Network network

Chapter: 2

Contents

2.1. SYSTEM AND ENVIRONMENTAL DATA

The data given in Clauses 2.3 below is for information only.

The Contractor shall be responsible for all necessary site investigations, required to confirm and/or to collect the data and to design all Works and equipment in his Scope to fully comply with the Specification in the light of the actual site conditions.

Data which the Contractor shall assume in the design of all works and equipment in his scope is given in Clauses 2.4 of the Technical Specification and Existing equipment data provided as part of TS, as well as any supplementary information or data received from the Employer during execution of project. However, before conducting detailed design studies the Contractor shall get the data reconfirmed (given in clause 2.4) from the Employer.

No extra cost shall be claimed by the Contractor for changes in the data before commencing the detailed studies for the project until unless the change directly results in the change of main equipment. There shall not be any extra cost claim by the Contractor on account of engineering for the above change in data before commencing the detailed studies.

The Employer shall also have the right to amend this data and the Contractor shall, if necessary, modify his design accordingly at any time up to the completion of the Contract. The Employer shall be liable only for changes in equipment/material/civil works and services/labor cost related thereto, and corresponding extension of time for completion demonstrated by the Contractor to have been directly necessitated by such change.

2.2. PROJECT SYNOPSIS

2.2.1 OVERVIEW

Pole-1 of Vizag Back-to-Back (BTB), hereinafter referred to as Vizag-I, HVDC has been commissioned by POWERGRID in September 1999.The BTB station has acted as an asynchronous link between the Eastern Region (ER) and the Southern Region (SR) and aided the system operator in adjoining AC network loading. It is used as major inter-regional power transfer link between ER & SR for power exchange and as well as Grid stability. Vizag-I is located in Visakhapatnam district near NTPC owned Simhadri STPS.

Vizag Back-to-Back (BTB) HVDC project consists of two Poles. Pole-1 and Pole-2 were commissioned in September 1999 and March 2005 by GEC-Alstom and ABB respectively.

POWERGRID has decided for the refurbishment of Pole-1 (1x500MW) of the HVDC Back-to-Back station at Vizag as per scope defined in Chapter 1.

Data of Vizag-I (Pole-I):

Rating	1 x 500 MW
DC Operating Voltage	205 kV
AC Voltage	For Performance: 380 - 420 kV
	For Rating: 360 - 440 kV
AC Side Frequency	For Performance: 48.5 - 50.5 Hz
	For Rating: 47.5 - 51.5 Hz
Overload Details	Designed for: **Continuous operation** at 1x500MW (1 pu) at maximum ambient temperature. **Two-hour overload** with rating of 1x550MW (1.1PU) at maximum ambient temperature, when all redundant coolers and heat exchangers are in service. This overload excursion is available at least once in every 12-hour period. **Five second overload** at power transfer up to 1x600MW (1.2pu), with all redundant coolers and heat exchangers out of service and maximum ambient temperature. 1.2pu Power transmission is to be available once in any 5-minute period except during a maximum of five minutes before and maximum of 30 minutes after operation at 1.1pu, 1x550MW. The overload capability as above has been provided on both individual as well as combined operation of pole 1 & 2.
Converter Transformer	234/117/117 MVA (Single-Phase)
Control Room Temperatures	26° C ± 1° C
Valve Hall Temperature	10° C to 55° C

2.2.2 DESCRIPTION OF AC SYSTEM

2.2.2.1 GENERAL INFORMATION

Vizag is located in the North-Eastern part of Andhra Pradesh. The Back-to-Back HVDC is intended to be used as inter regional link between ER and SR region.

2.2.2.2 SOUTHERN Region Network

The Southern region has the states/union territories of Andhra Pradesh, Tamilnadu, Karnataka, Kerala , Pondicherry, Telangana and consists of generating stations under central power utilities like NTPC, NHPC,NPCIL, IPPs etc. Data considered necessary for system studies shall be provided by the Employer before start of detailed engineering.

2.2.2.3 EASTERN Region Network

The Eastern region has the states/union territories of Odissa, Jharkhand, West Bengal, Bihar, Sikkim and consists of generating stations under central power utilities like NTPC, NHPC, NPCIL, IPPs etc. Data considered necessary for system studies shall be provided by the Employer before start of detailed engineering.

2.3 SITE CONDITIONS

As noted in Clause 2.1 the Contractor shall be responsible for all necessary site investigations to assure that all works and equipment in his scope of supply comply fully with the Specification. The Contractor shall establish the minimum values for bearing capacities and shall submit these to the Employer for approval prior to designing the foundation or using the values for any other purpose. The Contractor shall use the approved minimum values for design. Bidder may carry out soil investigation for outdoor cooler area, PLC area and storage area before submission of bid.

2.3.1 SITE CONDITIONS AT VIZAG

The bidder may please note that all information presented in clause 2.3.1.1 to 2.3.1.4 is made available as information only. If the bidder is not satisfied with an information included herein, he shall conduct, without any extra cost to the owner, all the necessary investigation to submit the Bid, and if successful, to perform the works.

2.3.1.1 SOIL INFORMATION

Soil bearing capacity 8.0 Tonnes/sq. mtr However, Bidder may carry out soil investigations for outdoor cooler area, PLC area and storage area as deemed necessary.

2.4.1.2 WIND

All structures shall be designed for Wind forces in accordance with IS-875 (Part III)-2015, Code of Practice for Design Loads (other than earthquake) for Buildings and Structures. Vizag-I converter station lies in Zone V with basic wind speed of 50 m/s at 10 m height above mean ground level. The risk level coefficient/factor shall be taken as 1.08. If terrain, height, structure size factor is less than 1.0, then these shall be neglected, otherwise they shall be considered.

2.4.1.3 RELATIVE HUMIDITY

Maximum 100%

Valve Hall Humidity during operations: <=60 %

2.4.1.4 ALTITUDE

The site altitudes above sea level are less than 1000 m.

2.4.1.5 ISOKERAUNIC LEVEL

30 days per year

2.4.1.6 SOLAR RADIATION

830 Cal/cm2 per hour.

2.4.1.7 RAIN FALL INTENSITY

In 24 hours: 250 mm

2.4.1.8 AIR POLLUTION

Heavily polluted as per IEC 60815

2.4.1.9 SEISMIC COEFFICIENT

Vizag-I converter station is located in Zone II according to IS-1893, Design Earthquake Hazard and Criteria for Earthquake-Resistant Design of Structures-Code of Practice . Importance factor for the stations is 1.5 (as per table no. 3 of IS-1893, part 4).

2.4.2 GENERAL DESIGN CRITERIA

The Employer's criteria for the design and control of the network are as below:

(a) The nominal system voltage and frequency are 400kV rms and 50 Hz. 400kV ac bus voltages shall normally be within ±5.0% of nominal voltage. Bus voltages outside this range may occur from time to time and may exist for long periods due to abnormal loads and/or contingencies.

(b) The equipment shall be rated to operate with bus voltage variation of at least +/- 10.0%.
AC system frequency shall normally be held within ±1.0% of nominal (50 Hz) but may be within ±3.0% for some periods. On very rare occasions, operations with frequencies up to 47.5 Hz can also occur and therefore equipment shall be designed to operate between 47.5 Hz and 51.5 Hz such that HVDC station shall not trip for these wider frequency excursions although power reduction shall be allowed for wider frequency excursions. Unless and otherwise stated, the operating frequency range for meeting the specified performance level shall be from 48.5 to 50.5 Hz.

(c) For calculating reactive power exchange, the 400 kV ac voltage variations to be taken shall be from 380-420 kV. The variations in frequency shall be from 48.5-50.5 Hz. As existing AC filters are to be used, detailed AC filter data shall be provided to the contractor.

(d) The system should be able to ride through any 3 phase, 5 cycle (100 ms) or single phase 10 cycles (200 ms) fault with consequent loss of a 400 kV equivalent line, 400 kV double circuit line (if these are on the same tower), loss of a 500 MW generator, loss of a pole, loss of all filter banks connected in the fault zone etc. Such contingencies would not require rescheduling of load / generation. The fault duration mentioned above corresponds to time assumed for persistence of fault. Back up fault clearing time shall be 600 ms and Single phase auto reclose on 400 kV AC lines shall be completed within 1.1 sec.

(e) Until otherwise stated, all equipment supplied under this contract shall be rated to operate safely for ac voltages between 360-440 kV and frequency between 47.5 -51.5 Hz at Vizag. For Filter ratings, HVDC power transmission ratings and reactive power exchanges, the frequency ranges are specified in the relevant clauses.

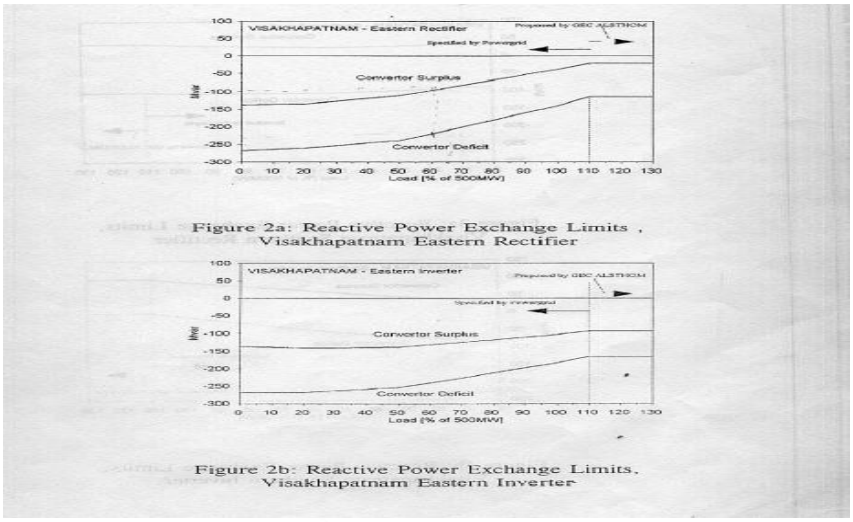
(f) The ac voltage unbalance at fundamental frequency shall be assumed equivalent to a negative phase sequence component of 1% for performance and 1.5 % for equipment rating purposes.

HVDC should continue operation at reduced power if conditions get outside this voltage, frequency and short circuit capacity ranges in technical specification. Bidders should specify conditions under which HVDC system would trip.

2.4.3 REACTIVE POWER CAPABILITY OF THE AC SYSTEM:

The reactive power absorbing and delivery capabilities of ac system are limited at converter buses. The contractor shall ensure the reactive power exchange between the converter station and the ac system on either side is restricted within the limits of reactive power or range of ac system parameter variation as defined hereunder.

2.4.3.1 EASTERN REGION The reactive power exchange capability of the Eastern region transmission system at Vizag (East) bus for various power flows on back-to back station are given in fig. 2.4.3.1.



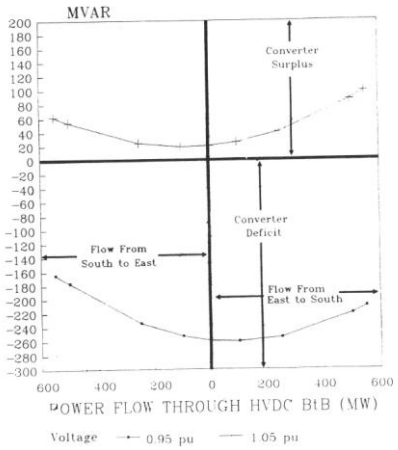


Figure 2.4.3.1 (Eastern System)

The design consideration shall be such that any one subbank filter can be taken out upto transmitted power level of 1000 MW. For power levels beyond 1000 MW this subbank shall be considered available.

2.4.3.2 SOUTHERN REGION

The reactive power exchange capability of the Eastern region transmission system at Vizag (South) bus for various power flows on back-to back station are given in fig. 2.4.3.2.

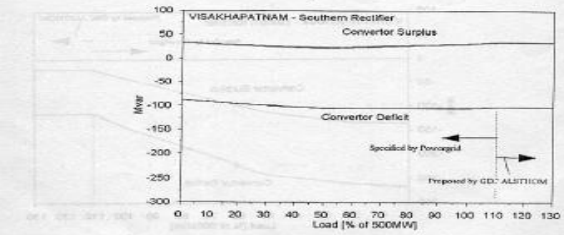


Figure 3a: Reactive Power Exchange Limits, Visakhapatnam Southern Rectifier

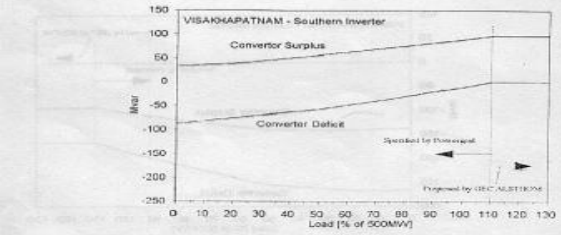


Figure 3b: Reactive Power Exchange Limits, Visakhapatnam Southern Inverter

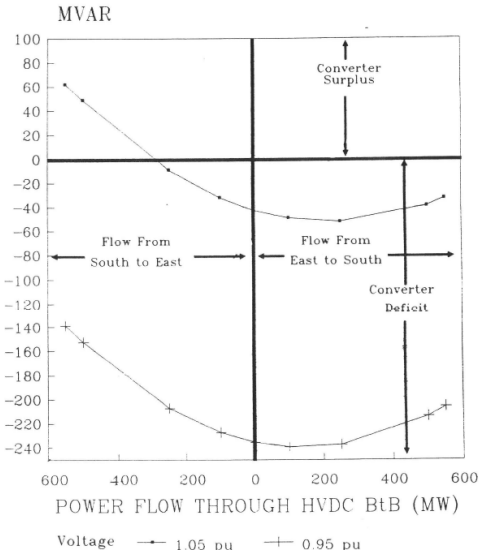


Figure 2.4.3.2 (Southern System)

The design consideration shall be such that any one subbank filter can be taken out upto transmitted power level of 1000 MW. For power levels beyond 1000 MW this subbank shall be considered available.

2.4.4 GENERATORS NEARBY VIZAG

Data for the representation of the generators in the vicinity of Vizag for use in studies to ensure that the HVDC system controls cannot excite the torsional modes of oscillations of the nearby generators in the system using a SPRING-MASS model of the turbine/generator shaft shall be furnished to contractor. The data for Turbine-Generator model for torsional analysis for generators (identified in sub synchronous screening study) set shall be given within three months of submission of sub synchronous screening study report. In case, any Turbine-Generator model data is not available for the detailed study, the contractor shall study and provide necessary operating instructions/restrictions to avoid excite sub synchronous oscillations which can be shared with load dispatch centre/ system operator.

2.4.5 SHORT CIRCUIT LEVELS

2.4.5.1 EASTERN REGION

At Vizag 400 KV Eastern bus the maximum fundamental frequency short circuit current shall be taken as 40 kA for one second at 420 kV for equipment. However, the short circuit level for present scope including valve design shall be taken as 50kA at 420 kV on primary side. The minimum Short Circuit Level (SCL) at Vizag 400 KV Eastern bus corresponding to dc load conditions and base operating conditions, at nominal voltage and fundamental frequency, shall be taken as follows:

Sr. No.	DC Power (Either one or both pole in operation)	Short Circuit Level / Short Circuit Ratio (SCR)
1	50-500 MW	Minimum 1500 MVA (minimum SCR = 3.0)
2	501-1000 MW	Minimum 3000 MVA (minimum SCR = 3.0)

2.4.5.2 SOUTHERN REGION:

At Vizag 400 KV Southern bus the maximum fundamental frequency short circuit current shall be taken as 40 KA for one second at 420 KV for equipment's. However, the short circuit level for present scope including valve design shall be taken as 50kA at 420 kV on primary side. The minimum short circuit level at Vizag 400kV Southern bus, at nominal voltage and fundamental frequency, shall be taken as follows.

Sr. No.	DC Power (Either one or both pole in operation)	Short Circuit Level / Short Circuit Ratio (SCR)
1	50-1000 MW	Minimum 1500 MVA (minimum SCR =1.5)

2.4.6 HARMONIC IMPEDANCES:

The ac system harmonic impedance to be used for the calculation of ac harmonic filter performance and rating as specified in technical specification are defined in terms of circle diagrams and enclosed as Annexure-Network Impedance.

2.4.7 SYSTEM STUDIES

The bidder shall include in his bid a list of the studies proposed to be carried out for the project and tools proposed to be used for all such studies.

In addition to above, Bidder shall propose Interaction studies considering HVDC links/FACTS devices in vicinity of Vizag HVDC Back-to-Back.Based on the Interaction studies, Contractor shall optimise the HVDC response time and recoveries under various fault conditions which should include proposed remedial actions at the other HVDC schemes that could be affected by this new scheme. During actual design, however, if it is felt that some additional studies have to be carried out to determine the performance, rating of equipment or to integrate the project in the existing network, the contractor shall carry out all such studies without any extra cost to the Employer.

The studies shall be carried out by using tools that have been validated for the type of study stipulated. In case a tool is not properly validated the Employer shall have the right to specify the tool and the contractor shall be bound to carry out study using the tool specified without any extra cost to the Employer.

2.4.7.1 STABILITY / MODULATOR / FREQUENCY CONTROL STUDIES

The above mentioned studies shall have to be conducted by the contractor with complete system representation up to 132 kV levels. The required system data to be modelled for these studies shall be furnished by the Employer.

2.4.7.2 AC SYSTEM EQUIVALENTS

The dynamic performance studies shall be carried out at the Contractor's works. For the purposes of these studies, to verify the dynamic performance of the Pole-1 and its integration into the network, and for over voltage studies the complete system may be represented by the equivalent networks (to be developed by the Contractor) based on the system data given by the Employer. Further, dynamic performance of the entire Vizag HVDC system and overvoltage studies are also to be carried out. For dynamic performance study, equivalent model of Vizag Pole-2 is to be developed by the contractor based on the data provided by the employer. The Contractor shall validate and demonstrate the suitability of the derived equivalents to the satisfaction of the

Employer before commencing any such studies. The equivalents to be prepared for peak load, and light load network scenarios. The dynamic network equivalent shall be prepared with full machine models having exciters, governor- turbine, generators, stabilizer models instead of voltage source models, up to two buses away. These dynamic equivalent networks shall be used in PSCAD Dynamic Performance study. Also the dynamic performance study shall be carried out with extremely weak scenario corresponding to the minimum SCLs mentioned in chapter 2.4.5 using Thevenin's equivalents.

2.4.7.3 THE SUBSYNCHRONOUS RESONANCE STUDIES

The studies to demonstrate that the HVDC system do not excite the torsional modes of oscillations of the generators at near by Vizag HVDC Back-to-Back (NTPC Simhadri on southern side and Rengali and Indravathi generators on eastern side) under all defined system operating conditions and that the HVDC has positive damping for all sub synchronous torsional modes of the generators shall be carried out by using the model of the actual control hardware of HVDC and by using tool that has been validated for such studies. Refer **Annexure-Generator** for preliminary list of generators in proximity of Chandrapur HVDC (up to three electrical buses away). However, generators to be screened for possibility of sub synchronous oscillations shall as per network data and not be limited to these generators.

2.4.8 AC LINES

The typical tower configuration for the 765kV/ 400 kV ac single & double circuit transmission lines shall be given to the successful bidder if required for the studies.

2.5 CONDUCTOR DATA

Conductor details as required for the study shall be furnished to the successful bidder.