



BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS GROUP

ENGINEERING MANAGEMENT, NEW DELHI

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SECTION-1

- 1. Scope & Specific Technical Requirements & Bill of quantities**
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1.1 Scope, Specific Technical Requirements & Bill of quantities

This technical specification covers the requirements of Integrated Intelligent Switchyard 3D Modelling & Engineering Solution, hereafter referred as "*Switchyard software solution*" including supply of complete package with all required modules, training and AMC.

Number of licenses required for "*Switchyard software solution*" are given in BOQ. However, the number may increase as per requirement in future during AMC period.

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.

Electrical design of switchyards and 3D modelling for 765/400/220/132/66/33kV Air Insulated Switchyards (including switchyards having GIS).

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

Typical SLD, Layout Plan & Section drawings of a large substation is enclosed in TS. Brief description of required features is as follows:

1.1.1 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 3D modelling software shall have built-in libraries of equipment-models upto 765kV which shall be ready-to-use with minor modification. Bidder is required to develop 100Nos of equipment models exclusively for BHEL. These shall be in addition to already existing library of the bidder. BHEL 3D symbols shall be populated before deployment of the software. 2D drawings of such equipment will be furnished to the bidder after placement of order. Details of such equipment is given in Annexure-A. It is also expected that bidder develops 3D equipment models for BHEL during the Guarantee and AMC period. Number of such models will be approximately 10 Nos each year.

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 any one 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.

1.1.2 Integrated Project Engineering 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.

1.1.3 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 interface and embedding in 3D model of switchyard.

- 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, Transformer, Reactor & NGR 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. Overall Dimensions of the models like height, width, length or diameter etc should be stretchable.

- 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 calculated within "*Switchyard software solution*" using sag algorithm (As per relevant IS/ IEC standard) which shall include temperature compensation. The sag shall accordingly be modelled for catenary curve for accuracy of clearance checks.

- 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 includes high frequency earthing for GIS. Capability required is physical earthmat laying & quantification.
- g. **Customization:** Equipment models (100Nos specific to BHEL) shall be populated in the library before deployment. Output deliverables like reports, bill of materials and 2D extracted drawings shall be customized after placement of order as per BHEL formats.

1.1.4 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. Mechanical clearance essentially means clearance between live-equipment and piping/ duct/ hydrant etc. 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 (DSLPL) 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.

1.1.5 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.

1.1.6 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

1.1.7 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)

Details of workstations, software and operating system (OS) available with BHEL is as follows

- Windows 8 (64Bit)
- SQL 2016
- ORACLE 12C
- AutoCAD 2015
- Workstations with Intel Core i3 processor, 3.6GHz, 16GB RAM

Bidder to ensure compatibility of their solution with above hardware, software and OS and also with their subsequent updation(s), to the extent possible, during warranty/AMC period.

1.1.8 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, fire hydrant piping layout
- EHV/HV cable layout
- Conceptual layout of building
- Road and Drain Layout
- Panel Layout
- Clearance Diagram & Report on Sag Calculatons.
- 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.

1.1.9 Bill of Quantities

Sl. No	Item Description	Unit	Quantity
1	Switchyard Software Solution <i>including customization</i> (Model to be furnished by bidder - perpetual)	License	6
2	Training 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.	Engineers	12
3	Pilot project Project shall be developed by the vendor alongwith BHEL engineers at TBG Noida. Deliverables shall be as per Clause 1.1.8.	Project	2
4	Documentation	Lot	1
5	Annual Maintenance Contract (AMC) after Guarantee period The scope shall include support and updates.	Years	3

- (i) Qty variation shall be +/-30% of contract value
- (ii) Bidder to strictly follow above Un-priced format for quoting

1.2 General Terms and Conditions

The entire work covered in this Tender shall be entrusted to a single vendor satisfying the qualifying criteria.

On-site work shall be carried out at TBG, Noida. Deployment and training shall be at Noida. The developed solution shall be installed on BHEL's Server/computer and its satisfactory operation demonstrated. BHEL reserves the right to ask for replacement of manpower provided by the vendor, in case of unsatisfactory performance.

All the required computer software (Programs, Packages etc) and the hardware (PCs etc) for development of this module have to be taken care of by the bidder. BHEL does not have any spare facilities to be extended for this project.

Office space for vendor's Laptop/ PC for development and support, power, courtesy of tea would be provided by BHEL.

Any software package to be procured by BHEL shall be clearly brought out in the technical & commercial bid. The software package will then be procured by BHEL before final deployment of the software. The software development work will be carried out on the licenses of the bidder till the software package is procured by BHEL or till the development work is over.

1.2.1 Technical Proposal

A detailed technical proposal shall be submitted along with technical offer detailing the following -

1. Approach of work, methodology adopted, list of deliverables with respect to requirements.
2. Assumptions / deviations with respect to the technical specs, if any, and expected technical inputs from BHEL team during the project execution.
3. Working modalities indicating computer systems & manpower proposed to be deployed at BHEL for this project.
4. List of all software programs / packages required to be used for the development of the software modules.
5. Proposed work schedule with duration so that total duration of the project does not exceed time schedule as per NIT.

1.2.2 System Manuals and CDs

Systematic and detailed documentation of all the work done shall be prepared and provided by the vendor. User manuals to facilitate easy operation of the customised solution shall also be prepared and provided. Printed manuals (5 sets) & 2 CDs shall be prepared for the system supplied. A list of manuals shall be submitted for BHEL's approval.

User manual shall be provided to facilitate learning at user-defined pace.

1.2.3 Acceptance Test Procedure (ATP)

Conducting Acceptance Test shall be the responsibility of the vendor. The vendor shall submit the Acceptance Test Procedure document for BHEL's approval.

1.2.4 Guarantee - Technical Support of System Supplied

The developed software shall be guaranteed for trouble-free operation for a period of 24 months from its acceptance and installation at BHEL. In case of any defects observed during the operation of this module during this period, the Vendor shall render their services at no additional cost for rectification of the same.

Scope of technical support shall cover Trouble-shooting and rectification of malfunctioning in the software, fine tuning of software, updating of System documentation and user manuals as well as learning capsule. It shall also include following

1. Ensuring the proper functioning of software solution by providing patches for bug fixing, latest version of software.
2. Testing of patches / updates has to be done in the test environment / lab prior to implementation in the live server.
3. Support for Migration to latest/updated versions of CAD software.
4. Support for current and future versions of window.
5. Maintenance, improvement and clean-up activities of backend.
6. All customization as part of specification being provided by vendor to BHEL TBG shall be covered.

1.3 Payment Terms

Payment shall be made after certification issued by BHEL Project Leader regarding the successful completion of scope of work as per the Payment Milestones defined in the Contract. The BHEL Project Leader shall be specified at the time of award of the Contract to successful Bidder.

Vendor shall submit the invoices to BHEL Project Leader within ten (10) days from the date of successful completion of job.

Payment terms shall be as follows:

Running Bill – 90% of the total value of work done item- wise.

Final Bill - 10 % after completion of total work as per contract agreement (after liquidating all defects).

S.No.	Description of Item/ Activity	Remarks
1.	Switchyard Software Solution	
	Deployment of Licensed Software after customization	50%
	After completion of activity at SN 2 and 3 below	40%
2.	Successful completion of Training at BHEL TBG, Noida	90%
3.	Successful completion of Pilot Project	90%
4.	Documentation	90%

S.No.	Description of Item/ Activity	Remarks
5.	Annual Maintenance Contract	Quarterly Payment

AMC Period: This shall be with effect from completion of total work as per contract agreement and after guarantee period is over (after liquidating all defects)

AMC Clause:

1. Ensuring the proper functioning of software solution by providing patches for bug fixing, latest version of software.
2. Testing of patches / updates has to be done in the test environment / lab prior to implementation in the live server.
3. Support for Migration to latest/updated versions of CAD software.
4. Support for current and future versions of window.
5. Maintenance, improvement and clean-up activities of backend.
6. All customization as part of specification being provided by vendor to BHEL TBG shall be covered under AMC.
7. Report on activities completed by vendor at BHEL TBG as part of AMC has to be submitted at the end of each quarter. List of patches / updates issued by the vendor during the quarter and implementation status at BHEL TBG has to be included in the report.

AMC Payment Terms:

Payment shall be made after certification issued by BHEL Project Leader at the end of each quarter regarding the successful completion of scope of AMC work

1.4 Completion of Contract

Vendor shall deliver the complete scope of work (Customisation, Deployment, Pilot Project and Training) within 3 months from the date of award of Contract and as per the time schedule approved during award of the contract.

The Vendor will use reasonable care and skill in providing the services and will be responsible for the quality of workmanship and accuracy of the deliverables. Vendor shall implement in-house quality control and shall carry out 100% quality checks before submitting to BHEL for acceptance.

The Contract shall be considered successfully completed upon acceptance of deliverables by the BHEL Project Leader.

Vendor will be responsible for adherence to the material movement and security procedures of BHEL. Vendor shall not utilize services of BHEL employees for carrying out contract jobs.

In case of violation of this condition, the contract will be terminated without any notice.

1.5 Technical & Intellectual Property Rights

Vendor shall treat all information that is generated in connection with this assignment as absolutely confidential. All information, analysis, reports and recommendations both in the form of hard copy or on electronic media will be the property of BHEL and must not be used by the vendor for any purpose other than this assignment. All bidders are required to sign non-disclosure agreement with BHEL.

Vendor shall indemnify BHEL any copyright or legal liabilities that may arise in use of the developed software or the methodology / models / techniques used by the vendor in development / implementation of the software module.

All source code as well as other deliverables generated under this works will become the property of BHEL.

Complete confidentiality shall be maintained by the vendor of all information/ documents as well as model data, etc provided by BHEL.

1.6 Training

The vendor shall indicate precise training requirements as per the solution offered. The schedule for training shall be indicated by the vendor and finalised based on mutual agreement between the vendor and BHEL. The vendor shall provide training at BHEL premises.

Complete training Programme including contents and course material etc. shall be approved by BHEL before commencement of training. Course material/book and faculty shall be provided by the vendor.

1. Software training shall be imparted by well-qualified and experienced faculty.
2. Training curriculum shall include training on the complete system including new software (if any) so that the engineers are able to operate the system and generated all the deliverables (design document & Training).
3. Complete training programme including contents and course material etc. shall be approved by BHEL before commencement of training.
4. The training shall be conducted at BHEL Noida.
5. Minimum hardware configuration to be deployed for training, in case hardware is to be provided by the vendor, to be mentioned.

Details of Pilot project shall be given after placement of order. This shall be carried out after conducting training and shall have following number of bays **

- a. 765kV - Two Diameters (One and a half switching scheme)
- b. 400kV - Three Diameters (One and a half switching scheme)
- c. 220kV - Four Bays (Two Main and Transfer switching Scheme)

*** Number of Bays may change*

The bays will have all the equipment/ items viz. Circuit Breaker, Isolator, Current Transformers, Voltage Transformers, Power Transformer, Reactor, Cables, civil items (Trench, Road, Towers, Gantry, foundations etc)

This switchyard shall also have one Control Room Building with Panels and AC Ducts etc. Project shall be developed by the vendor alongwith BHEL engineers. Deliverables shall be as per Clause 1.1.8.

Any correction/ updation required in the offered solution of the bidder, after the conclusion and learnings from Pilot project, will be done by the bidder without any commercial implications.

1.7 Progress Reporting and Review

Fortnightly progress reports shall be submitted by the vendor to BHEL, indicating progress, bottlenecks, resource deployment. Review meetings shall be held regularly with BHEL.

1.8 Time Schedule

A tentative time schedule format for project implementation after placement of order is three months (12 weeks) from the date of LOA. The vendor shall provide a detailed schedule for BHEL's approval.

In the event of placement of order by BHEL, immediately on receipt of order, the vendor shall depute technical personnel with requisite specialisation and experience to interact on collection of inputs, details of existing process, solution proposed, details of formats required etc., finalisation of schedule of customisation, etc.

1.9 Instruction to bidders who wish to submit their offers

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

Offer of bidders 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.	Work Completion Schedule at contract stage (Form 4)
VII.	Technical Proposal as per clause 1.2.1

1.10 DISCLAIMER

The information contained in this document 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 document.

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 document.

Annexure -A

Sl. No	Item Description	Number of BHEL Equipment Models	Attributes (Minimum)
1	Circuit Breaker	8	kV, Creepage
3	Isolators (Disconnectors), Earth Switches	36	kV
2	Current Transformer	7	kV, Creepage
4	Voltage Transformer	8	kV, Creepage
5	Coupling Capacitor	2	kV, Creepage
6	Bus Post Insulators	6	kV, Creepage
7	Lighting Arresters	6	kV, Creepage
8	Power Transformers	6	kV, Number of Windings
9	Reactors	6	kV
10	Capacitor Bank	1	kV
11	Cable Termination Kit	1	-
12	Horn Gap Fuse	2	-
13	Aux Transformer	4	kV
14	Wave Trap	4	mH
15	Others	3	-

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 at least 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: 1) Bidder must submit all supporting documents along with their offer. 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. 3) In case bidder is not OEM of the software, the PQR conditions shall be met by the OEM.	

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) Address: Telephone: Fax: E-mail: Web site:
5	Address of Works: Address: Telephone: Fax: E-mail:
6	Details of marketing agent (For Foreign manufacturer): Address: Telephone: Fax: E-mail:
7	Authorized representative of the company having the Power of Attorney (POA): Name(s): Designation: Address: Telephone: Fax: 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 by whom the Contract was awarded e-mail ID Telephone No. Fax No.	
A4(i)	Name of sub-station or switchyard executed under the Contract	
(ii)	Voltage level of sub-station or switchyard	
(iii)	No. of bays in the sub-station or switchyard	
A5(i)	Date of successful execution of the Contract (<i>enclose completion certificate/taking over certificate</i>)	
(ii)	No. of years the above referred contract is in satisfactory operation as on the date of bid opening <i>"Satisfactory Operation" means Certificate issued by the Employer (End User) certifying the satisfactory operation and usage without any adverse remark</i>	
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:

Signature of the Authorized
representative)

Place:

Name-

(Designation) -

(Company Seal)

Form-4

Work Completion Schedule

S1. No.	Description Work	Period in weeks from the effective date of award of contract
1.	Installation of software with required number of user licenses, documentation, user manuals alongwith required customisation	
2.	Successful completion of Pilot Project	
3.	Training of engineers	

Date:

(Signature)

Place:

(Printed Name)-

(Designation) -

(Company Seal)