# NOTICE INVITING EXPRESSION OF INTEREST FOR INTEGRATED INTELLIGENT SWITCHYARD 3D MODELLING AND ENGINEERING SOLUTION

## EOI REFERENCE NUMBER: TBEM/EOI/3D/2018-19

**BHARAT HEAVY ELECTRICALS LIMITED**
**Transmission Business Group, Noida**

## NOTICE INVITING EXPRESSION OF INTEREST (EOI)

Bharat Heavy Electricals Limited (BHEL, A MAHARATANA Government of India Enterprise) incorporated under the Companies Act, 1956, having its Registered Office at BHEL House, Siri Fort, New Delhi invites EOI for "Integrated Intelligent Switchyard 3D Modelling & Engineering Solution", hereafter called ***"Switchyard Software Solution"*** from 3D modelling software suppliers to provide complete switchyard 3D modelling solutions for 765/400/220/132kV Air Insulated Switchyards and switchyards having GIS.

All corrigenda, addenda, amendments, clarifications, time extensions etc. related to this EOI will be hosted on www.bhel.com

Schedule of EOI process

The schedule of activities during the EOI shall be as follows:

**Four weeks from the date of publication in newspapers/BHEL Website.**

**EXPRESSION OF INTEREST FROM SOFTWARE SERVICE PROVIDERS FOR "*SWITCHYARD SOFTWARE SOLUTION*"**

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# SECTION-1
## Expression of Interest

# 1.0 Expression of Interest (EOI)

## 1.1 About Bharat Heavy Electricals Limited (BHEL)

BHEL is an integrated power plant equipment manufacturer and one of the largest engineering and manufacturing company of its kind in India engaged in the design, engineering, manufacture, construction, testing, commissioning of a wide range of products and systems for core sectors of the economy, viz. Power, Transmission, Industry, Transportation (Railways), Renewable Energy, Oil & Gas, Water and Defense with over 180 products offerings to meet the needs of these sectors. The Manufacturing Set Up, Power Sector Operations and Business Sectors establishment has pan India presence and currently deploys as many as 39821 regular employees for managing the operations.

For More details about the entire range of BHEL's products, Systems and operations, please visit www.bhel.com.

## 1.2 About Transmission Business Group (TBG)

BHEL, a well-established player in the field of power transmission has a vast experience of more than four decades and offers major products and systems with contemporary technologies. Transmission Business Group of BHEL undertakes projects on turnkey basis for AC switchyards/substations (AIS & GIS) up to 765 kV, HVDC Converter Stations, Flexible AC Transmission systems.

## 1.3 EOI: BHEL's Requirement

BHEL seeks expression of Interest for "***Switchyard Software Solution***", from bidders who provide solutions for switchyard engineering by creating an intelligent 3D model of substation including its equipment and who qualify for this assignment as per PQR.

This 3D model shall be exportable for its integration with power plant model (Power plant model is being prepared on PDMS of Aveva and SmartPlant of Intergraph, AutoCAD etc.).

The software shall be capable of concurrent engineering, engineering automation, sub-station layout standardization through templates & reuse of project data.

**The purpose of EOI is:**

- To arrive at details of specification meeting technical requirements of engineering of switchyard and 3D modelling

- To finalise terms of payment
- To shortlist interested competent parties for further processing through open or limited tenders.

**As part of EOI, bidders are required to submit in hard/soft copy:**

- Technical offer alongwith catalogues, writeup, demo videos, calculation modules, sample deliverables (2D Plan & Section drawings, Isometric views, Bill of Quantity)
- Documents meeting the PQR as per Section 2 and various Forms.
- Critically examine the technical feasibility of proposed assignment and comment on the same with detailed reasoning, based on their experience.
- Provide feedback on the technical requirement given in clause 1.4 and other terms and conditions so as to ensure the best practices of industry are well incorporated into the same to enable BHEL to provide the best solution to its customer.
- Budgetary offer of all the modules and software offered as per clause 1.5.
- Examine "Terms of payment" as per clause 1.5 w.r.t. milestone completion duration & linked percentage payment and provide feedback with reasoning.

BHEL reserves the right to accept or reject (fully or partially) suggestions given by bidders, without assigning any reasons. By participating in this EOI, the bidder gives BHEL the right to use the information provided by bidder to finalise the specification for this package.

Depending on the need, post submission of EOI by the bidder, further engagement with the bidder may include providing clarifications to BHEL by mail or phone, presentations, online web based demo and across the table discussions at BHEL TBG's office in NOIDA.

## 1.4 Scope under EOI:

The expression of interest (EOI) is for shortlisting the interested competent parties for providing "*Switchyard software solution*" for electrical design of switchyards and 3D modelling for 765/400/220/132kV Air Insulated Switchyards (including switchyards having GIS..

A substation project can have more than three voltage levels i.e. 765kV / 400kV / 220kV /132kV /66kV with 10 bays or 10 diameter in each voltage level or 25 bay in 400/220/132kV/66kV rating.

Typical SLD, Layout Plan & Section drawings of a large substation enclosed at section 5.

Brief description of required features is as follows:

## 1.4.1. General

The *"Switchyard software solution"* shall have the capability to make intelligent 3D model of substation which includes equipment modelling, design of electrical layout, analysis w.r.t clearance, building, earthing layout, design calculations etc. and work in multiuser and multi-location mode. The overall 3D model of substation shall be integrated with project management features.

The 3D modelling software shall have built-in libraries for various equipment upto 765kV for ready to use with minor modification.

The single line diagram, 3D models, Electrical Plan & Electrical section shall be integrated. The system shall detect any conflicts if there is an equipment which is shown in the single line diagram and not shown in the 3D model and vice versa. It shall provide dynamic views which update both 2D & 3D views whenever anyone of the view is updated. The *"Switchyard software solution"* should have the provision to incorporate user defined symbols, legends and notes etc in 2D drawings and BOMs.

## 1.4.2. Integrated Project Engineering Management system

All data shall be structured as per project, voltage levels and corresponding bays.

The *"Switchyard software solution"* shall be capable of concurrent engineering, engineering automation, sub-station layout standardization through templates & reuse of project data.

The *"Switchyard software solution"* should have Central Data Editing functionality so that when any of the necessary property associated with project is changed, same shall be reflected in related drawings and document.

The *"Switchyard software solution"* should guarantee data reuse by managing standard bays or template or part-stations.

The *"Switchyard software solution"* should have ERP integration capability with full consistency of ERP & CAD data.

## 1.4.3. Electrical Layout

a. **Design of electrical layout** – 3D modelling of the complete switchyard including AIS Equipment (Air Insulated Switchyard), GIS equipment (gas Insulated switchyard),

Transformers, Reactors, various connections (in separate identifiable phases by different color) and control room & auxiliary building.

For initial GIS model, basic modelling of GIS & GIB shall be possible in the solution. The detailed 3D model of the GIS & GIB shall be provided by BHEL from the GIS Vendor, which is to be imported in the software for further detailing.

b. **Equipment modelling** – The model of basic equipment such as i.e. like Circuit breakers, Isolators, Current transformer, voltage transformer, Wave trap, Post Insulators , String insulators etc shall be intelligent. The software should understand the Voltage level of the live (charged) part with terminal of single or three phases, Insulated part, Dead part (tank) with earth terminal, Local Control Box and Lattice or Pipe structure (earthed). Software should have the capability of hook points and intelligent snap functions to connect related objects, so that they can automatically snap together and move as one unit when repositioned.

c. **High Voltage Connections** - The connections between the equipment shall be either through flexible conductors or rigid conductors. The model should be intelligent and the system should analyse the model to check the integrity of phases (each phase shall be marked in different colour).

The sag of the conductors and string insulator shall be modelled and shall preferably be calculated in the system by sag algorithms for catenary curve for accuracy of clearance checks with temperature compensation.

d. **Mechanical Interface** - Pipe routing option by command for routing of fire hydrant pipe of outdoor transformers, reactors etc.

e. **Trench Layout -** Trench configuration shall be designed separately, and also modelling of cable trenches, cable trestle, cable ducts, buried cables, pull pits, underhung trays etc. shall be included in scope. Capability required is quantification of trench material. Routing for EHV/HV cables shall be modeled taking care of bending radius etc.

f. **Earthing -** Earthing design shall be done separately by BHEL through earthing design software. Main earth mat grid (underground) and risers to the equipment earthing terminal shall be modelled in 3D by giving grid spacing with either Copper or MS earthing that incudes high frequency earthing for GIS. Capability required is physical earthmat laying & quantification.

## 1.4.4. Engineering Analysis :

**Electrical Clearance**: The system should also check the various mechanical and electrical clearance viz. phase to phase, phase to ground, section clearance based on default/defined engineering rules. The conflicts/warning shall be shown in the model so that the engineer can shift the equipment or fence. The shifting of equipment shall lead to shifting of complete equipment (i.e. equipment, structure & foundation) and its connection. It should also have the capability of clash-detection.

**Direct stroke lightning protection (DSLP) of switchyard & buildings:** The software should be able to perform lightning protection calculation and results in the form of lightning protection volumes, curvature, area and zone. The volume of DSLP protection shall be generated in 3D automatically by the system based on rolling sphere method derived from IS 2309/ IEEE 998/ IEC 62305 and calculation of lightning protection classes based on location of shield wire, lightning mast. The towers, conductors, equipment, building etc which are not covered/ protected shall protrude out of the volume. The design engineer can then modify the shield wire (location and height), height or location of lightning mast. The software shall be intelligent to optimize DSLP with No. of LM & use of shield wire.

## 1.4.5. Scope of Structural / Civil /Mechanical

a. **Structures (Lattice / Pipe)**: Substation structures such as gantries, towers, equipment support structures (both lattice and pipe) shall also modelled to prepare complete Switchyard 3D model.

b. **Building**: The scope in civil shall be to create surface models of Sub-station control room buildings & GIS building of any form, size and geometric complexity. The building shall be modelled with doors, windows & stairs etc.

c. **Indoor Equipment** : The equipment placed in the control room building shall also be modelled with some basic intelligence - Panels, LT Switchgear, MV switchgear, Dry Type Transformer, Battery chargers, Batteries, Illumination fixtures etc

d. **Mechanical Equipment**: Air conditioning ducts/diffusers, Crane girder etc in GIS building/ control room building.

e. **Civil works:** Surface modeling of RCC foundations, compound walls, fence, roads, drains, gate, cable trench, culverts etc.

## 1.4.6. Bill of Material

Bill of Material shall be in structured form:

- Main HV/EHV Equipment

- Flexible Conductors , Rigid Conductors and shield wire
- Earthing Conductors
- Trench Material
- EHV/HV cable length
- Clamp & Connectors
- Panels & switchgear

### 1.4.7. Interface with third party software

Interface with third party software & Data exchange with capability of importing & exporting files/model to ensure reusability

- Autocad .dwg or .dgn format for GIS
- STAAD
- MS Excel
- Interface with power plant 3D software (PDMS / Intergraph)

It may be possible to generate intelligent pdf for sharing data.

### 1.4.8 Deliverables

The deliverables of this module shall be extraction of following 2D drawings from the 3D model(s)

- Plot plan
- Layout Drawing (Section and Plan)
- Structure loading drg
- Erection Diagram (Section and Plan)
- Earthing Layout
- DSLP Layout
- Foundation Layout
- Trench/ Duct Layout
- EHV/HV cable layout
- Conceptual layout of building
- Road and Drain Layout
- Panel Layout
- Clearance Diagram
- Automatic generation of Bill of Material and its report. (The software should have capability to customize the report and Output reports to TXT, CSV, HTML, RTF, PDF, XLS, MHT files. Etc.)

  Exportable 3D model of sub-station for customer review and integration with Power Plant model.

## 1.5 Scope of Main Tender & Payment Terms

### 1.5.1 Bill of Quantities

| Sl. No | Item Description | Unit | Quantity |
|---|---|---|---|
| 1 | ***Switchyard Software Solution***<br>(Model to be furnished by bidder – perpetual / rental) | Licence | 6 |
| 2 | **Any other software required** - engineering software, database etc.<br>(Bidder to decide based on the features and functionalities in the software.) | Lot | 1 |
| 3 | **Customisation**, if required.<br>(Bidder to specify details of customization required) | Lot | 1 |
| 4 | **Training**<br>Imparting hands-on training at TBG Noida, to engineers in basic design concepts, tools and features of the software. The objective shall be to impart skills in creating 3D substation. | Lot | 1 |
| 5 | **Annual Maintenance Contract (AMC)**<br>The scope shall also include entering an AMC initially for two years for software support and software updates. | Lot | 1 |

### 1.5.2 Payment Terms

| Sl. No | Item Description | Payment Terms |
|---|---|---|
| 1 | Switchyard Software Solution - Software | 60% within 6 weeks of successful installation.<br>20% after completion of training & demonstration of features.<br>20% after completion of customisation & successful completion of one pilot project. |
| 2 | Any other software required | 100% within 6 weeks of successful installation |
| 3 | Customisation, if required | 100 % within 6 weeks of completion of customisation. |
| 4 | Training | 100 % within 6 weeks of hands-on Training |
| 5 | AMC | 50 % half yearly |

## 1.6 Instruction to bidders who wish to submit Proposal against EOI:

Interested companies who wish to associate with BHEL for the aforesaid requirement may submit their responses against this EOI in the prescribed format.

Expression of Interest should contain the following information.

| | |
|---|---|
| I. | Company Business profile & Organization Structure (Form 1) |
| II. | Technical QR Supporting document/Documentary evidence against the Qualification Criteria (Form 2) |
| III. | Form of technical compliance (Form 3) |
| IV. | Technical offer along with catalogues, writeup, demo videos, sample deliverable of software (2D Plan & Section drawing, Isometric views, Bill of Quantity etc) |
| V. | System requirements for running software (Server & Client machines) |
| VI. | Examine "Terms of payment" as per clause 1.5 w.r.t. milestone completion duration & linked percentage payment and provide feedback with reasoning. (Form 4) |

| | |
|---|---|
| VII. | Budgetary offer of all the modules and software offered as per Form in clause 1.5. |
| VIII. | Work Completion Schedule at contract stage (Form 5) |

## 1.7 Contact Details for submission of Complete Offer in hard copies & Queries:

Sanjay Singh
Senior Engineer – Materials Management
Transmission Business Group
Bharat Heavy Electricals Limited
Tower –A, 5th Floor, Advant Navis IT Business Park,
Plot No. 7, Sector-142, Expressway, Noida (UP)-201305
Phone No: +91-120-674-8509
Fax No: +91-120-674-8579
Mobile - +91 989-909-5970
E-mail: sanjay.singh@bhel.in

For any queries, following persons may be contacted:

- Mr. Rakesh Singh, AGM/Engineering, TBG, NOIDA rakesh.singh@bhel.in
- Mr. Vivek Kapil, DGM/Engineering, TBG, NOIDA vivekk@bhel.in

## 1.8 DISCLAIMER

The information contained in this Expression of Interest document (the "EOI") or subsequently provided to Applicant(s), whether verbally or in documentary or any other form, by or on behalf of Bharat Heavy Electricals Limited (BHEL) or any of its employees or advisors, is provided to Applicant(s) on the terms and conditions set out in this EOI.

This EOI is not an agreement and is neither an offer nor invitation by BHEL to the prospective Applicants or any other person.

BHEL also accepts no liability of any nature whether resulting from negligence or otherwise howsoever caused arising from reliance of any Applicant upon the statements contained in this EOI.

The issue of this EOI does not imply that BHEL is bound to select and shortlist Applicants for next stage or to enter into any tie-up agreements with shortlisted Applicants for the Project.

The Prospective Business Partner shall bear all costs associated with the preparation, of offer and submission of EOI, BHEL shall in no case be responsible or liable for these costs regardless of the conduct or outcome of the EOI process

# SECTION - 2
## Qualifying Requirements

# TECHNICAL QUALIFICATION REQUIREMENT

| | Eligibility Criteria | Documents to be provided |
|---|---|---|
| **(a)** | The bidder should have supplied switchyard specific 3D modelling & automation software to atleast two Transmission Utilities / Design Consultants / Substation EPC contractors | PO/ Letter of Agreement/ LOI of similar works |
| **(b)** | Software working without any adverse reports for at least 2 years. | Performance Certificate etc. from users. |
| | Note :<br><br>1) Bidder must submit all supporting documents along with their offer.<br>2) All documents (including third party documents/supporting documents) in language other than English, certified translated copy in English language should also be furnished. After satisfactory fulfillment of all the above criteria/ requirement, offer shall be considered for further evaluation as per NIT and all other terms of the tender. | |

# Section - 3
## Bid Forms

# Form-1
## COMPANY PROFILE

| | **General information:** |
|---|---|
| 1 | Name of the Company : |
| 2 | Place of Incorporation/ Registration: |
| 3 | Year of Incorporation/Establishment |
| 4 | Address of the company (Head Office, Registered Office, Business Office)<br>Address:<br>Telephone:<br>Fax:<br>E-mail:<br>Web site: |
| 5 | Address of Works:<br>Address:<br>Telephone:<br>Fax:<br>E-mail: |
| 6 | Details of marketing agent (For Foreign manufacturer):<br>Address:<br>Telephone:<br>Fax:<br>E-mail: |
| 7 | Authorized representative of the company having the Power of Attorney (POA):<br>Name(s):<br>Designation:<br>Address:<br>Telephone:<br>Fax:<br>E-mail: |

**Please attach the POA of authorized representative duly notarized as enclosure to FORM-1.**

Date: Signature of the Authorized representative )

Place: Name-

(Designation) -

(Company Seal) ……..

# Form-2
# Data/Details of in support of Technical QR
**(In support of meeting the Qualification Criteria specified in Section-2].**

| | | |
|---|---|---|
| **Name of the Bidder (Single Firm)** | | |
| A1. | Name of Contract | |
| A2. | Contract Reference No. & Date of Award | |
| A3. | Name and Address of the Employer/Utility<br>by whom the Contract was awarded<br>e-mail ID<br>Telephone No.<br>Fax No. | |
| A4(i)<br><br>(ii)<br>(iii) | Name of sub-station or switchyard executed under the Contract<br>Voltage level of sub-station or switchyard<br>No. of bays in the sub-station or switchyard | |
| A5(i)<br>(ii) | Date of successful execution of the Contract<br>*(enclose completion certificate/taking over certificate)*<br>No. of years the above referred **contract** is in **satisfactory operation** as on the date of bid opening<br>*"Satisfactory Operation" means Certificate issued by the Employer (End User)certifying the satisfactory operation and usage without any adverse remark* | |
| A6. | Scope of work executed under the above contract | |
| A7. | Capacity in which the Contract was undertaken | |
| A8. | Details/documentary evidence submitted in support of stated experience/Contract | Performance Certificate issued by the customer. |

Date: Signature of the Authorized representative )

Place: Name-

(Designation) -

(Company Seal) …….

## Form-3
## SCHEDULE OF TECHNICAL COMMENTS

The following are our comments on the Technical Specification:

| Sl. No | Clause Number / Page Number | Comments |
|---|---|---|
| | | |

Date:

Place:

Signature of the Authorized representative )

Name-

(Designation) -

(Company Seal) ……..

# Form-4

## SCHEDULE OF COMMENTS ON SCOPE OF MAIN TENDER AND PAYMENT TERMS

The following are our comments:

| Sl. No. | Serial Number of Clause 1.5 | Comments |
|---|---|---|
| | | |

Date:

Place:

Signature of the Authorized representative )

Name-

(Designation) -

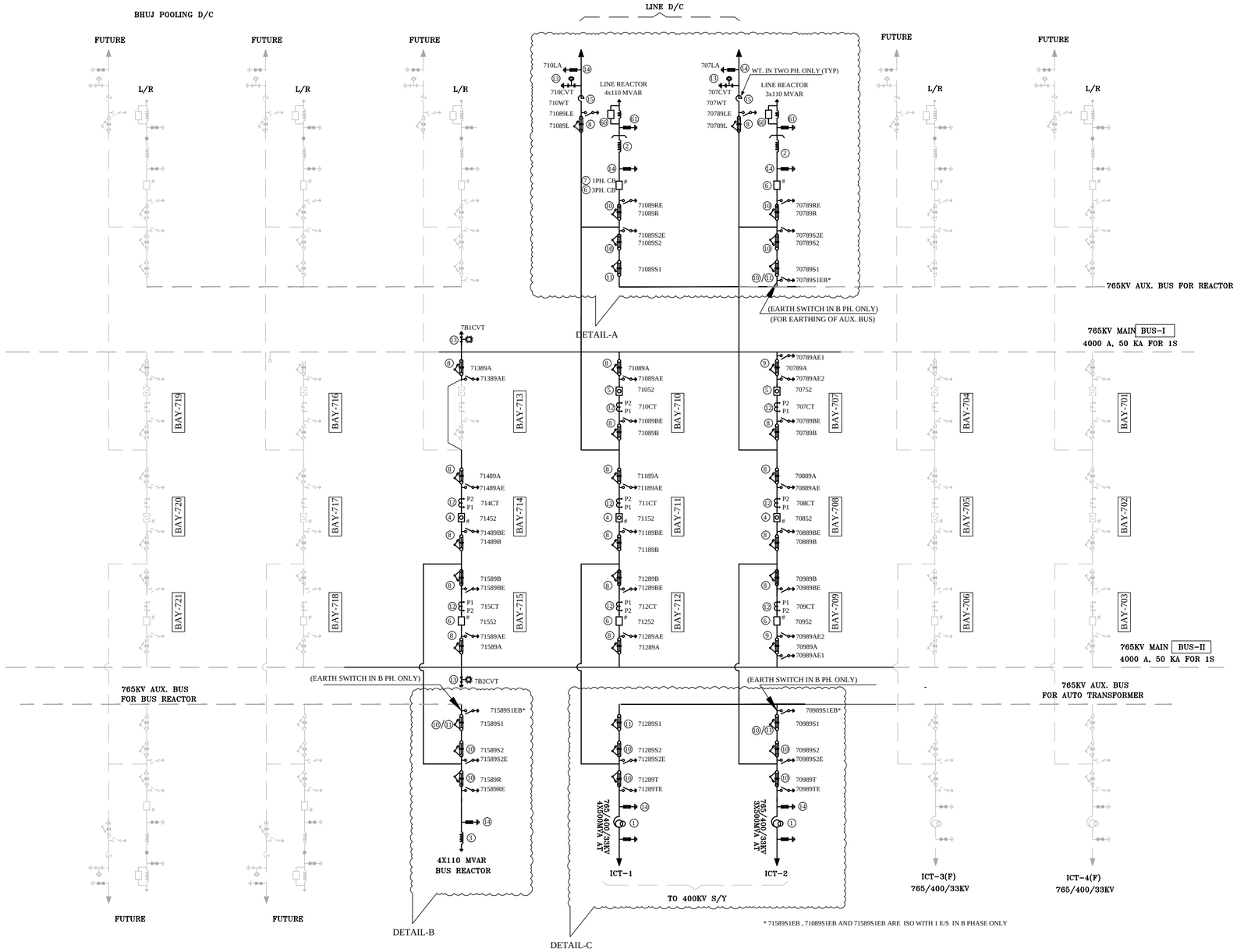
(Company Seal) ……..

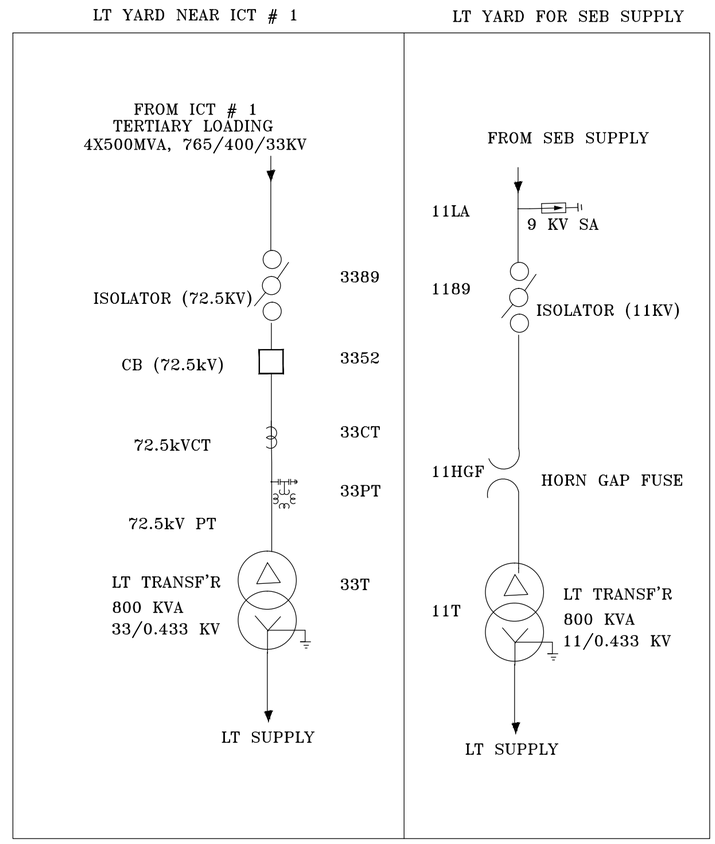
# Form-5
# (Work Completion Schedule)

| Sl. No. | Description Work | Period in months from the effective date of award of contract |
|---|---|---|
| 1. | Installation of software at a central server with required number of user licenses, documentation, user manuals alongwith required customisation / interfacing with other softwares | |
| 2. | Successful testing of software and deliverables with all required features to make it live | |
| 4. | Training of engineers | |

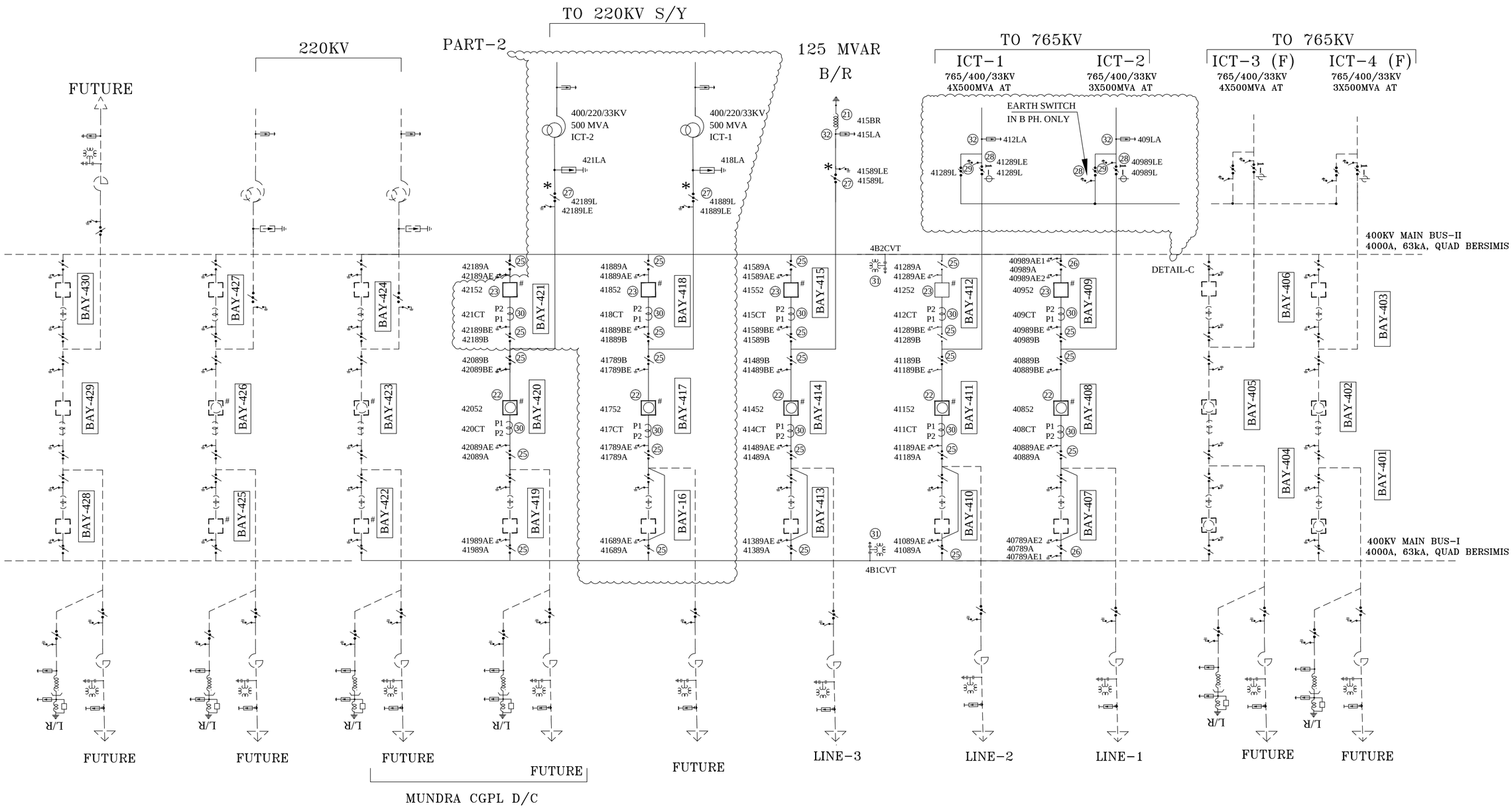
Date: (Signature) …….

Place: (Printed Name)-
(Designation) -
(Company Seal) ……..

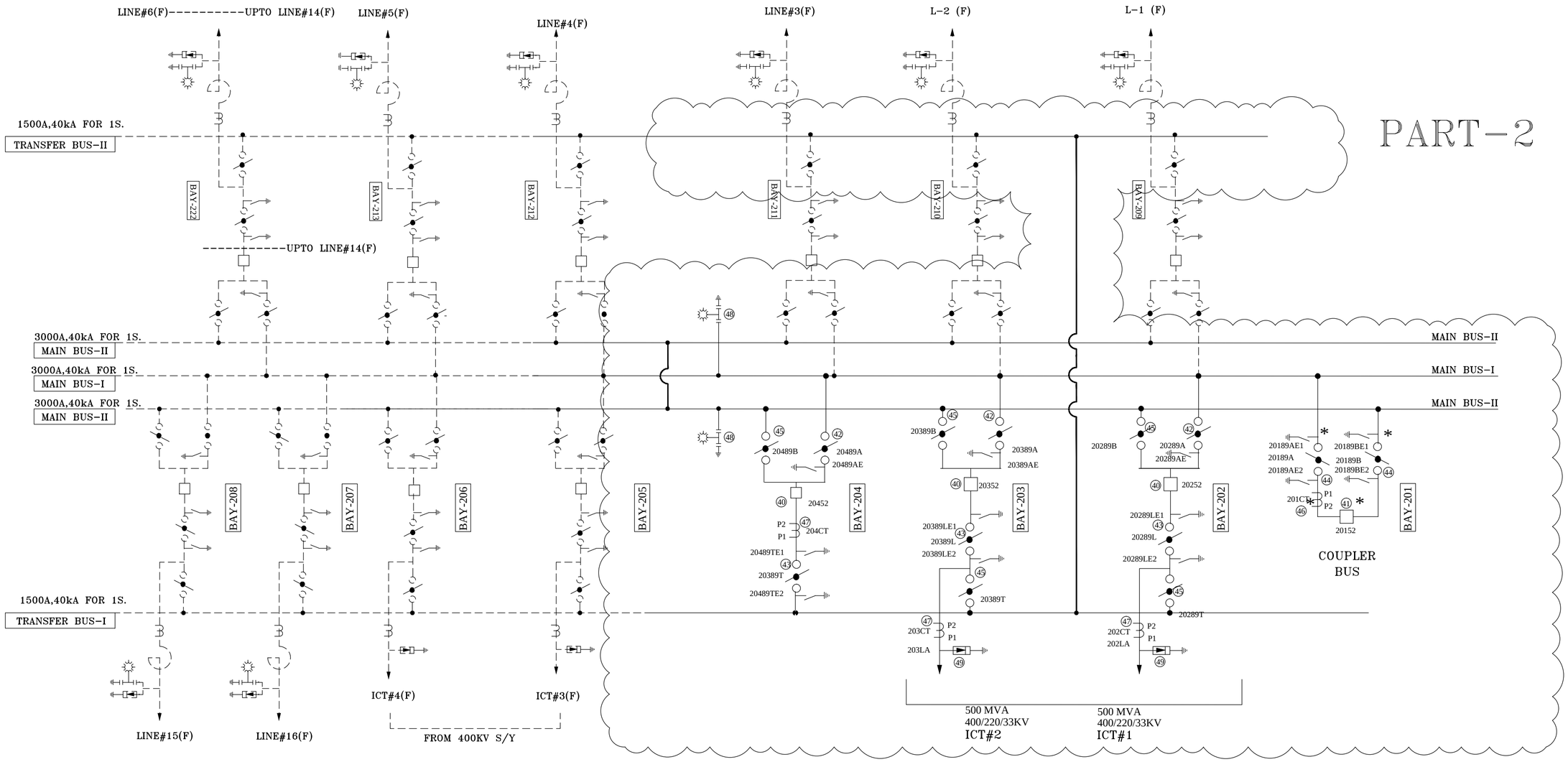



765KV SINGLE LINE DIAGRAM

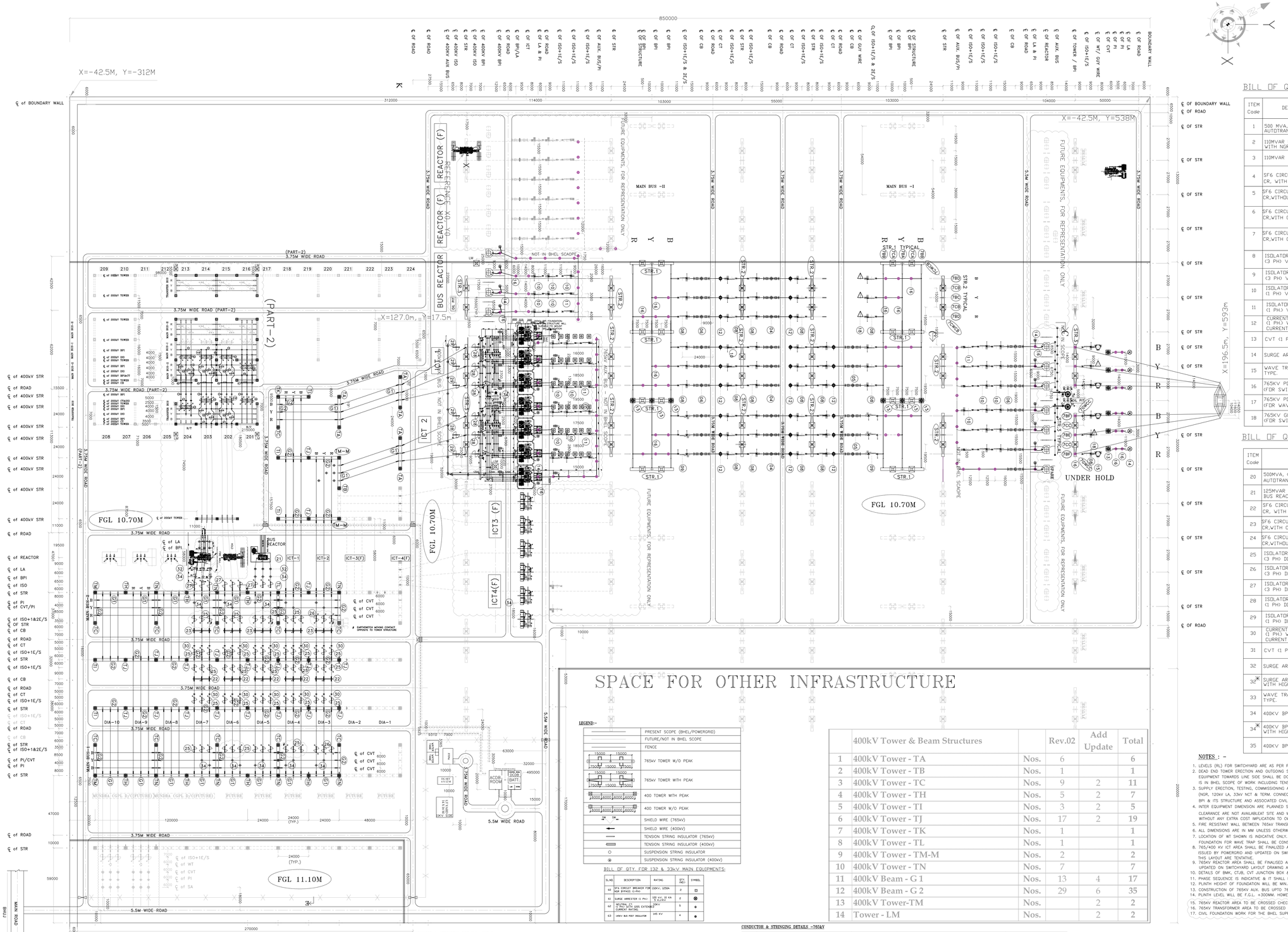



# 400KV SINGLE LINE DIAGRAM




PART-2

# 220KV SINGLE LINE DIAGRAM




# SPACE FOR OTHER INFRASTRUCTURE

LEGEND:-

| | |
|---|---|
| | PRESENT SCOPE (BHEL/POWERGRID) |
| | FUTURE/NOT IN BHEL SCOPE |
| | FENCE |
| | 765kV TOWER W/O PEAK |
| | 765kV TOWER WITH PEAK |
| | 400 TOWER WITH PEAK |
| | 400 TOWER W/O PEAK |
| | SHIELD WIRE (765kV) |
| | SHIELD WIRE (400kV) |
| | TENSION STRING INSULATOR (765kV) |
| | TENSION STRING INSULATOR (400kV) |
| | SUSPENSION STRING INSULATOR |
| | SUSPENSION STRING INSULATOR (400kV) |

BILL OF QTY. FOR 132 & 33kV MAIN EQUIPMENTS:

| SL.NO | DESCRIPTION | RATING | QTY. (NO.) | SYMBOL |
|---|---|---|---|---|
| 60 | SF6 CIRCUIT BREAKER FOR 132KV, 1250A AGR BYPASS (1-PH) | | 9 | |
| 61 | SURGE ARRESTER (1 PH.) | 120 kV, 10 KA 132KV | 9 | |
| 62 | NEUTRAL CT (1 PH) WITH 120% EXTENDED CURRENT RATING. | 33KV | 5 | |
| 63 | 145kV BAS PASS INSULATOR | 145 KV | 4 | |

| | 400kV Tower & Beam Structures | | Rev.02 | Add Update | Total |
|---|---|---|---|---|---|
| 1 | 400kV Tower - TA | Nos. | 6 | | 6 |
| 2 | 400kV Tower - TB | Nos. | 1 | | 1 |
| 3 | 400kV Tower - TC | Nos. | 9 | 2 | 11 |
| 4 | 400kV Tower - TH | Nos. | 5 | 2 | 7 |
| 5 | 400kV Tower - TI | Nos. | 3 | 2 | 5 |
| 6 | 400kV Tower - TJ | Nos. | 17 | 2 | 19 |
| 7 | 400kV Tower - TK | Nos. | 1 | | 1 |
| 8 | 400kV Tower - TL | Nos. | 1 | | 1 |
| 9 | 400kV Tower - TM-M | Nos. | 2 | | 2 |
| 10 | 400kV Tower - TN | Nos. | 7 | | 7 |
| 11 | 400kV Beam - G 1 | Nos. | 13 | 4 | 17 |
| 12 | 400kV Beam - G 2 | Nos. | 29 | 6 | 35 |
| 13 | 400kV Tower-TM | Nos. | | 2 | 2 |
| 14 | Tower - LM | Nos. | | 2 | 2 |

NOTES :-

1. LEVELS (RL) FOR SWITCHYARD ARE AS PER POWER GRID DRAWING NO C/ENGG/WR2/WR-II/BHUJ/SITE LVL-03 REV-02 DATED 09.09.2016
2. DEAD END TOWER ERECTION AND OUTGOING STRINGING OF LINE CONDUCTOR & SHIELD WIRE ARE NOT IN BHEL SCOPE BUT CONNECTION OF EQUIPMENT TOWARDS LINE SIDE SHALL BE DONE BY BHEL. SUPPLY OF TENSION INSULATOR STRING ON LINE SIDE OF TAKE OFF GANTRY IS IN BHEL SCOPE OF WORK INCLUDING TENSION CLAMP FOR EARTHWIRE.
3. SUPPLY, ERECTION, TESTING, COMMISSIONING AND EARTHING OF 765kV TRAFO & REACTOR INCLUDING (OLTC & TERMINAL CONNECTOR OF TRAFO) & (NGR, 120kV LA, 33kV NCT & TERM. CONNECTOR OF REACTOR), FORMATION OF HV, LV, TERTIARY, NEUTRAL & AUXILIARY BUSES ALONG WITH BPI & ITS STRUCTURE AND ASSOCIATED CIVIL WORKS IS NOT COVERED IN SCOPE OF WORK AS PER TS SECTION PROJECT
4. INTER EQUIPMENT DIMENSION ARE PLANNED SO AS TO ACHIEVE REQUIRED PHYSICAL AND ELECTRICAL CLEARANCE. HOWEVER IF ELECTRICAL CLEARANCE ARE NOT AVAILABLEAT SITE AND MODIFICATIONS ARE REQUIRED TO ACHIEVE IT, THE REQUIRED MODIFICATION WILL BE DONE BY BHEL WITHOUT ANY EXTRA COST IMPLICATION TO OWNER.
5. FIRE RESISTANT WALL BETWEEN 765kV TRANSFORMER UNITS AND 765kV REACTORS UNITS ARE NOT IN BHEL SCOPE.
6. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED
7. LOCATION OF WT SHOWN IS INDICATIVE ONLY, EXACT LOCATION SHALL BE FINALIZED DURING ERECTION COMMISSIONING STAGE BASED ON LINE PARAMETERS
8. FOUNDATION FOR WAVE TRAP SHALL BE CONSTRUCTED FOR ALL THREE PHASES IN 765KV AREA.
765/400 KV ICT AREA SHALL BE FINALIZED AFTER RECEVING PROJECT SPECIFIC ICT AREA LAYOUT FROM POWERGRID. HENCE THE SAME SHALL BE ISSUED BY POWERGRID AND UPDATED ON SWITCHYARD LAYOUT DRAWING ACCORDINGLY & ICT INTERCONNECTIONS SHOWN ON THIS LAYOUT ARE TENTATIVE.
9. 765KV REACTOR AREA SHALL BE FINALISED AFTER RECEVING PROJECT SPECIFIC REACTOR AREA LAYOUT FROM POWERGRID. HENCE THE SAME SHALL BE UPDATED ON SWITCHYARD LAYOUT DRAWING ACCORDINGLY & REACTOR INTERCONNECTIONS SHOWN ON THIS LAYOUT ARE TENTATIVE.
10. DETAILS OF BMK, CT/B, CVT JUNCTION BOX & SWITCHYARD PANEL ROOM (SPR) LOCATION SHALL BE SHOWN IN CABLE TRENCH LAYOUT DRAWING.
11. PHASE SEQUENCE IS INDICATIVE & IT SHALL BE VERIFIED AT SITE DURING EXECUTION, ALONG WITH TRANSFORMER LINE.
12. PLINTH HEIGHT OF FOUNDATION WILL BE MIN.300MM FROM FINISHED GROUND LEVEL (F.G.L.).
13. CONSTRUCTION OF 765KV AUX. BUS UPTO 765KV TRANSFORMER AND 765KV REACTOR ARE NOT IN BHEL SCOPE.
14. PLINTH LEVEL WILL BE F.G.L. +300MM. HOWEVER TO MEET BEAM AT SAME HEIGHT, RESPECTIVE PLINTH LEVEL WILL BE RAISED AS REQUIRED.
15. 765kV REACTOR AREA TO BE CROSSED CHECKED WITH TBEA LAYOUT – 1TDEA160SC031 BEFORE PROCEEDING OF CIVIL WORKS
16. 765kV TRANSFORMER AREA TO BE CROSSED CHECKED WITH SIEMENS LAYOUT – SIE-EL-01-BHUJ-102 BEFORE PROCEEDING OF CIVIL WORKS
17. CIVIL FOUNDATION WORK FOR THE BHEL SUPPLIED 765 BPI/LA , 400kV BPI IN 765KV TRANSFORMER / REACTOR SOKE PIT AREA IS EXCLUDED FROM BHEL SCOPE.

| | Lattice Structure for Towers & Beams | | |
|---|---|---|---|
| | **Standard Structures for 765kV** | | |
| a | 7CA column | Nos. | 16 |
| b | 7BB | Nos. | 16 |
| c | 7BA | Nos. | 8 |
| d | 7CB column | Nos. | 26 |
| e | 7BC | Nos. | 13 |
| f | 7BD | Nos. | 26 |
| g | 7GWCB | Nos. | 26 |
| h | 7CC column | Nos. | 8 |
| i | 7BE | Nos. | 4 |
| j | 7BF | Nos. | 8 |
| k | 7GWCC | Nos. | 8 |

## BILL OF QTY. FOR 765kV MAIN EQUIPMENTS (50KA FOR 1 SEC):

| ITEM Code | DESCRIPTION | RATING | QTY. (NO.) (PART-1) | SYMBOL |
|---|---|---|---|---|
| 1 | 500 MVA, (1-PH) AUTOTRANSFORMER | 765/400/33KV | 7 | |
| 2 | 110MVAR LINE REACTOR (1-PH) WITH NGR(550 Ohm). | 765KV | 7 | |
| 3 | 110MVAR BUS REACTOR (1-PH) | 765KV | 4 | |
| 4 | SF6 CIRCUIT BREAKER WITH CR, WITH CSD (3-PH) | 3150A | 3 | |
| 5 | SF6 CIRCUIT BREAKER WITH CR,WITHOUT CSD (3-PH) | 3150A | 2 | |
| 6 | SF6 CIRCUIT BREAKER WITHOUT CR,WITH CSD (3-PH) | 3150A | 5 | |
| 7 | SF6 CIRCUIT BREAKER WITHOUT CR,WITH CSD (1-PH) | 3150A | 1 | |
| 8 | ISOLATOR WITH ONE E/SW (3 PH) VERTICAL KNEE TYPE | 3150A | 17 | |
| 9 | ISOLATOR WITH TWO E/SW (3 PH) VERTICAL KNEE TYPE | 3150A | 2 | |
| 10 | ISOLATOR WITH ONE E/SW (1 PH) VERTICAL KNEE TYPE | 2000A | 33 | |
| 11 | ISOLATOR WITHOUT E/SW (1 PH.) VERTICAL KNEE TYPE | 2000A | 12 | |
| 12 | CURRENT TRANSFORMER (1 PH.) WITH 120% EXTENDED CURRENT RATING. | 3000A | 24 | |
| 13 | CVT (1 PH.) | 9800pF | 12 | |
| 14 | SURGE ARRESTER (1 PH.) | 624 kV | 24 | |
| 15 | WAVE TRAP (1 PH.) PEDESTAL TYPE. | 1mH, 3150A | 04 | |
| 16 | 765KV POST INSULATOR (FOR SWITCHYARD ) | | 69 | |
| 17 | 765KV POST INSULATOR (FOR WAVE TRAP ) | | 12 | |
| 18 | 765KV GUY WIRE (FOR SWITCHYARD) | | 05 | |

## BILL OF QTY. FOR 400kV MAIN EQUIPMENTS:(63KA FOR 1 SEC)

| ITEM Code | DESCRIPTION | RATING | QTY. (PART-1) (NO.) | QTY. (PART-2) (NO.) | SYMBOL |
|---|---|---|---|---|---|
| 20 | 500MVA, (3-PH) AUTOTRANSFORMER. | 400/220/33KV | 0 | 2 | |
| 21 | 125MVAR BUS REACTOR (3-PH) | 420 kV | 1 | 0 | |
| 22 | SF6 CIRCUIT BREAKER WITH CR, WITH CSD (3-PH) | 3150A | 4 | 1 | |
| 23 | SF6 CIRCUIT BREAKER WITHOUT CR,WITH CSD (3-PH) | 3150A | 3 | 2 | |
| 24 | SF6 CIRCUIT BREAKER WITHOUT CR,WITHOUT CSD (3-PH) | 3150A | 0 | 0 | |
| 25 | ISOLATOR WITH ONE E/SW (3 PH) DOUBLE BREAK TYPE | 3150A | 17 | 6 | |
| 26 | ISOLATOR WITH TWO E/SW (3 PH) DOUBLE BREAK TYPE | 3150A | 2 | 0 | |
| 27 | ISOLATOR WITH ONE E/SW (3 PH) DOUBLE BREAK TYPE | 2000A | 1 | 2 | |
| 28 | ISOLATOR WITH ONE E/SW (1 PH) DOUBLE BREAK TYPE | 3150A | 7 | 0 | |
| 29 | ISOLATOR WITHOUT E/SW (1 PH) DOUBLE BREAK TYPE | 3150A | 5 | 0 | |
| 30 | CURRENT TRANSFORMER (1 PH.) WITH 120% EXTENDED CURRENT RATING. | 3000A | 21 | 9 | |
| 31 | CVT (1 PH.) | 4400pF | 6 | 0 | |
| 32 | SURGE ARRESTER (1 PH.) | 336 kV | 3 | 6 | |
| 32* | SURGE ARRESTOR (1 PH.) WITH WITH HIGH LEVEL STRUCTURE | | 7 | 0 | |
| 33 | WAVE TRAP (1 PH.) PEDESTAL TYPE. | 0.5mH, 2000A | 0 | 0 | |
| 34 | 400KV BPI (FOR SWITCHYARD) | 400KV | 24 | 10 | |
| 34* | 400KV BPI (FOR SWITCHYARD) WITH HIGH LEVEL STRUCTURE | | 24 | 0 | |
| 35 | 400KV BPI (FOR WT) | 400KV | 0 | 0 | |

## SYSTEM PARAMETERS (765kV):-

| Sl.No. | DESCRIPTION OF PARAMETER | 765kV SYSTEM | 400kV SYSTEM | 220kV SYSTEM | 36kV SYSTEM |
|---|---|---|---|---|---|
| 1 | HIGHEST SYSTEM VOLTAGE | 800kV | 420kV | 245kV | 36kV |
| 2 | NORMAL SYSTEM VOLTAGE | 765kV | 400kV | 220kV | 36kV |
| 3 | RATED FREQUENCY | 50Hz | 50Hz | 50Hz | 50Hz |
| 4 | NO. OF PHASES | 3 | 3 | 3 | 3 |
| 5 | RATED INSULATION LEVELS | | | | |
| | i) FULL WAVE LIGHTNING IMPULSE WITHSTAND VOLTAGE (1.2/50microsec.) | ±2100kV | ±1550kV | ±1050kV | ±170kV |
| | ii) SWITCHING IMPULSE WITHSTAND VOLTAGE (250/2500microsec.) DRY & WET | ±1550kV | ±1050kV | -- | -- |
| | iii) ONE MINUTE POWER FREQUENCY DRY WITHSTAND VOLTAGE (rms) | 830kV | 630kV | 460kV | 70kV |
| 6 | CORONA EXTINCTION VOLTAGE | 508kV | 320kV | 156kV | |
| 7 | MAX. RADIO INTERFERENCE VOLTAGE LEVEL AT 508kV (rms) FOR 765 kV & AT 320 kV (rms) FOR 400kV. | 2500 micro volts | 1000 micro volts | 1000 mV | |
| 8 | RATED SHORT CIRCUIT CURRENT FOR 1 SEC. DURATION | 50kA | 63kA | 40kA | 25kA |
| 9 | SYSTEM NEUTRAL EARTHING | EFFECT. EARTHED | EFFECT. EARTHED | EFFECT. EARTHED | EFFECT. EARTHED |

## BILL OF QUANTITY – 220kV

SCHEDULE OF EQUIPMENT (OUTDOOR)

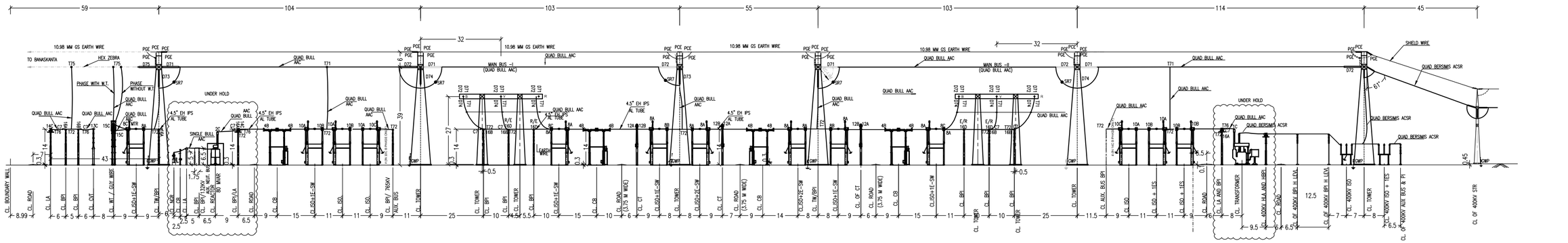
| ITEM CODE | DESCRIPTION | SYMBOL | QUANTITY IN NOS. |
|---|---|---|---|
| 40 | 245kV, 1600A, 40kA/1s CIRCUIT BREAKER (3-Ph) | | 3 |
| 41 | 245kV, 2500A, 40kA/1s CIRCUIT BREAKER (3-Ph) | | 1 |
| 42 | 245kV, 1600A, 40kA/1s HDB ISOLATOR WITH 1E/S (3-Ph) | | 3 |
| 43 | 245kV, 1600A, 40kA/1s HDB ISOLATOR WITH 2E/S (3-Ph) | | 3 |
| 44 | 245kV, 2500A, 40kA/1s HDB ISOLATOR WITH 2E/S (3-Ph) | | 2 |
| 45 | 245kV, 1600A, 40kA/1s HDB TANDEM ISOLATOR WITHOUT E/S (3-Ph) | | 5 |
| 46 | 245kV, 1600A (150/1), 40kA/1s CURRENT TRANSFORMER (1-Ph) | | 3 |
| 47 | 245kV, 1600A (1200/1), 40kA/1s CURRENT TRANSFORMER (1-Ph) | | 9 |
| 48 | 245kV CAPACITIVE VOLTAGE TRANSFORMER (4400 pF) (1-Ph) | | 6 |
| 49 | 216kV SURGE ARRESTER (1-Ph) | | 6 |
| 50 | WAVE TRAP | | 0 |
| 51 | 245kV POST INSULATOR (5.5M HEIGHT) | | -- |
| 52 | 245kV POST INSULATOR (HIGH LEVEL) | | -- |

## CONDUCTOR & STRINGING DETAILS -400kV

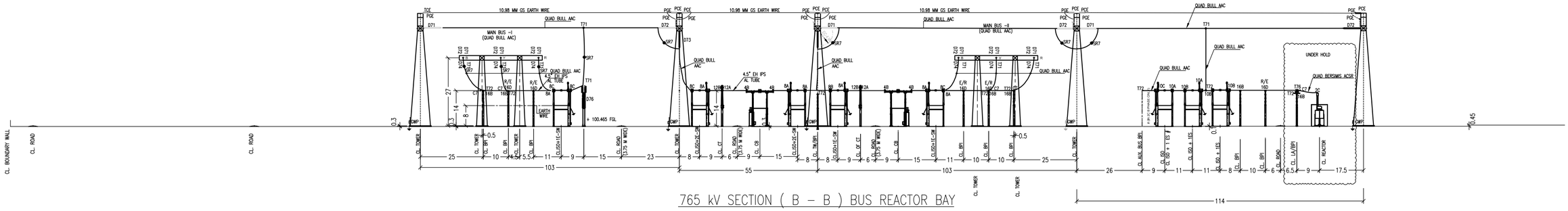
| SL.NO. | DESCRIPTION | LEVEL FROM PLINTH | SUB-CONDUCTOR | TENSION INSULATOR STRING/PHASE |
|---|---|---|---|---|
| 1. | MAIN BUS-I & II | (AT 15M HEIGHT) | QUAD AAC BULL CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING | DOUBLE TENSION 120 kN POLYMER STRING INSULATOR |
| 2. | JACKBUS | (AT 22M HEIGHT) | QUAD BERSIMIS ACSR CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING | DOUBLE TENSION 120 kN POLYMER STRING INSULATOR |
| 3. | DROPPERS/JUMPERING | – | QUAD BERSIMIS ACSR CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING | V TYPE STRING–120kN POLYMER STRING INSULATOR |
| 4. | EQUIPMENT INTERCONNECTION | (AT 8M HEIGHT) | 4.5" IPS AL. TUBE /QUAD ACSR BERSIMIS CONDUCTOR WITH 450MM SPACING | |
| 5. | EARTHWIRE | (AT 29.5M HEIGHT) | 7/3.66mm GI WIRE (10.98mm DIA) | |
| 6. | BUS CVT, CVT & LA IN LINE BAYS | – | TWIN BERSIMIS ACSR CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING | |

## CONDUCTOR & STRINGING DETAILS -765kV

| SL.NO. | DESCRIPTION | LEVEL FROM PLINTH | SUB-CONDUCTOR | TENSION INSULATOR STRING/PHASE |
|---|---|---|---|---|
| 1. | MAIN BUS-I & II | (AT 27M HEIGHT) | QUAD AAC BULL CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING | DOUBLE TENSION 210 kN POLYMER STRING INSULATOR |
| 2. | JACKBUS | (AT 39M HEIGHT) | QUAD AAC BULL CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING | DOUBLE TENSION 210 kN POLYMER STRING INSULATOR |
| 3. | DROPPERS/JUMPERING | – | QUAD AAC BULL CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING | V TYPE STRING–210kN POLYMER STRING INSULATOR |
| 4. | EQUIPMENT INTERCONNECTION | (AT 14M HEIGHT) | 4.5" IPS AL. TUBE (120mm OD)/QUAD AAC BULL CONDUCTOR WITH 450MM SPACING | |
| 5. | EARTHWIRE | (AT 45M HEIGHT) | 7/3.66mm GI WIRE (10.98mm DIA) | |
| 6. | INTERCONNECTION BETWEEN 765/400kV TRAFO TO 400kV SUB-STATION | | QUAD BULL/BERSIMIS ACSR CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING/4.5" IPS AL. TUBE | |
| 7. | EQUIPMENT INTERCONNECTION NEAR 765/400kV ICT AREA FOR HIGH BPI&HIGH LA | (AT 12M HEIGHT) | QUAD BULL/BERSIMIS ACSR CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING/4.5" IPS AL. TUBE | |




765 kV SECTION ( A – A ) LINE AND ICT BAY

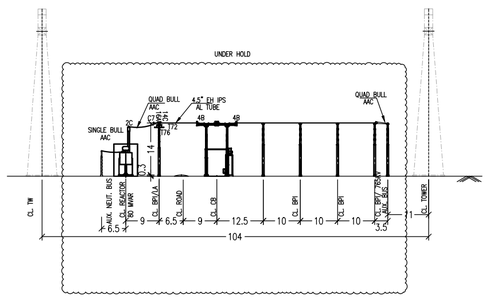



765 kV SECTION ( B – B ) BUS REACTOR BAY

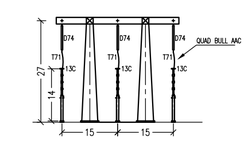

GROUND LEVEL

CLEARANCE TABLE AS PER POWERGRID SPECIFICATION:–

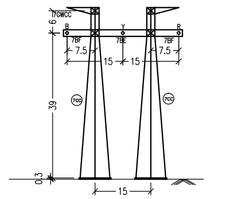
| Sl.No. | DESCRIPTION | 765kV SYSTEM |
|---|---|---|
| 1 | PHASE TO PHASE<br>FOR CONDUCTOR–CONDUCTOR CONFIGURATION<br>FOR ROD–CONDUCTOR CONFIGURATION | 7600mm<br>9400mm |
| 2 | PHASE TO EARTH<br>FOR CONDUCTOR–CONDUCTOR STRUCTURE<br>FOR ROD–CONDUCTOR CONFIGURATION | 4900mm<br>6400mm |
| 3 | SECTIONAL CLEARANCE | 10300mm |
| 4 | MIN HEIGHT OF EQPMT BUS CENTRE LINE ABOVE PLINTH LEVEL | +14000mm |
| 5 | MIN CLEARANCE IN AIR FOR TRANSFORMER & REACTOR<br>A) PHASE TO PHASE<br><br>B) PHASE TO EARTH | 6700mm<br>(FOR BIL–1950 kVp & SIL–1550kVp<br>5800mm<br>(FOR BIL–1950 kVp & SIL–1550kVp |
| 6 | VERTICAL DISTANCE BETWEEN LOWEST PART OF INSULATOR TO PLINTH | 2550mm |




765 kV SECTION (C – C) SPARE LINE REACTOR




TYP. SECTION OF 765KV BUS CVT

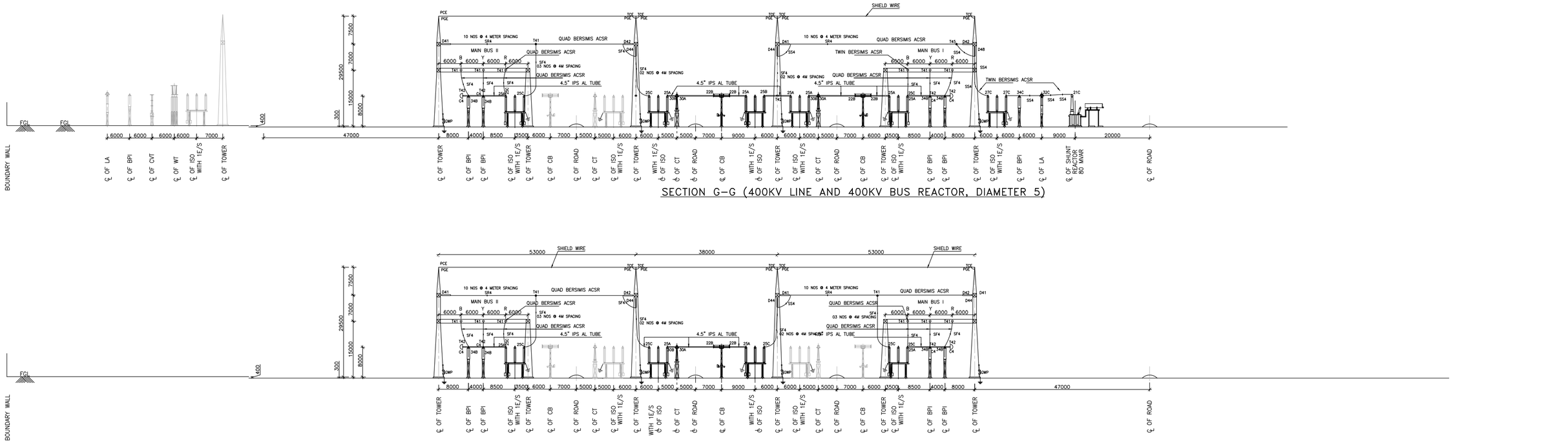



TYP. SECTION OF 765KV LINE END TOWER

REF DRAWINGS :
ELECTRICAL LAYOUT – PLAN TB–385–510–002
SINGLE LINE DIAGRAM : DRG NO. TB–385–510–001

NOTES :
1. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
2. PC = PHASE CLEARANCE, EC = EARTH CLEARANCE SC = SECTION/SAFETY CLEARANCE.

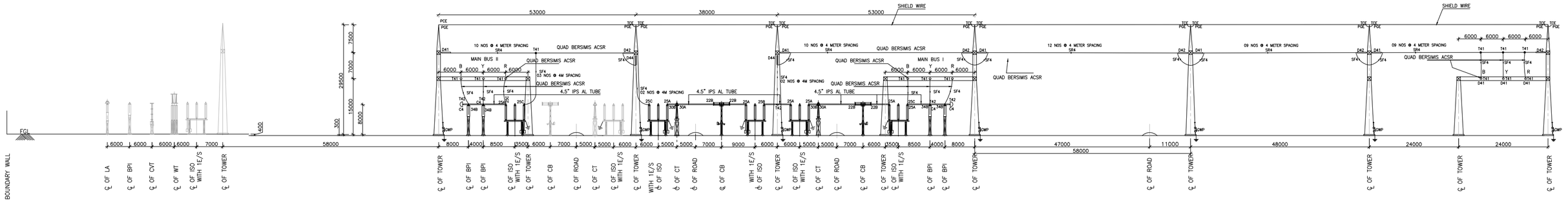
LEGEND :–
PRESENT SCOPE
FUTURE / EXISTING SCOPE



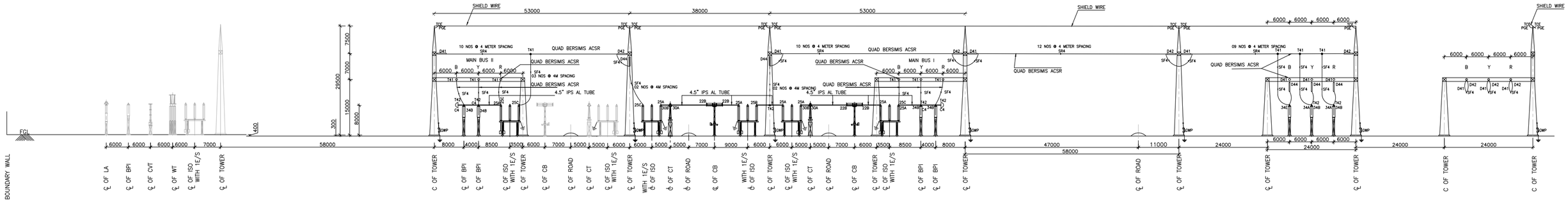

SECTION G–G (400KV LINE AND 400KV BUS REACTOR, DIAMETER 5)



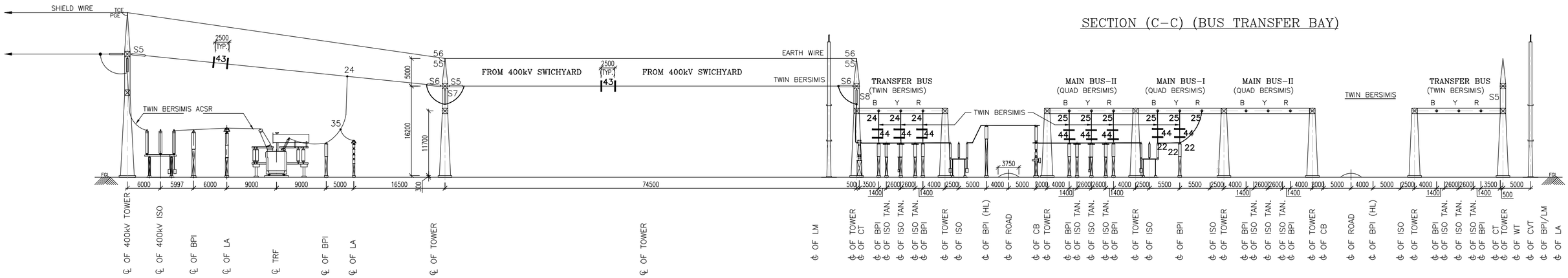

SECTION I–I (400KV LINE AND 400/220KV ICT, DIAMETER 7)



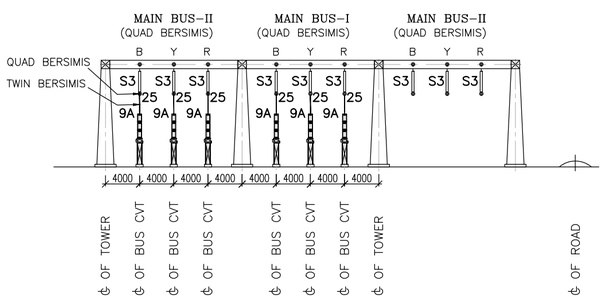

SECTION F–F (400KV LINE AND 765/400KV ICT) DIAMETER 4



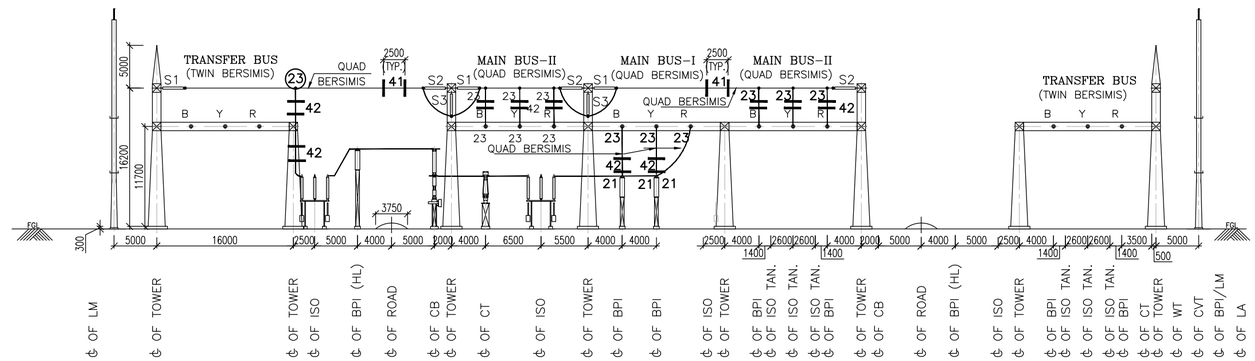

SECTION E–E (400KV LINE AND 765/400KV ICT) DIAMETER 3




SECTION (C–C) (BUS TRANSFER BAY)




SECTION (D–D) (BUS CVT)




SECTION (B–B) (BUS COUPLER BAY)