVL has set up four (4) nos. 765 kV Single Circuit (approximate 890.578 circuit km in length), Two (2) nos. 400 kV Double Circuit (approximate 53.502 circuit km in length) transmission lines and two nos. 765/400 kV Substations at Bhopal (Madhya Pradesh) and Dhule (Maharashtra) under "System Strengthening scheme for WR" on Build, Own, Operate and Maintain (BOOM) basis.

The Transmission System covered under the Scheme facilitates in evacuation of power from various IPP Generating Stations and power pooled at pooling stations of PGCIL located at Jabalpur, in Madhya Pradesh and at Dhule in Maharashtra State to various beneficiaries in Western Region.

The Project consists of construction, operation and maintenance of following transmission lines and substations by the Project Company (BDTCL):

Transmission Lines

i. Jabalpur – Bhopal (BJ) 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 259.693 circuit km.
ii. Bhopal – Indore (BI) 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 175.75 circuit km.
iii. Bhopal (IPTC) – Bhopal (BB) (MPPTCL) 400 kV D/C transmission line with quad ACSR 'Moose' conductor, 17.362 circuit km.
iv. Aurangabad – Dhule (AD) 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 192.235 circuit km.
v. Dhule – Vadodara (DV) 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 262.90 circuit km.
vi. Dhule (IPTC) – Dhule (DD) (MSETCL) 400 kV D/C transmission line with quad ACSR 'Moose' conductor, 36.14 circuit km.

Substations

i. Bhopal (IPTC) Substation (2x1500 MVA, 765/400 kV)
ii. Dhule (IPTC) Substation (2x1500 MVA, 765/400 kV)

3.2. Transmission System

BDTCL project is part of the system strengthening scheme of the Western Region to facilitate the transfer of up to 5,000MW of electricity from the coal belt in the East, to the energy deficient regions of western and northern India. It involves 765 kV Single Circuit Lines; Vadodara-Dhule-Aurangabad and Indore-Bhopal-Jabalpur, two (2) nos. 400 kV Double Circuit transmission lines and two (2) nos. 765/400 kV substations at Bhopal and Dhule to strengthen the transmission system in the states of Madhya Pradesh, Maharashtra and Gujarat. BDTCL is considered as a critical part of national grid as it facilitates the evacuation of power from Odisha & Chhattisgarh to load centers. This network also provides energy stability to Indore, Dewas and Aurangabad among the other industrial pocket of the route.

The following transmission elements are covered as part of transmission scheme “System Strengthening in WR" associated with Odisha phase-1 IPP projects:

i. Jabalpur – Bhopal 765 kV S/C line
ii. Bhopal – Indore 765 kV S/C line
iii. 765/400 kV, 2x1500 MVA substation at Bhopal
iv. Bhopal (IPTC) – Bhopal (MPPTCL) 400 kV D/C Line

And the following Elements are covered as part of transmission scheme “System Strengthening in WR" associated with new IPP projects in Chhattisgarh:

i. Aurangabad – Dhule (IPTC) 765 kV S/C line
ii. Dhule (IPTC) – Vadodara 765 kV S/C line
iii. 765/400 kV, 2x1500 MVA substation at Dhule (IPTC)
iv. Dhule (IPTC) – Dhule (MSETCL) 400 kV D/C Line

The Project Company has signed Transmission Service Agreement (TSA) with 22 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 765 kV and 400 kV transmission systems.

The Project Company 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 and its interconnection with the Power Grid Corporation of India Ltd. (PGCIL)/ State Transmission Utility (STU) system to be in order. The design and prototype of all types of towers was completed and Type test of all the four types of Towers was done successfully.

The salient features of technical requirements/ parameters for various 765 kV & 400 kV 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 & 3.3 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 for 765kV Transmission Line

Parameters	Value
Nominal voltage	765 kV
Maximum system voltage	800 kV
Lightning Impulse withstand Voltage	2100 kVpeak (BIL)
Power Frequency withstand Voltage	830 kVrms (dry)
Switching impulse withstand voltage (dry & wet)	1550 kVpeak (BSL)
Minimum corona extinction Voltage	508 kVrms phase to earth (dry)
Radio Interference Voltage between 0.5 and 2 MHz at 508 kV rms	2500 micro volts max.
Maximum Conductor Temperature	85ºC
Maximum Earthwire Temperature	53ºC

Table 3.3: System Parameters for 400kV Transmission Line

Parameters	Value
Operating voltage	400 kV
Maximum system voltage	420 kV
Lightning Impulse withstand Voltage	1550 kV peak
One Minute Power Frequenc withstand Voltage	630 kV rms (dry)
Switching impulse withstand voltag (Dry & Wet)	1050 kV rms
Minimum corona extinction Voltage	320 kV rms phase to earth (dry)
Radio Interference Voltage betwee 0.5 and 2 MHz at 320 kV rms	1000 microvolts max.
Maximum Conductor Temperature	85ºC
Maximum Earthwire Temperature	53ºC

IE observed that the above service conditions and system parameters are generally accepted for 765 kV and 400 kV transmission lines.

3.3.1. 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 are of composite Long Rod Insulators as per specified electro – mechanical strength and total creepage.

The insulators of the suspension strings consist of composite long rod insulators for a three phase, 50 Hz, effectively earthed 765 kV S/C AC and 400 kV D/C transmission system. Coupling is ball and socket type with dimensions as per IEC 120/ IS: 2486 (Part II).

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

Table 3.4: Design Parameters – 765 kV line with Quad Bersimis Conductor

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

Table 3.5: Design Parameter – 400 kV line with Quad Moose Conductor

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	13020	120	120
Double 'I' suspension Towers A	13020	120	240
Quadruple Tension for Towers B,C, D	13100	160	640

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 shall be designed to facilitate cleaning. The design and supply of Grading Rings is in the scope of Insulator supplier.

The Insulators have been subjected to Type Tests, Acceptance Tests and Routine Tests as per relevant National/ International Standards and prevailing practice.

IE observed the technical parameters stipulated in the specifications for insulators are suitable for use on 765 kV and 400 kV transmission systems.

3.3.3 Conductor

Conductors are current carrying element of the transmission lines which transmits electricity. The most common conductor in use for transmission today is aluminum conductor steel reinforced (ACSR).

Aluminum 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.

The conductor used is Quad ACSR 'Bersimis' for 765 kV Transmission line and Quad ACSR 'Moose' for the 400 kV lines. The sub conductor spacing is 450 mm for 400 kV and 457 mm for 765 kV Transmission lines. The salient parameters of the conductors are given below:

Table 3.6: Design Parameters - Conductor

Description	**ACSR 'Moose'**	**ACSR 'Bersimis'**
Size of the conductor	54/3.53 mm Al +7/3.53 mm Steel	42/4.57 mm Al +7/2.54 mm Steel
Overall Diameter (mm)	31.77	35.04
Minimum UTS (kN)	161.2	154
Unit Mass (Kg/km)	2004	2181
Configuration	Vertical for D/C	Horizontal for S/C
Total sectional Area	597 sq. mm	689.5 sq. mm
Description	**ACSR 'Moose'**	**ACSR 'Bersimis'**

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

As per information available with IE, ACSR Moose conductor has been extensively used by PGCIL and other utilities on 400 kV lines and ACSR Bersimis on 765 kV lines and the performance has been found to be satisfactory.

3.3.4 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.

Single circuit 765 kV line with quad conductor has Horizontal configuration of conductors and 400 kV D/C line has vertical configuration. Various type of towers used are based on the final detailed survey carried out by BDTCL and upon the soil investigation carried out by the erection contractor.

EHV transmission lines are used to transmit power over long distances. Substations act as inter connecting points between transmission lines for step up/down of the voltages and provide monitoring as well as protection to the grid.

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 considered 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 single circuit towers have been used on 765 kV lines and D/C towers on 400 kV lines.

Table 3.7: 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 3.8:

Table 3.8: 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) Optical Ground Wire (OPGW)

Fibre Optic/OPGW based telecommunication terminal equipment (OPGW containing 24 Fibres)) are being provided; the same shall be utilized for Data, Voice and line protection applications. For protection purposes, both end Digital Protection Couplers (DPCs) shall be included. However, for line protection application, back up communication channel/link may be considered as per requirement so as to take care of OPGW/Telecommunication equipment outage.

BDTCL has installed approximately 917 kms of optical fiber cables (OPGW) with ten fiber pairs available for dark fiber lease.

BDTCL has deployed OPGW as it contains single-mode optical fibres with low transmission loss allowing long distance transmission at high speeds.

d) Hardware Fittings & Accessories

The Hardware fittings are suitable for employment of hot line maintenance techniques so that usual hot line operations can be carried out with ease, speed and safety.

As per the specification, 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.

e) CVT and Instrument Transformers:

BDTCL has two 765/400 kV substations (at Bhopal and Dhule) which are equipped with several capacitor voltage transformers, (or CVT), and Current transformers to enable measurement of EHV power system parameters by stepping down EHV signals to low voltage signals.

3.3.2. 500 MVA 1-Phase Transformers

As per requirement, the power transformers confirms to IEC: 60076 / IS: 2026. Major parameters of these transformers are given in the table below.

Table 3.9: Major Parameters of 500 MVA, Single Phase 765/400 kV Transformer

Parameters	Value
Rating – HV/ IV/LV (Tertiary)	500 MVA / 500 MVA /167 MVA
Cooling	ONAN / ONAF / (OFAF or ODAF) or ONAN / ONAF1 / ONAF2
Rating at different cooling	60% / 80% / 100%
Voltage Ratio	(765/√3) /(400/√3) /33 kV
Phases	Single
Impedance	HV/IV : 14 %

	HV/LV : 195 % IV/LV : 180 %
Vector Group	YNaOd11

BDTCL has 14 single phase 500 MVA power transformers (at Bhopal and Dhule substations) for stepping down power from 765 KV to 400 KV including two spare single phase transformers. Thus each substation has 3,000 MVA of transformation capacity.

IE observed the technical parameters stipulated in the specifications for Transformer are suitable for use on 765 kV transmission system. The above parameters are generally accepted for transformers.

3.3.3. Reactors

Shunt Reactor comply with IEC: 289 / IS: 5553.

Table 3.10: Major Parameters of 765 kV & 400 kV Shunt Reactors

Parameters	**Value (765 kV)**	**Value (400 kV)**
Capacity	80 MVAR single phase at 765/√3 kV	125 MVAR, Three phase
Rated Voltage	765/√3 kV and; 800/√3 kV at maximum continuous operating voltage	420 kV
Insulation level for Winding Lightning Impulse withstand Voltage; Switching surge impulse withstands voltage.	1950 kV peak 1550 kV peak	1300 kVp (1.2/50 µsec) 1050 kVp (20/200/500 µsec)
Insulation level of Neutral Impulse withstand Voltage; Power frequency voltage.	550 kVp 230 kV rms	550 kVp 230 kV rms
Cooling System	ONAN (Natural Oil Circulation)	ONAN (Natural Oil Circulation)

BDTCL has 22 Nos 765 kV Reactors installed at Bhopal and Dhule substations for voltage control.IE observed the technical parameters stipulated in the specifications for 765 and 400 kV Reactors are suitable for use on 765 kV and 400 kV transmission systems. The above parameters are generally accepted for Reactors.

3.3.4. Circuit Breakers

The circuit breakers are used to break the circuit if any fault occurs in any of the instrument. These circuit breaker breaks for a fault which can damage other instrument in the substation. For any unwanted fault over the station we need to break the line current. This is only done automatically by the circuit breaker.

As per the requirement, Circuit Breaker comply to IEC: 62271-100 & IEC-6064 and are of SF6 type.

Table 3.11: Major Parameters of 800 kV & 420 kV Circuit Breakers

Parameters	**Value (765 kV)**	**Value (400 kV)**
Type of circuit breaker	SF6	SF6
Rated frequency	50 Hz	50 Hz

Parameters	Value (765 kV)	Value (400 kV)
Number of poles	Three (3)	Three (3)
Rated Continuous Current	3150 A	3150 A
Rated Short Circuit Current breaking at rated voltage	40 kA with percentage DC component as per IEC- 62271-100 corresponding to minimum opening time under operating condition specified.	50 kA with percentage DC component as per IEC- 62271-100 corresponding to minimum opening time under operating condition specified.
Symmetrical interrupting capacity	40 kA rms	50 kA rms
Rated Short Circuit making current capability	102 kAp	125 kAp
System Neutral earthing	Effectively Earthed	Effectively Earthed
Reclosing	Single phase and three phase	Single phase and three phase
Rated Operating Duty	O-0.3sec-CO-3min-CO cycle	O-0.3sec-CO-3min-CO cycle

The substations at Bhopal and Dhule are also equipped with various switching equipment like Circuit breakers, Isolators and protection devices like lightning arrestors.

IE observed the technical parameters stipulated in the specifications for 800 kV and 420 kV Circuit Breakers are suitable for use on 765 kV and 400 kV transmission system.

3.4. Construction Technology

Project Company has used advanced technology, such as helicopters for stringing transmission lines and tower erections for few stretches of BDTCL line in order to make least impact on the area and community.

In order to achieve higher predictability of work schedules and minimal logistics issues during construction, Project Company had deployed aerial technologies involving a helicopter to erect towers as well as string conductors aerially on transmission towers, allowing speedier execution of works, especially in remote and difficult terrain. This results in considerable time savings achieved in pulling conductors by a helicopter as compared to other manual methods used in the conventional projects. Such technologies minimize social and environmental disturbances during the installation of transmission lines.

3.5. Codes and Standards

The technical specifications for the project are in line with the Indian and international Codes and Standards. The relevant codes and standards are mentioned in the technical specifications. The supply, erection and construction of the substations and the transmission lines is as per the requirements of the technical specifications and the relevant codes and standards thus ensuring the technical capability and quality of the project.

3.6. Type Testing of Towers and Major Equipment for Substation and Transmission Lines

The Technical specifications specify the requirement for Type testing of Towers and all Major Equipment for Substation and Transmission Lines in line with the relevant codes and standards.

IE reviewed the type test certificates of the Towers, Circuit Breakers, Current Transformers, CVT, Isolators, Lightning Arresters, Relays, Conductors, Insulators and Hardware fittings provided by the Project Company and the same were found to be in order.

3.7. Quality Assurance and Safety Aspects

3.7.1. 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 are 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.

3.7.2. 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 have been followed in the Project. During the execution of the project, all stores were properly fenced and provided with adequate lights. Safety equipment / accessories were used by site workers.

3.8. Contract Packages & Schedules

The Project is being implemented on multiple contracts basis under the supervision of BDTCL by reputed suppliers and contractors.

The Contracts were placed on the suppliers and contractors for two (2) nos. 765/400 kV substations, four (4) nos. 765 kV single circuit transmission lines, two (2) nos. 400 kV D/C transmission lines, Transformers and Reactors as given below:

i. Contract for Offshore/ Onshore supply of 765/400 kV Power Transformers along with all accessories and for Supervision of execution of services associated with installation of Transformers, was awarded to **M/s Hyundai Heavy Industries Company Limited, Korea**.

ii. Contract for Offshore/ Onshore supply of 765 kV and 400 kV Reactors along with all accessories and for Supervision of execution of services associated with above works was awarded **to M/s Baoding Tianwei Baobian Company Limited, China**.

iii. **M/s. Areva T&D India Limited (Areva)** was awarded the contract for supply of substation equipments for 765/400 kV Bhopal and Dhule substations. Areva's scope of work included manufacture, assembly and testing at Works, packing and supply of substation equipments, equipment structures, for the two substations (excluding Transformers and Reactors). Contract for Civil works and Erection of substation equipments including its testing and commissioning was also awarded to Areva.

iv. **M/s. KEC International Limited (KEC)** was awarded the contract for supply of Tower/ Tower Materials for Aurangabad **–** Dhule, Dhule – Vadodara and Dhule (IPTC) – Dhule (STU) transmission lines. KEC's scope of work included manufacture, assembly and testing at Works, packing and supply of Tower Materials and Fasteners including Tower Body Extensions and Stubs, for the Transmission Lines. Contract for Erection of Towers, arranging Right of Way and obtaining necessary Clearances (except Forest Clearance) as well as erection of the Transmission Lines including its testing and commissioning was awarded to KEC.

v. **M/s. Simplex Infrastructure Limited (Simplex)** was awarded the contract for supply of Tower/ Tower Materials for Jabalpur – Bhopal, Bhopal – Indore and Bhopal (IPTC) – Bhopal (STU) transmission lines. Simplex's scope of work included manufacture, assembly and testing at Works, packing and supply of Tower Materials and Fasteners including Tower Body Extensions and Stubs, for the Transmission Lines. Contract for Erection of Towers, arranging Right of Way and obtaining necessary Clearances (except Forest Clearance) as well as erection of the Transmission Lines including its testing and commissioning was awarded to Simplex.

vi. Contract for Supply of 210 KN, 160 KN & 120 KN Insulators was awarded to **M/s Xian Electric Engineering Company Limited, China.**

vii. Contract for supply of Hardware Fittings & Spacer Dampers for 765 kV & 400 kV lines was awarded to **Mosdorfer India Private Limited**.

viii. Contracts for supply of Bersimis & Moose Conductor was awarded to **Apar Industries Limited, Hind Aluminium Industries Limited and Sterlite Technologies Limited**.

Table 3.12: Brief Structure of Contracts

S. No.	Contract	Broad Scope of Work	Contractor
765/400 kV Substations – Two nos.			
	Supply Contract	Design, detailed engineering, manufacturing, supply of all equipments for Two (2) nos. substations each of 2 x 1500 MVA, 765/400 kV, excluding supply of 765/400 kV transformers and 765 KV & 400 KV reactors.	M/s Areva T&D India Limited. New Delhi
	Erection Contract	Erection work for Two (2) nos. substations each of 2 x 1500 MVA, 765/400 kV, substations including 765/400 kV transformers and 765 kV & 400 kV reactors.	
	Civil Work Contract	Civil work for construction of Two (2) nos. substations each of 2 x 1500 MVA, 765/400 kV,	

S. No.	Contract	Broad Scope of Work	Contractor
		including foundations for 765/400 kV transformers and 765 kV & 400 kV reactors.	
	Offshore Supply Contract	Design, detailed engineering, manufacturing, supply of Fourteen (14) nos. 765kV/√3 / 400kV/√3, 1-Phase, 500 MVA Power transformers along with accessories for Two (2) nos. substations each of 2 x 1500 MVA, 765/400 kV.	M/s Hyundai Heavy Industries Co., Limited, Seoul, Korea.
	Onshore Supply Contract	Supply of Transformer Oil, Neutral CTs and Spares etc FOR Bhopal (MP) & Dhule (Maharashtra)	
	Onshore Services Contract	Services for Erection (Supervision), Testing & Commissioning of Transformers.	
	Supply Contract	Design, detailed engineering, manufacturing, supply of Twenty two (22) nos. 765 kV/√3 1-Phase, 80 MVAr Reactors and One (1) no. 400 kV, 3-Phase, 125 MVAr Reactor along with accessories for Two (2) nos. substations each of 2 x 1500MVA, 765/400 kV, substations.	M/s Baoding Tianwe Baobian Electric Co. Ltd., China.
	Onshore Services Contract	Services for Erection (Supervision), Testing & Commissioning of Reactors.	
765 kV Transmission lines – 4 nos. & 400 kV Transmission lines – 2 nos.			
	Supply Contract	Supply of Tower material for 765 kV Transmission line from Jabalpur to Bhopal, Bhopal to Indore and 400 kV D/C Transmission lines from Bhopal (IPTCL) to Bhopal (MPPTCL)	M/s Simplex Infrastructure Limited., Kolkata
	Erection Contract	Erection Work for 765 kV Transmission lines from Jabalpur to Bhopal, Bhopal to Indore and 400 kV D/C Transmission lines from Bhopal (IPTCL) to Bhopal (MPPTCL)	
	Civil work Contract	Civil Work for construction of 765 kV Transmission lines from Jabalpur to Bhopal, Bhopal to Indore and 400 kV D/C Transmission lines from Bhopal (IPTCL) to Bhopal (MPPTCL)	
	Supply Contract	Supply of Tower material for 765 kV Transmission line from Dhule to Aurangabad, Dhule to Vadodara and 400 kV D/C Transmission lines from Dhule (IPTCL) to Dhule (MSETCL)	M/s KEC International Limited, Mumbai
	Erection Contract	Erection work for 765 kV Transmission line from Dhule to Aurangabad, Dhule to Vadodara and 400 kV D/C Transmission lines from Dhule (IPTCL) to Dhule (MSETCL)	
	Civil work Contract	Civil work for construction of 765 kV Transmission line from Dhule to Aurangabad, Dhule to Vadodara and 400 kV D/C Transmission lines from Dhule (IPTCL) to Dhule (MSETCL)	
Umbrella Contracts for Substations and Transmission Lines			
	Umbrella Agreement	Composite EPC work	M/s. KEC International Limited
	Umbrella Agreement	Composite EPC Work	M/s. SIMPLEX Infrastructure Limited

S. No.	Contract	Broad Scope of Work	Contractor
	Umbrella Agreement	Composite EPC Work	M/s. Areva T&D India Ltd.
Supply Contract for Conductors.			
	Supply Contract for 4000 Kms	Scope of work broadly covers Design, detailed engineering, manufacturing, shop inspection, routine and acceptance type tests, seaworthy/ roadworthy packing, forwarding and delivery at F.O.R destination (Project sites) of ACSR Conductor (Bersimis) for 765 kV S/C lines in non–returnable drums	M/s. Apar Industries Ltd.
	Supply Contract for 2400 Kms	Scope of work broadly covers Design, detailed engineering, manufacturing, shop inspection, routine and acceptance type tests, seaworthy/ roadworthy packing, forwarding and delivery at F.O.R destination (Project sites) of ACSR Conductor (Bersimis) for 765 kV S/C lines in non–returnable drums	M/s. Hind Industries Ltd.
	Supply Contract for 4359 Kms of Bersimis Conductor and 652 Kms of Moose Conductor.	Scope of work broadly covers Design, detailed engineering, manufacturing, shop inspection, routine and acceptance type tests, seaworthy/ roadworthy packing, forwarding and delivery at F.O.R destination (Project sites) of ACSR Conductor (Bersimis & Moose) for 765 kV S/C & 400 kV D/C lines in returnable steel drums.	M/s Sterlite Power Transmission Ltd.
Contract for Supply of Insulators.			
	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 S/C and 400 kV D/C Transmission lines.	Xian Electric Engineering Company Limited, China
Contract for Supply of Hardware Fittings and Spacer Dampers			
	Supply Contract	Design, Engineering, manufacturing, inspection, testing, type testing, packing & forwarding and delivery of Hardware Fittings & Spacer Dampers for 765 kV S/C and Hardware fittings for 400 kV D/C lines on FOR site 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.

3.9. Availability

As per 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.

3.10. Condition Assessment of Asset

The Project is complete and all the eight (8) nos. elements of the project have been commissioned and are operational. The COD of the last element which is the Dhule – Vadodara 765 kV S/C Transmission line has been declared on 13th June 2015. The COD of the Bhopal Substation is 6th December, 2014 while that of Bhopal Substation is 30th September, 2014.

3.10.1. Review of Plant Design / Technical Details

As per the specification provided by the Project Company, the Transmission lines, Towers and Substations 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.

3.10.2. Current Status of Asset

a) 765 kV S/C Jabalpur – Bhopal Transmission Line – 259.693 circuit km

The total length of the line is 259.693 circuit kms with a total of 665 nos. towers. The line is complete and is operational. The COD of the Transmission line has been declared on 9th June 2015. The CEA approval for energization of the 765 kV S/C Jabalpur-Bhopal Transmission Line was issued vide certificate ref. No. CEI/3/EI/RIO(W)/Insp/2015/687 dated 1st June 2015. The successful completion of 24 hrs trial run was achieved on 9th June, 2015 as accorded by the POSOCO Certificate vide letter dated 15th June, 2015.

b) 765 kV S/C Bhopal – Indore Transmission Line – 175.75 circuit km

The total length of the line is 175.75 circuit kms with a total of 455 nos. towers. The line is complete and is operational. The COD for Bhopal-Indore line is 19th Nov. 2014. The CEA approval for energization of the 765 kV S/C Bhopal-Indore Transmission Line was issued vide certificate ref. No. CEI/3/EI/RIO(W)/Insp/2014/646 dated 13th Aug. 2014. The successful completion of 24 hrs trial run was achieved on 19th November, 2014 as accorded by the POSOCO Certificate vide letter dated 1st December, 2014.

c) 400 kV D/C Bhopal – Bhopal Transmission Line – 17.362 circuit km

The total length of the line is 17.362 circuit km with a total of 27 nos. towers. The line is complete and is operational. The COD for the Bhopal-Bhopal line is 12th August, 2014. The CEA approval certificate for energization of the 400 kV D/C Bhopal-Bhopal Transmission Line was issued vide certificate ref. No. CEI/3/EI/RIO(W)/Insp/2014/452 dated 13th June 2014. The successful completion of 24 hrs trial run was achieved on 12th August, 2014 as accorded by the POSOCO Certificate vide letter dated 25th August, 2014.

d) 765 kV S/C Aurangabad - Dhule Transmission Line – 192.235 circuit km

The total length of the line is 192.235 circuit km with a total of 509 nos. towers. The line is complete and is operational. The COD for the Auranagabad-Dhule line is 5th Dec. 2014. The CEA approval certificate for energization of the 765 kV S/C Aurangabad-Dhule Transmission Line was issued vide certificate ref. No. CEI/3/EI/RIO(W)/Insp/2014/950 dated 20th Oct. 2014. The successful completion of 24 hrs trial run was achieved on 5th December, 2014 as accorded by the POSOCO Certificate vide letter dated 1st January, 2015.

e) 765 kV S/C Dhule – Vadodara Transmission Line – 262.90 circuit km

The total length of the line is 262.90 circuit km with a total of 679 nos. towers. The line is complete and is operational. The COD for the Dhule- Vadodara line is 13th June 2015. The CEA approval certificate for energization of the 765 kV S/C Dhule – Vadodara Transmission Line was issued vide certificate ref. No. CEI/3/EI/RIO(W)/Insp/2015/145 dated 2nd February, 2015. The successful completion of 24 hrs trial run was achieved on 13th June, 2015 as accorded by the POSOCO Certificate vide letter dated 23rd June, 2015.

f) 400 kV D/C Dhule (IPTC) – Dhule (STU) Transmission Line – 36.14 circuit km

The total length of the line is 36.14 circuit km with a total of 56 nos. towers. The line is complete and is operational. The COD for the Dhule – Dhule line is 6th December, 2014. The CEA approval certificate for energization of the 400 kV D/C Dhule – Vadodara Transmission Line was issued vide certificate ref. No. CEI/3/EI/RIO(W)/Insp/2014/813 dated 29th September, 2014. The successful completion of 24 hrs trial run was achieved on 6th December, 2014 as accorded by the POSOCO Certificate vide letter dated 29th December, 2014.

g) Substation at Bhopal

765/400kV Substation at Bhopal is commissioned and is operational. The COD for the Bhopal Substation is 30th September, 2014.

The CEA approval certificate for energization of the 765/400 kV Bhopal Substation was issued vide certificate ref. No. CEI/3/EI/RIO (W)/Insp/2014/453 dated 13th June 2014 & certificate ref. No. CEI/3/EI/RIO (W)/Insp/2014/805 dated 26th Sept. 2014.

The Certificate for completion of trial operation of the 765/400 kV Bhopal Substation was issued by POSOCO vide Certificate no. WRLDC/BDTCL/002 dated 6th Aug. 2014 & Certificate no. WRLDC/BDTCL/005 dated 21st Oct. 2014.

h) Substation at Dhule

The substation at Dhule is commissioned and is operational. The COD of the Dhule Substation is 6th Dec. 2014.

The CEA approval certificate for energization of the 765/400 kV Dhule Substation was issued vide certificate ref. No. CEI/3/EI/RIO (W)/Insp/2014/178 dated 28th Feb. 2014.

The Certificate for completion of trial operation of the Dhule Substation was issued by POSOCO vide Certificate no. WRLDC/BDTCL/008 dated 30th Dec. 2014.

3.11. Useful Life of Asset

The review of the Technical documents pertaining to the project by IE including the Technical Specifications, Type Test Certificates and Quality Plan of the different equipment/ components of the Substations & Transmission Lines confirm the quality of components and technical suitability of the Substation & Transmission Lines.

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. The useful life of different Substation equipment is indicated below:

Equipment	Approx life period
Circuit Breaker (All types and ratings)	10000 operations
Isolators with Earth switches(All types and ratings)	35 years
ICT's (765/400 kV)	35 years
Reactors (All Types and ratings)	35 years
Current Transformer (All types and ratings)	35 years
Capacitor Voltage Transformers (All types and ratings)	35 years
Lightening Arrestors (400 kV)	35 years
Lightening Arrestors (765 kV)	35 years
33/11 kV Distribution Transformer	35 years
Battery Charger (220 V and 48 V)	35 years
Battery Banks (220 V and 48 V)	1000 cycles
ACDB panels	35 years
DCDB panels	35 years
MLDB panels	35 years
320 kVA Diesel Generator	35 years
Relays	35 years
PLCC Panels	35 years
FOTE panels	35 years
SAS system	35 years
NIFPS(for Transformers and Reactors)	35 years
Hydrant Fire Protection system (for Buildings)	35 years
Large Video Screens	10 years

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

3.12. Technical Guarantee

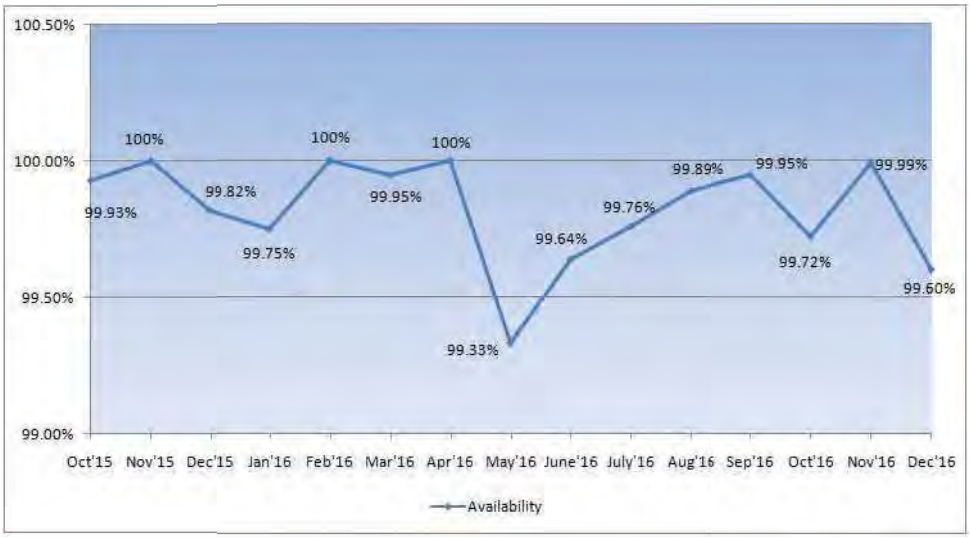
Typically contract for Transmission Project does not envisage any performance guarantee parameters. However, the project is being implemented in line with the technical specifications with proper quality checks.

The Certificate for approval for Energization from CEA ensures the completeness and technical acceptability of the project. IE observed that all the elements have received the CEA approval for the same,

3.13. Availability of Transmission Lines and Substations

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 Transmission Service Agreement is 98%.

The Project Company has submitted the monthly availability certificates for the BDTCL Transmission System. The availability of transmission lines from Oct 2015 to Dec 2016 is 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 substations and the lines. IE observed that the Availability is maintained more than 99%. IE is of the view that with prudent maintenance practices and deployment skilled manpower, maintaining 98% availability is achievable.

3.14. 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 O&M Organization Set-up & its adequacy

The BDTCL transmission system consists of eight (8) nos. transmission elements with six (6) nos. transmission lines and two (2) nos. substations. All the eight (8) nos. elements are complete and are operational. The COD of the last element which is the Dhule – Vadodara 765 kV S/C Transmission line has been declared on 13th June 2015. The COD of the Bhopal Substation is 6th December, 2014 while that of Bhopal Substation is 30th September, 2014.

The Operation and Maintenance of the BDTCL transmission system is conducted by personnel assigned with specific roles and responsibilities as per the O&M organization chart.

The Head (O&M) of SPGVL is responsible for the Operation & Maintenance for BDTCL and other projects of SPGVL.

The patrolling and maintenance of Transmission Lines is outsourced to two different Agency. The maintenance works for 765 kV S/C Bhopal – Indore Transmission Line, 765 kV S/C Bhopal – Jabalpur Transmission Line and 400 kV D/C Bhopal – Bhopal Transmission line was awarded to M/s. Telegence India vide letter dated 23rd June, 2015. The Maintenance works for 765 kV S/C Dhule – Aurangabad Transmission Line, 765 kV S/C Dhule – Vadodara Transmission Line and 400 kV D/C Dhule – Dhule Transmission Line was awarded to M/s. JBS Eneterprises Pvt. Ltd. vide letter dated 23rd June, 2015. The total work order Period is valid for 36 months i.e. 3 years from the date of successful commissioning of the respective lines. Supervision of operation and maintenance work being carried out by the contractor is done by the SPGVL in-house team. .

The operations of Bhopal and Dhule 765/400 kV substation is outsourced to M/s. Encotech Energy (India) Pvt. Ltd. through two separate contracts.

The contract for deputation of Shift Operators and Technicians required for operation of Bhopal 765/400 kV substation was signed on 23rd September, 2014. The scope of the Operator includes visual checks of Substation equipment, maintaining records of equipments, co – ordinating with CTU/ RLDC/ Other substation site, Monitoring of maintenance work, health check of Substation equipments, monitoring and checking of Tools & Plants available etc. The scope of the Technician includes visual checks of Substation equipment, maintaining records of equipments, maintenance work of equipments, health check of Substation equipments, monitoring and checking of Tools & Plants available.

The contract for deputation of Shift Operators and Technicians required for operation of 765/400 kV Dhule substation was signed on 16th March, 2015. The scope of the Operator includes visual checks of Substation equipment, maintaining records of equipments, co – ordinating with CTU/ RLDC/ Other substation site, Monitoring of maintenance work, health check of Substation equipments, monitoring and checking of Tools & Plants available etc. The scope of the Technician includes visual checks of Substation equipment, maintaining records of equipments, maintenance work of equipments, health check of Substation equipments, monitoring and checking of Tools & Plants available.

For each of the substations, there are five (5) nos. Shift In-charge for the operation of substation. In addition to the above, the O&M organization chart for the substation also specifies the following personnel:

- Maintenance expert engineer,
- Protection/ trouble shooting manger,
- O&M Planning & Outage Co-ordinator,
- Special Services for Substation Central Control room & OPGW.

The transmission lines in the Bhopal hub is divided into two (2) nos. sections. Each section is taken care by Section In-charge from the SPGVL In-house O&M team. The O&M contractor takes care of all the O&M activities under the guide lines of the Section In-Charge.

The transmission lines in the Dhule hub is divided into two (2) nos. sections. Each section is taken care of by Section In-charge from the SPGVL In-house O&M team. The O&M contractor takes care of all the O&M activities under the guide lines of the Section In-Charge

To optimize costs, the contractor has deployed manpower and stores at Bhopal and Dhule hubs. The gangs at these hubs 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.

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.

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

a) Routine, Periodic, Preventive & Predictive maintenance for the transmission lines is done by O&M contractor as per guide lines provided by SPGVL and under the supervision of SPGVL team.
b) Close monitoring of O&M contractor/ agency, maintaining data and analysis to reduce down time is done by SPGVL Team.
c) Mandatory spares are provided by SPGVL to the contractor.
d) Break down / Emergency is handled jointly by O&M contractor, SPGVL O&M & EHS (Environment, Health & Safety) Team.

The deployment of Contractor's personnel in different lines of BDTCL as provided by the Project Company is indicated below:

Sl no	Location	Contractor's personnel deployed	Approx. Length in KM	Transmission line
1	Sonkatch	9 (1E, 1S, 5F, 2H)	175	Bhopal-Indore Line
2	Bhopal	12 (1E, 1S, 8F, 2H)		Bhopal-Indore Line
3	Raisen	9 (1E,1S, 5F, 2H)	260	Bhopal-Jabalpur Line, Bhopal-Bhopal Line
4	Deori	14 (1E, 1S, 8F,4H)		Bhopal-Jabalpur Line, Bhopal-Bhopal Line
5	Bedaghat	9 (1E, 1S, 5F, 2H)		Bhopal-Jabalpur Line, Bhopal-Bhopal Line
6	Dhule	14 (1M, 1E, 1SO, 4F, 5H,1S,1 SK)	263	Dhule to Vadodara Transmission Line
7	Umalla	9 (1E,4F, 3H,1S)		Dhule to Vadodara Transmission Line
8	Selamba	9 (1E,4F, 3H,1S)		Dhule to Vadodara Transmission Line
9	Pulam bari	9 (1E,1S, 4F, 3H)		Dhule to Aurangabad Transmission Line
Total Of BDTCL		**94 persons**		

Legend

M	Manager
S	Supervisor
E	Engineer
F	Fitter
H	Helper
SK	Store
SO	Safety

IE is of the opinion that the O&M organization set-up and the arrangement envisaged for the O&M of the substations & transmission lines is adequate. The operation and maintenance of substations directly by SPGVL with manpower support from a designated contractor and warranty by OEMs & EPC contractor shall ensure effective operation of the substations. 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 is effective in the smooth and trouble-free operation of the lines.

Project Company has kept Transmission line spares at Bhopal Store like anchor shackles, double arcing horn, socket clevis, armour rod set, clevis eye straight, corona free suspension clamp, ball clevis, counter weight set, spares of OPGW single suspension assy & OPGW single/double tension assy, OPGW for vibration damper, insulators, anti clambing device, danger/number/phase sign plates, conductors, opgw conductor, nut, bolts & washer, vibration damper, earthing, midspan joint and repaire sleave, tower part, stub etc.

Project Company has kept Substation spares at Bhopal Store like Transformer Radiator Cooling Fan (Cage), Hardware Fittings for Corona Ring, Lighting Arester Corona Ring, Yoke Plate for substation, Mobile Moving contact, Inter Connector, TB of Isolator, Nuts, Bolts, washer, Copper Cable, Expansion type Terminal Connector, Terminal connector for Circuit Breaker, T connector, Ball Valve, Butterfly Valve, Gasket, Oil Temp. Indicator, Post Insulators, Contractor for Relay, Normal Actuator, Aluminium Conductor, GI Flat Strip, Aluminium Angle, Relays, spares for CB, Charger, fuse etc.

Project Company has kept MC & Tools at Bhopal Store like Conductor Die for Alluminium & Steel, pilot – wire Bobbin, Roller, Spanners, Safety equipment, Synthethic P.P. Rope Yellow , Discharge Rod 765 KV & 400 KV, Kitto Clamp , Swivel Joint, Wire Rope, Bobbin Rod, OPGW conductor and conductor rollers are kept in open yard.

IE is of the view that Project Company has kept adequate spares to facilitate in reducing the down-time of the Transmission lines and substation.

4.1. Operation & Maintenance (O&M) Procedures

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

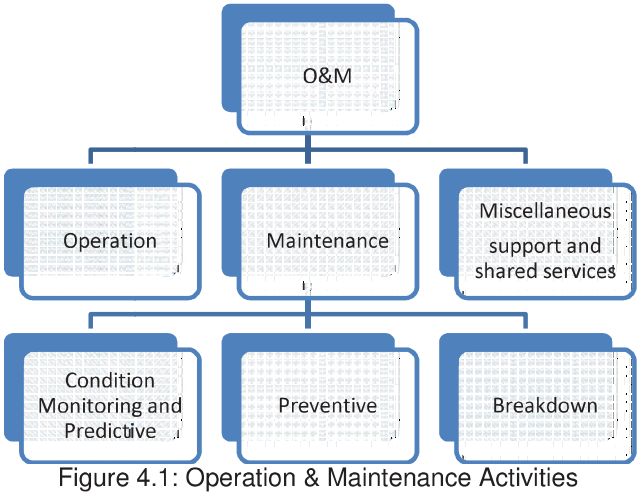


Figure 4.1: Operation & Maintenance Activities

The O&M philosophy for the Substations & Transmission lines is defined in the O&M manual for BDTCL.

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

- To achieve the availability of more than 99.50% for the transmission lines/ substations.
- To set up a lean but efficient organisation and minimum O&M cost.
- To set superior operational and maintenance standards in power transmission network.
- Adopt new technologies for O&M
- Achieve Excellence in Quality, Health, Safety, Security and Environment

To achieve the above objectives, BDTCL shall adopt the following measures:

- Follow Standard Operating Procedures (SOP) for operation of line and substations for maintaining targeted availability.
- Training In house staff for developing O&M competency.
- Operational data management and analysis
- Focus of maintenance shall be majorly on proactive approach instead of reactive approach

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

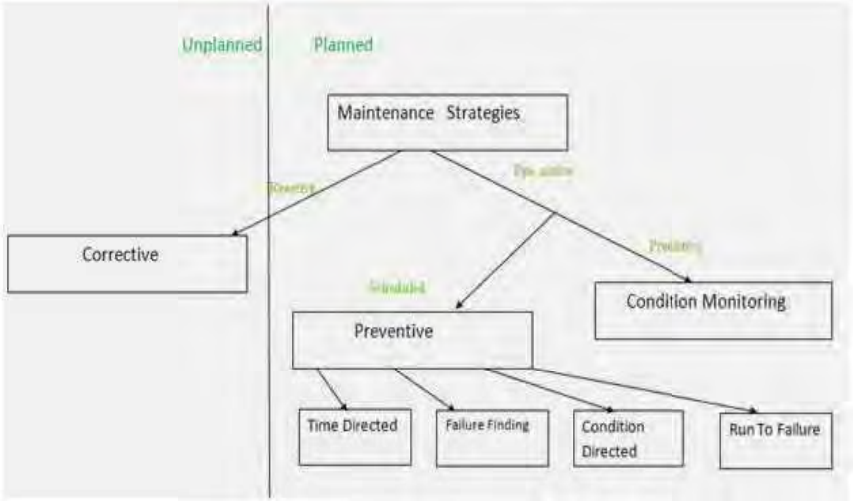


Figure 4.2: Maintenance Strategy

The maintenance activities carried out in Bhopal Hub Lines is indicated below:

Activity Description	Frequency
Ground patrolling from last year july-15 to August 2016	10 times (Bhopal – Indore line) 10 times (Bhopal- Jabalpur line)
Emergency patrolling	22 times (B-I line) for some critical/tripping/ auto reclose 20 times (JAB- BPL line) for some critical locations /tripping locations / auto reclose location
Shut down nature work	13 times (BI line) 3 times (JAB - BPL line)
Tree cutting work	30 times (BI line) More than 25 times (JAB - BPL line)

Thermo-vision Scanning	Started from March - May End, 2016(BI Line) Under progress.(JAB – BPL Line)
Induction level Testing	In the month of May-16 BI Line (3/5/16)
Tack welding	Around 20 locations attend in BI Line (from Aug to Sep, Nov – Dec in 2015 & Feb -2016) 3 Locations JAB- BPL line(in the month of Feb, 2016)

The maintenance activities carried out in Dhule Hub Lines is indicated below:

Daily Maintenance Work:

- ✓ Routine patrolling of line
  - Ground patrolling - Daily - Minimum 23 towers in one day
  - Tower top patrolling - one time in 4 month - all towers
  - Night Patrolling - One time in a week 10 towers in one day
- ✓ Thermovision Scanning - one time in a year
- ✓ Tower Footing Resistance - one time in a year
- ✓ Corona Scanning - base on line requirement - one time in a year

Rectification Work:

- ✓ Tightening of tower N&B
- ✓ Tightening & fixing of CP earthing lug and N&B
- ✓ Coping
- ✓ Soil levelling work

Revetment Work

Revetment done at location 47/2 in the month of July'2015. It is near to karajan river bad & in monsoon season water flow near to tower leg.

Rectification work (land cutting & Sag) for maintain requisite ground clearance

Land cutting work carried out in section 43/5 – 43/6, 44/4 – 44/5 & 51/10 – 52/0 in the month of July – August'2015 for maintain requisite ground clearance.

Sag rectification work carried out in opportunity base shutdown on dated 19th & 20th Jan'2016 between section 59/0 – 60/0 for maintain requisite ground clearance. We got 14.70 mtr clearance.

Line Maintenance Work

Project Company informed that they had carried out line maintenance works in opportunity base shutdowns. Details of works are as follow

On dated 12/09/2015 Period: 4 hrs

- Spacer damper tightening work between tower 212 & 213
- Jumper tightening work on tower 210 & 213
- Fixing of spacer damper keeper pieces between tower 398-399

On dated 17/01/2016 to 21/01/2016 Period: 5 days

In this period Project Company informed that they have attended most of towers in entire line

- Fixing of spacer damper keeper pieces
- Jumpers tightening and Nuts & Bolts inserted
- Spacer damper tightening
- Fixing of Corona Control rings
- Clamp fixing of Grading rings
- Fixing of arcing horns
- Fixing of Bird guards
- Fixing of Copper bonds, E/W vibration dampers, OPGW V.D. etc

On dated 11/02/2016 Period: 1 day

- As a part of opening of line spacer dampers, Project Company informed that they had carried out fully tightening of spacer dampers in 6-7 sections. Project Company informed that they have watching those sections periodically when it will open & how.
- Jumpers tightening

Live Line OPGW Rectification Work

Project Company informed that they have carried out live line OPGW replacement work in the month of Dec – Jan'2016. Total 16.15 KMs OPGW replaced in 8 sections and we got 20 fiber through end to end link.

Sr. no.	Section	Length in mtr.
1	D gantry - 2/3	2503
2	28/0 - 28/7	2912
3	28/7 - 28/12	2009
4	28/32 - 29/1	878
5	35/0 - 36/0	3858
6	42A/9 - 43/0	3236
7	51/10 - 52/0	407
8	68/0 - 69/0	341
Total		**16144**

4.1.1. Operation & Maintenance of Substations

The Project Company has furnished the **Standard Operating Procedures (SOP) of the BDTCL Bhopal Substation**. The purpose of this procedure is to ensure safety of men, reliable operation for export and import of electrical power through 765kV and 400kV switchyard. The SOP defines the Power supply checks, Permissive checks, Charging procedure, Shutdown Procedure and Emergency Operation of the different equipment in the substation. The SOP also defines guidelines for handling emergencies.

The O&M Manual for BDTCL defines the Substation Maintenance Schedule which includes the maintenance schedule of the following equipment:

a) Power Transformers
b) Reactors
c) Circuit breakers
d) Isolators
e) Current Transformers
f) CVTs

g) Lightning Arresters
h) LT Switchgear Panels & LT Breakers
i) Protection & Metering System
j) Battery & Battery charger
k) Cables
l) Lighting
m) Earth pits
n) Lightning protection
o) Busbar/ Conductors
p) AC & Ventilation
q) Fire Protection System
r) Automation Maintenance & Control, Relay Panels
s) Earthing System
t) Other equipment like DG, Aux transformer, 11&33 kV Transmission Line etc.

The details of the maintenance activities to be performed for the maintenance of the above equipment at different intervals (daily, weekly, monthly, quarterly, half-yearly, yearly) are defined in the O&M Manual. Each of the maintenance activities are clearly categorized into Shutdown & Non-Shutdown Activities.

The O&M manual also defines the time limit for repair/ rectification for different types of breakdown.

The following test equipment are available at the substations:

- Circuit breaker DCRM and Timing kit
- Multimeter and leakage tester
- 12 kV Insulation tester
- Three phase variac
- Multimeters
- OTDR
- Transmission line signature analyser
- Earth resistance measurement kit

As informed by the project Company, all regular tools and tackles required for maintenance are available at the substation.

As per IE, the Substation Maintenance Schedule in the O&M manual and the SOP of the substation cover all the aspects required for safe operation of the substation and to maximize the availability of the substation. The maintenance activities of Bhopal and Dhule substation are indicated below:

Bhopal Substation

- ✓ Installation of N2 system of 765 KV Bus Reactor, Y –phase (Sr. no. 5K11)
- ✓ Stability test of 765 KV Bus Reactor with normal phases and along with spare units.
- ✓ Rectification of SCADA system (OWS-1 and associated software's).
- ✓ Rectification of FOTE panel of Indore and Jabalpur Line.

Dhule Substation

- ✓ Preventing Maintenance of several yard equipments like Isolator, BMK, Circuit Breaker and CVT were performed / inspected.

- ✓ Tightness of the cables and corrective operation were checked and corrected wherever required.
- ✓ All the individual MB's were inspected and maintained towards the safety of the electrical equipment.

4.1.2. Operation & Maintenance of Transmission Lines

To maximize the availability of the transmission lines, the routine/ preventive maintenance of the lines is carried out as per the schedule defined in the O&M Manual of BDTCL. However, there shall 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. Routine, corrective, and emergency response activities are conducted in accordance with the O&M typical schedules. The O & M department carries out planning of various maintenance activities including monitoring of maintenance activities that may include Electrical, Mechanical or Civil Maintenance.

4.1.3. Routine Maintenance (Preventive Maintenance)

BDTCL has adopted 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. BDTCL 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	Immidiate

The routine maintenance activities are conducted on a regular basis according to the nature of terrain, environment, surroundings, etc so as to achieve the desired level of performance. The maintenance activities are predefined and the schedules are laid in advance to identify and repair any deficiencies. The following activities which are the part of routine maintenance are described below:

- 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 traveling 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 copy 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.
- **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.

4.1.4. 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. The following are examples of corrective maintenance:

- Non-cyclical vegetation clearing to remove saplings or larger trees in the ROW.
- Structure or conductor maintenance in which earth must be moved, such as the creation of a landing pad for construction or maintenance equipment.
- Structure (e.g., cross-arm, insulator, structure) replacement.
- Follow-up restoration activities, such as seeding, noxious weed control, and erosion control.
- Conductor repair or replacement, which requires the use of several types of trucks and equipment and grading to create a safe work area to hang and pull the conductor into place.

As per the trip record submitted by the Project Company, IE observed that the Bhopal-Indore Transmission line was tripped for 1265 hours from 29th March 2015 to 21 May 2015. The Bhopal substation was tripped for 385 hours from March 2015 to January 2016.

The transmission lines under Dhule Hub were tripped for 221 Hours from April 2015 to December 2015. The Dhule Substation down for 498 hours from April 2015 to December 2015.

The transmission line under Bhopal Hub was tripped for 103.47 hours and under Dhule Hub was tripped for 0.36 hrs from April 2016 to June 2016. The Dhule substation was down for 57.13 hrs and Bhopal substation was tripped for 93.12 hours from April 2016 to June 2016.

IE observed that the tripping time has decreased from last year which is good sign of preventive maintenance.

4.1.5. 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 shall 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. Emergency situations may include:

- Failure of conductor splices.
- Damage to structures or conductors from wildfire, high winds, ice, or other weather related conditions.
- Line or system outages or fire hazards caused by trees falling into conductors.
- Breaking or imminent failure of cross-arms or insulators, which could, or does, cause conductor failure.
- 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).

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 reclosure 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

As per IE, the practices followed for routine, corrective and preventive maintenance of the transmission line and the Standard Operating Procedures for O&M of transmission lines cover all the aspects required for timely maintenance of the transmission lines and ensuring the maximum availability.

4.2. 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 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 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 for transmission lines and substations laid down by the Project Company are comprehensive and include all the aspects required for effective operation and maintenance of the transmission lines.

4.3. 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

BDTCL has implemented the 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 DTCL 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;
    a) Site organization
    b) Emergency Plan
    c) Training record
    d) Project Plan (Project quality plan, project EHS plan, EHS site manual)
    e) Contract with customer, contracts with subcontractors
    f) Risk assessments and preventive plans
    g) Safety tool box talk record
    h) EHS reports (Weekly, accidents, near-misses, etc.)

i) EHS plan follow up
j) Weekly EHS report
k) Routine self assessment check list
l) Fire extinguisher
m) Non conformity report

10. Internal & External Control

For Mandatory Safety Requirement and Score (MSRS) System the responsibilities & Authorities flow chart is shown below:

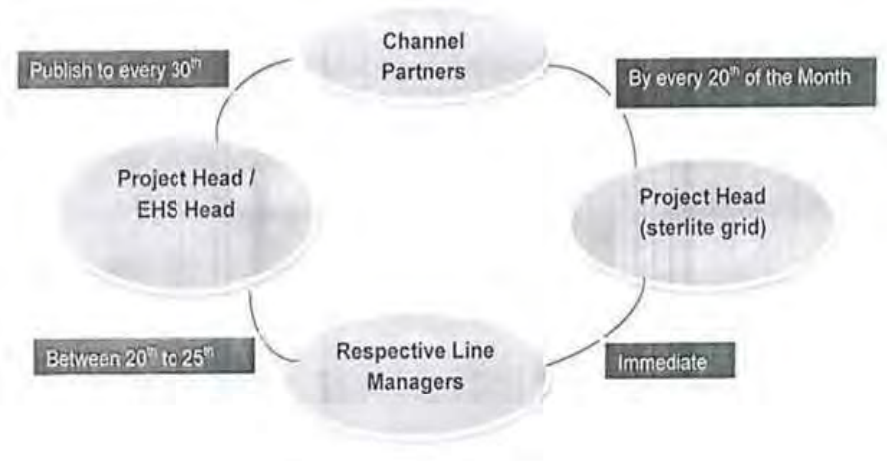


Figure 5.1: Flow Chart for MSRS System

The Channel Partners submit the MSRS checklist with evidence to project head every month. The Project Head forwards the same to respective line managers for further examination. The line managers visit the site with the same sheet & resend to Project Head/ EHS Head. The EHS Head/ EHS Manager publish the report every month.

5.2.2. EHS Inspection Procedure.

The EHS Inspection Procedure applies to the BDTCL 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 managements 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 etc) 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 sample reports of Safety Observation Tours and EHS Inspection reports for the project.

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 SPGVL EHS manual. This procedure applies to across the SPGVL constriction 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 (BDTCL) shall sign off the respective non-conformance report.

The Project Company has submitted some of the Non Conformance Reports for Dhule hub and a summary of the work stoppages at Dhule during 2014. 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 obtained / to be obtained.

Table 6.1: Status of key Permits & Licenses

S. No.	Description	Authority	Present Status
i.	Company Registration	Registrar of Company	Completed.
ii	Transmission License	Central Electricity Regulatory Commission (CERC)	Completed.
iii	Forest Clearance	State Govt./ MOEF	Obtained. (Except for Stage 2 Forest Clearance which in under progress for Dhule-Dhule and Dhule –Aurangabad Line)
iv	Approval under Section 68 of Electricity Act, 2003	GOI, Ministry of Power	Completed.
v	Approval from GOI under section 164 of Electricity Act 2003	GOI, Ministry of Power	Completed.
vi	Approval from CERC under Section 17(3)	CERC	Completed.
vii	Environmental Clearance	-	No environmental clearance is required for Transmission Line Project.
viii	Power & Telecommunication Coordination Committee Clearance (PTCC)	CEA / Ministry of Power	Approval for all the PTCC clearances is available.
ix	Railway Crossing	Ministry of Railways / Concerned division of Indian Railway	Approvals for all the crossing have been received.
x	Road Crossing	National Highway/ State Road Department	Received
xi	River Crossing	Navigation Authority	Project Company informed that clearances from the Navigation Authority is not required as Rivers are Non Navigation Rivers.
xii	Power Line Crossings	Concerned State Power Utilities / PGCIL	Approval for all 77 power line crossings is available.
xiii	Aviation Clearance	Airport Authority of India	Proposals submitted for both Dhule and Bhopal Hub and NOC has been received.
xiv	Defense Clearance	GOI, Ministry of Defense	NoC obtained.
xv	Transmission Service Agreement (TSA)	BDTCL & LTTCs	Received

6.2. Summary of Findings

IE found that all the major Permits/ Licenses like Transmission License, Approval under Section 68, Section 164 and Section 17 (3) of Electricity Act, 2003, forest clearance have already been obtained by the Project Company.

The validity of all the permits and clearances as mentioned above for the transmission line are valid throughout the Project life.

7. OVERALL STATUS

Bhopal Dhule Transmission Company Limited (hereinafter referred as "BDTCL or Project Company") a subsidiary SPGVL has set up four (4) nos. 765 kV Single Circuit (approximate 890.578 circuit km in length), Two (2) nos. 400 kV Double Circuit (approximate 53.502 circuit km in length) transmission lines and two nos. 765/400 kV Substations at Bhopal (Madhya Pradesh) and Dhule (Maharashtra) under "System Strengthening scheme for WR" on Build, Own, Operate and Maintain (BOOM) basis.

The Project consists of construction, operation and maintenance of following transmission lines and substations by the Project Company (BDTCL):

Transmission Lines

i. Jabalpur – Bhopal 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 259.693 circuit km.
ii. Bhopal – Indore 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 175.75 circuit km.
iii. Bhopal (IPTC) – Bhopal (MPPTCL) 400 kV D/C transmission line with quad ACSR 'Moose' conductor, 17.362 circuit km.
iv. Aurangabad – Dhule 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 192.235 circuit km.
v. Dhule – Vadodara 765 kV S/C transmission line with quad ACSR 'Bersimis' conductor, 262.90 circuit km.
vi. Dhule (IPTC) – Dhule (MSETCL) 400 kV D/C transmission line with quad ACSR 'Moose' conductor, 36.14 circuit km.

Substations

i. Bhopal (IPTC) Substation (2x1500 MVA, 765/400 kV)
ii. Dhule (IPTC) Substation (2x1500 MVA, 765/400 kV)

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 Indians 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 the Technical Specifications and the same were found to be in order.

The Project Company 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 and its interconnection with the PGCIL system to be in order. The design and prototype of all types of towers for 765 kV towers was completed and Type test of all the towers was done successfully. IE reviewed the type test certificates of various equipment/ components used in the project 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 to 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 include the requisite tests and inspections in line with Indian and International standards at various stages of the manufacturing process.

The Project has been executed under the supervision of BDTCL by reputed suppliers and contractors.

The Project has been implemented on multiple contracts basis.

- The EPC contract for the two (2) nos. 765/400 kV substations (excluding supply of transformers & reactors) was placed upon M/s Areva T&D India Ltd.
- The contract for supply of Fourteen (14) nos. 765kV/√3 / 400kV/√3, 1-Phase, 500 MVA Power transformers was placed upon M/s Hyundai Heavy Industries Company Limited, Korea.
- The contract for supply of Twenty two (22) nos. 765 kV/√3 1-Phase, 80 MVAr Reactors and One (1) no. 400 kV, 3-Phase, 125 MVAr Reactor was placed upon M/s Baoding Tianwei Baobian Company Limited, China.
- The EPC contract for the Transmission lines in the Dhule hub (excluding supply of conductor, insulators, hardware & accessories provided as free issue items by Owner to EPC contractor) was awarded to M/s KEC International Limited.
- The EPC contract for the Transmission lines in the Bhopal hub (excluding supply of conductor, insulators, hardware & accessories provided as free issue items by Owner to EPC contractor) was awarded to M/s Simplex Infrastructure Limited.
- The contract for Supply of 210 KN, 160 KN & 120 KN Insulators was awarded to M/s Xian Electric Engineering Company Limited, China.
- The contract for supply of Hardware Fittings & Spacer Dampers for 765 kV & 400 kV lines was awarded to Mosdorfer India Private Limited.
- The contracts for supply of Bersimis & Moose Conductor were awarded to Apar Industries Limited, Hind Aluminium Industries Limited and Sterlite Technologies Limited.
- Design & Engineering of Towers and Foundations etc was done in–house by the Project Company.

The BDTCL transmission system consists of eight (8) nos. transmission elements with six (6) nos. transmission lines and two (2) nos. substations. All the eight (8) nos. elements are complete and are operational. The COD of the last element of the BDTCL transmission system, the 765 kV S/C Dhule – Vadodara line was declared on 13th June 2015.

Element wise COD dates are mentioned below:

1. Jabalpur – Bhopal 765 kV S/C – COD was achieved on 9th June, 2015 and is operational.
2. Bhopal – Indore 765 kV S/C – COD was achieved on 19th November, 2014 and is operational.
3. Bhopal – Bhopal 400 kV D/C – COD was achieved on 12th August, 2014 and is operational.
4. 765/400 kV Bhopal Substation at Agaria – COD was achieved on 30th September, 2014 and is operational.
5. Dhule – Vadodara 765 kV S/C – COD was achieved on 13th June, 2015 and is operational.
6. Dhule – Aurangabad 765 kV S/C – COD was achieved on 5th December, 2014 and is operational.
7. Dhule – Dhule 400 kV D/C – COD was achieved on 6th December, 2014 and is operational.
8. 765/400 kV Dhule Substation – COD was achieved on 6th December, 2014 and is operational.

The review of the Technical documents pertaining to the project by IE including the Technical Specifications, Type Test Certificates and Quality Plan of the different equipment/ components of the Substations & Transmission Lines confirm the quality of components and technical suitability of the Substation & Transmission Lines. 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.

The target availability of the project as per Transmission Service Agreement is 98%. The Project Company submitted the monthly availability certificates for the BDTCL Transmission System from Oct 2015 to Dec 2016. IE observed that most of the time, that the Availability is maintained more than 99%. IE is of the view that with prudent maintenance practices and deployment skilled manpower, maintaining 98% availability is achievable.

IE reviewed the O&M Organization Set-up and the O&M methodology being used for the Operation and Maintenance of the substations and transmission lines.

For Project Operation and Maintenance activities the Project Company has out – sourced the works to different agencies. However, supervision of the O&M activities is being done in – house by the Project Company.

For maintenance works of all the 765 kV S/C and 400 D/C Transmission Line in Dhule Section is accorded to M/s. JBS Enterprise Pvt. Ltd and for 765 kV S/c and 400 kV D/C Transmission Lines in Bhopal section the maintenance works are out sourced to M/s. Telegence India. For the operation of sub – station in Dhule and Bhopal the works are outsourced to M/s. Encotech Energy (India) Pvt. Ltd.

IE is of the opinion that the proposed O&M organization set-up and the arrangement envisaged for the O&M of the substations & transmission lines is adequate. The operation and maintenance of substations directly by SPGVL with manpower support from a designated contractor and warranty by OEMs & EPC contractor shall ensure effective operation of the substations. 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 is effective in the smooth and trouble-free operation of the lines. Additionally, the providing mandatory spares by SPGVL shall facilitate in reducing the down-time of the lines.

As informed by the project Company, all regular tools and tackles required for maintenance are available at the substation. As per IE, the Substation Maintenance Schedule in the O&M manual and the Standard Operating Procedures of the substation cover all the aspects required for safe operation of the substation and to maximize the availability of the substation. Additionally, the practices followed for routine, corrective and preventive maintenance of the transmission line and the Standard Operating Procedures for O&M of transmission lines cover all the aspects required for timely maintenance of the transmission lines and ensuring the maximum availability.

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 Effective date of TSA is 31st March, 2011 and TSA shall continue to be effective until the expiry date which shall be the date which is 35 years from the scheduled COD of the Project. The scheduled COD of the Project works out to 31st March, 2014.

IE reviewed the provisions of the Transmission Service Agreement (TSA) and found the same to be in order.

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. This includes the Mandatory Safety Requirement and Score (MSRS) System which is to be used by SPGVL Employees and channel partners who may be concerned in any way with operation of work at site, property or premises for the implementation of EHS practices. The Project Company submitted sample reports of Safety Observation Tours and EHS Inspection reports for the project. The Project Company also submitted some of the Non Conformance Reports for Dhule hub and a summary of the work stoppages at Dhule during 2014. IE observed that by these processes, 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.

IE found that all the major Permits/ Licenses like Transmission License, Approval under Section 68, Section 164 and Section 17 (3) of Electricity Act, 2003, Forest Clearance have already been obtained by the Project Company.

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