BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT
NOIDA

DOCUMENT NO.	TB-PBTU-DTL-GIS-TIKRIKHURD	Rev 00	Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION	NAME	BY	AK	VK
TITLE 400/220/66kV Gas Insulated Switchgear with its accessories		SIGN			
		DATE	24.01.2025	27.01.2025	27.01.2025
		GROUP	TBEM		
		WO No.			

CUSTOMER	Delhi Transco Ltd. (DTL)
PROJECT	Pre Bid Tie up for, Design, Engineering, Supply, Erection, Testing & Commissioning of 400/220/66kV GIS Tikrikhurd Sub-Station with complete civil works & automation on Turnkey Basis.

Contents

Remarks: Bidder to note that data and details of Guaranteed Technical Particulars shall not be reviewed during Technical Evaluation/ Review, hence compliance of Guaranteed Technical Particulars in line with Technical Specification has to be ensured by the bidder.

Rev. No.	Date	Altered	Checked	Approved	
Distribution				To	
				Copies	

SECTION 1: CHECKLIST FOR TECHNICAL EVALUATION

Along with the technical offer/ bids, the bidder should submit this checklist confirming the inclusion of the enclosures as listed below,

Sl. No.	Documents to be enclosed	Bidder to confirm (Please tick "Confirmed")
1.	Supporting documents for compliance of Technical Qualifying Requirement.	Confirmed
2.	Unpriced BOQ duly mentioning "Quoted" for all the items, signed and sealed.	Confirmed
3.	Annexure-A & B duly filled, signed and sealed.	Confirmed

Note: Any bidder not meeting the above requirement is liable for non-evaluation.

The above checklist is reviewed and verified for,

NIT Reference No.:

Name of Bidder:

Name of Project:

Date:

Bidder's Stamp & Signature

Contents

This document covers broader guideline for bidder's scope of supply & services. The same shall be prevailing on all other section of technical specification.

1. SCOPE

This technical specification covers the requirements of (1.) design, type testing, engineering, fabrication, manufacturing, shop assembly, inspection and testing at manufacturer's works, proper packing, supply and delivery to project site, (2.) supervision of material reconciliation, installation / erection, (3.) execution of site testing & commissioning along with necessary kits, tools & equipment , putting GIS with LCC & its Accessories into successful operation complete with all materials, support structures, anchoring bolts, chemical anchor, accessories, commissioning spares & maintenance spares, special spanners, special tools & tackles, any specific required ancillary services, SF6 gas for first filling & spare etc. including design studies, training of BHEL / Customer personnel for offered GIS & its Accessories complete in all respects for efficient & trouble-free operation mentioned under this specification.

The complete technical specification comprises of following sections:

Section-1	:	Scope, Project Specific Technical Specification & Bill of Quantities
Section-2	:	Equipment Specification under scope of Supplies
Section-3	:	Project Details & General Technical Requirements (For All Equipment under the Project)
Section-4	:	Annexures Annexure A- Compliance Certificate Annexure B- Schedule of Technical Deviations

The following order of priority shall be followed. In case of conflict between requirements specified in various documents, the more stringent one shall be followed. BHEL/Customer concurrence shall, however, be obtained before taking a final decision in such matters.

1. Statutory Regulations
2. Section-1(PART-A) Standard Scope Matrix
3. Section-1(PART-B)
4. Section-2
5. Section-3

Bidder shall furnish list of conflicts/ ambiguities/ deviations, if any, along with their technical offer and also furnish the basis that is considered for submitting technical offer. BHEL will address the bidder's listed conflicts prior to award. In case of ambiguity, bidder shall inform BHEL of their interpretation. In case bidder fails to convey the same prior to award, BHEL decision on interpretation shall be considered final if need arises during the execution. No additional cost or extra time on account of conflicts/ ambiguities/ deviations shall be admissible.

In general, no deviation from the requirements specified in various clauses of this specification shall be allowed and hence, a certificate to this effect shall have to be furnished along with the offer (Annexure-A), however bidder shall furnish list of conflicts/ ambiguities/ deviations (Annexure-B), if any.

Please note, any deviation not specifically brought out in Annexure-B (Schedule of Technical Deviations) shall not be admissible for any time and commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer. Any conflicts/ ambiguities/ deviations mentioned elsewhere in technical offer shall not be reviewed.

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the notice inviting tender/ enquiry.

2. SPECIFIC TECHNICAL REQUIREMENTS

Project specific technical requirements shall be as per Section-1 (Part-B) of technical specification.

3. GENERAL TECHNICAL REQUIREMENTS (Part-1 of 2)

1. SF6 gas for initial installation of complete GIS System, including wastage during installation, testing and successful commissioning shall be deemed included in the bidder's scope. Manufacturer to supply additional qty so as to cater the losses during installation, testing & commissioning.
2. The offered GIS with LCC & its Accessories shall be complete in all respect in compliance to technical specification and relevant IS / IEC / IEEE standards as applicable. Any other equipment/material required to complete the specified GIS scope of work are inclusive of bidder's scope of supply & services.
3. All essential and desirable accessories are deemed inclusive of offer i.e. and not limited to Gas Monitoring Devices, Pressure Switches, PD sensors, Pressure relief device, insulator, expansion joint/ flexible, bellows/ compensators like lateral mounting units, Axial compensators, Parallel compensators, tolerance compensators and vibration compensators etc. complete in all respect.
4. Total contract value may vary up to ±20% at contract stage.
5. Any Item not quoted mentioned "**Not Applicable**" in bid price schedule and found applicable as per technical specification and system requirement shall be supplied free of cost by bidder without any time / cost implication to BHEL / Customer.
6. Length & route of GIB is purely indicative and same shall be finalized during detailed engineering stage.
7. BHEL reserve rights to amend Bay sequence during contract stage, no separate claim shall be admissible in this regard.
8. Supply scope of Testing & Maintenance Equipment – Scope of supply of following Equipments shall be applicable exclusively if covered in BOQ / BPS. However same shall not be used for erection/ installation, testing and commissioning of GIS, hence bidder to bring Special Tools &, tackles, Testing & Maintenance Equipment/ Instruments at site for during erection/ installation, testing & commissioning on returnable basis.
    a. SF6 Gas leakage detector
    b. Gas filling and evacuating plant: (Gas Processing unit)
    c. SF6 gas analyser
    d. Portable Partial Discharge(PD) monitoring system
    e. Online Partial Discharge Monitoring System
9. Main Bus 1 / 2 / Transfer Bus etc. Gas Insulated Bus Bars running across the length of the switchgear to interconnect each of the bay modules (as per layout) and necessary interfaces (as applicable under the technical requirement) is

deemed inclusive in the scope. The same may or may not be indicated with break-up in BOQ / BPS.

4. GENERAL TECHNICAL REQUIREMENTS (Part-2 of 2)

Other general requirements GIS with LCC & its Accessories shall be as follows,

1. Guaranteed Technical Particulars: Bidder to submit detailed GTP in line with technical specification during contract stage for review and approval. GTP & drawings submitted with technical bid shall only be reviewed during contract stage only. Bidder to please note, deviations / conflict if any please be mentioned in schedule of technical deviations only.
2. The positioning of the circuit breaker in the GIS shall be such that it shall be possible to access the circuit breaker of any feeder from the front side for routine inspection, maintenance and repair without interfering with the operation of the adjacent feeders.
3. The physical layout shall ensure free movement of the SF6 Gas Cart and easy access to all components of the GIS for operation and maintenance purposes.
4. Bidder shall submit list of consumables with shelf life of less than six months and same shall be dispatched before commencement of erection or after clearance from BHEL/Customer whichever is earlier. No separate dispatch clearance shall be required for consumables. The service activities shall include consumables/ commissioning spares required during commencement of GIS installation, testing and commissioning in all respect. Cost of the same deemed inclusive.
5. Bidder shall offer their latest type tested model to accommodate the specified & allocated space as per attached layout drawing of GIS.
6. Bidder shall conduct insulation co-ordination studies in line with IEC for establishing surge arrester rating, quantity and any other requirement for successful operation of GIS. however, additional supply of surge arrester in line with above required shall be paid as per Bill of Quantity, as applicable.
7. Bidder to submit Study report of VFTO generated for 400kV GIS installation.
8. Bidder shall check and ensure adequacy of system protection for successful operation of GIS. After checking of system by bidder, GIS shall be installed and if any failure, malfunction of any part occurs after/ during commissioning, same shall be replaced immediately without any extra cost.
9. Final documentation shall be submitted in hard copy (Four prints) and soft (Three

CDs/DVDs)

10. In the case if CSD is specifically called in BPS / BOQ / Section-1(PART-B) of technical specifications, the same should have display facility at the front for the display of settings and measured values. In case where CSD does not have complete display facility for settings and measured values, bidder to supply one number laptop PC with pre-installed, licensed software for each site. Special cable required for integration is deemed inclusive in bidder's scope.

11. Complete interfacing with GIS and CSD shall be in bidder's scope. Any additional item like transducer, contact multiplication relay, switches, special/screened cables, modification hardwired, modification in schematics (if any) required for interfacing and for complying to the technical specification requirement shall be in bidder's scope and shall be included in quoted price. No price implication for the same shall be entertained during detailed engineering.

12. Bidder to submit all supporting documents in English. If document submitted by bidder is other than English language, self-attested English translated document should also be submitted.

5. MODE OF MEASUREMENT FOR GIB DUCT

The payment of bus-duct along with support structure shall be paid as per running meters in line with provisions of Technical Specification & Bid Price schedule.

2. Gas Insulated Bus Duct (GIB) length of bus duct outside the GIS BAY MODULE shall be considered for mode of measurement from the end of Bay equipment (VT, LA etc.) to end equipment (SF6 to air bushing / SF6 to oil bushing/ Cable connection module etc.). This includes both indoor & outdoor GIB, including any TEE bends/L bends/ elbows/etc.

3. Any change in bay pitch (distance between bays): In a case where shifting of GIS bays shall be called by BHEL (during contract stage) due to layout requirement / cost optimization / revision / change in civil architectural requirement or due to expansion joint requirement in the GIS building, Bidder to incorporate the same with full compliance of technical requirement. Payment equivalent of BPS / BOQ item under head "Gas Insulated Bus Duct" shall be operated for additional length of Main Bus, subject to such shifting is not attributed to bidder.

6. STRUCTURE & HARDWARE (INCLUDING STRUCTURE STEEL)

Structural Steel, Support Structure, Walkway, Inserts & Hardware (required for installation & operation of complete GIS system with LCC & its Accessories etc.) are deemed inclusive of bidder's scope of supply. The same may or may not be indicated

with break-up in BOQ / BPS.

All steel structure members shall be hot-dip galvanized after fabrication (excluding floor embedded items for which standard practice is to be followed). All field assembly joints shall be bolted. Field welding shall generally not be acceptable. Noncorrosive metal or plated steel shall be used for bolts and nuts throughout the work.

The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above and 900 gm/sq.m for coastal area (if defined in Section-1B / Section-2 of technical specification) For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq.m minimum and **900 gm/sq.m for coastal area** (if defined in Section-1B / Section-2 of technical specification).

1. Lattice / Pipe structure Materials for support of GIS, Bus Ducts, SF6 to oil bushing/ SF6 to cable connection and SF6 to air bushing/ connection including Anchor Fastener Bolts, Foundation Bolts, Base Plate / Channel / Metallic / Structural Member for seating of GIS system, all floor and wall Embedded Items, wall crossing arrangements, Rails and/ or other items structural items as required. Manufacturer shall provide suitable foundation channels and anchor bolts to support the switchgear assemblies. All mounting bolts, Anchor Fasteners, foundation bolts, nuts and washers, equipment fixing hardware shall be provided to fasten the switchgear base frames to the foundation channels as applicable
2. Chemical / Mechanical Anchors Bolts are to be provided by bidder for GIS, GIB & SAB.
3. The GIS Equipment shall be complete with all necessary supports, ladders, galleries, staircases, catwalks, movable platforms or walkways (for accessing the equipment above two meters for maintenance and operation), mechanism cabinets, internal cable raceways etc. for each bay and it shall be of modular construction and extendable design.
4. Structural steel for complete GIS system with LCC & its Accessories is deemed inclusive in bidder's scope of supply.

7. EARTHING MATERIALS OF GIS

1. Earthing material of GIS are deemed inclusive of bidder's scope of supply. The same may or may not be indicated with break-up in BOQ / BPS.
2. Bidder to submit detailed calculations and layout drawings for earthing system during detailed engineering stage based on technical specification, bidder's design philosophy, IS/IEC/IEEE requirement as applicable. Bidder to provide the bill of quantity of entire GIS system with LCC & its Accessories
3. Supply of 40 mm MS ROD, 75X12 mm GI Flat, 50X06 mm GI Flat is not in bidder's scope of supply.

4. **COPPER GROUNDING MESH FOR GIS**: Bidder to consider scope of Copper Flat & hardware supply as follows

A. If Requirement is called in Technical Specification	
a. Bidder's Scope of Supply	If covered in BOQ / BPS.
b. Not in Bidder's Scope of Supply	If not covered in BOQ / BPS.
c. In case COPPER GROUNDING MESH concluded as Not in Bidder's Scope of Supply (i.e. BHEL scope of supply) : Copper Riser Connection for GIS equipment Shall be brought approximately **200** mm above the FINISHED FLOOR LEVEL shall be supplied by BHEL. Onward earthing connections for GIS equipment shall be in the scope of the bidder.	

B. If Requirement is not exclusively called in Technical Specification but required as per manufacturer's design	
a. Bidder's Scope of Supply	Required, even if a separate BOQ / BPS item is not indicated.

1. **All** other materials, including onward risers, earthing materials, hardware (nuts, bolts, washers, lugs, etc.) required as per the earthing design, shall be included in the GIS Manufacturer's scope of supply. However, the installation/erection of earthing will be carried out by the BHEL team under the supervision of the bidder/manufacturer, in accordance with the manufacturer's design.
2. Installation/ erection/ laying of earthing system for GIS shall be done by BHEL/ its contractor, however, supervision shall be provided by bidder as per approved design philosophy.
3. Special requirement for earthing (as mentioned in Section-2) shall be duly taken

care while designing the earthing system for GIS and its associated system.

Remark:- BPS: Bid Price Schedule & BOQ: Bill of Quantity with TS

8. INTERNAL CABLES

1. Power, control & instrumentation cables for **Cabling** (1.) within GIS, (2.) GIS to LCC, (3.) LCC to LCC (excluding incoming power cable) shall be deemed inclusive in bidder's scope of supply. The same may or may not be indicated with break-up in BOQ / BPS.
2. Scope includes for completeness for GIS system with LCC & its Accessories
3. Cabling between LCC to LCC shall be applicable if required in bidder's design philosophy.
4. Cables required for bidder supplied GIS sub-system i.e. condition monitoring system (Gas monitoring system, PD monitoring system etc) are to be supplied by bidder as complete system.
5. Necessary Cable Lug, Glands & shroud etc. required for installation of bidder's supplied cable are deemed inclusive in bidder's scope.
6. Bidder to provide detailed "Bill of Quantity" during detailed engineering stage. Cabling & termination schedule for the same shall be provided by successful bidder along with AS BUILT drawing during contract stage.
7. Power Cable TB's (for both AC & DC incoming feeder cables) shall be suitable for termination of requisite cable.

9. DRAWINGS / DOCUMENTS FOR MANUFACTURING CLEARANCE

The drawings/ documents, as follows shall be used for providing technical clearance for manufacturing of GIS and furthermore, it shall be used for delay analysis, if any, from bidder. The first drawing submission will be counted from the date of submitting reasonably correct drawings.

Sl. No.	Overall Drawings approval required in Cat I /Cat II
LOT-1	
1	GIS- Gas Schematics with Single Line Diagram (Including CT VT

	Parameters)
2	GIS- Guaranteed Technical Particulars (Including all GIS equipment)
3	GIS- Layout Plan & Section
4	GIS- Interfacing Drawings for Cable Connection Module / SF6 to Air Bushing / SF6 to Oil Module (as applicable under scope) with Guaranteed Technical Particulars
5	GIS- Type Test Reports (Including all GIS equipment)
6	GIS- Quality Assurance Plan & Inspection Test Schedule
LOT-2	
7	GIS- Secondary Engineering Base Design & Control Schematics for GIS and Local Control Cabinet
8	GIS- Maintenance Equipment Catalogue with Guaranteed Technical Particulars, test reports
9	GIS- Civil Design Specification with Foundation Loading Diagram (Including interfacing details)
10	GIS – Support Structure, Platform, Wall & Floor Inserts & Hardware drawing & BOM
11	GIS- Earthing Layout with Design
12	GIS- Quantification for main Items, Spares, Consumables
13	Design Calculations (Having interface on GIS Manufacturing)
OTHER	
14	GIS- 3D OGA Drawing (3D-Model with complete editable data base) compatible with Autocad & Primtech for complete GIS & its accessories.
15	Manuals on unloading, safe storage, transportation, installation, testing, commissioning, routine check, preventive maintenance

10. TYPE TEST

Please refer Section-1(PART-B) and Section-2 of technical specification for the details of type test requirement. All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine & acceptance tests in accordance with requirements stipulated under respective sections of technical specification.

11. QUALITY PLAN

Bidder to follow valid customer approved (1.) Manufacturing Quality Pan, (2.) factory acceptance test (FAT) procedure & (3.) Site acceptance test (SAT) procedures, as per Customer procedure. In case the bidder doesn't have Customer approved Quality Plan, it will be the bidder's responsibility to get its Quality Plan approved from the ultimate Customer within 30 days from the date of issue of after award of LOI / PO whichever is earlier.

All materials shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved quality plan. The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of the specification.

GIS and its associated materials shall be subject to inspection by BHEL/ Customer / authorized representative at bidder / manufacturing works. Hence, Bidder shall furnish all necessary information concerning the supply to BHEL. During fabrication, the equipment shall be subject to inspection by BHEL/ Customer or by an agency authorized by BHEL/ Customer to assess the progress of work as well as to ascertain that only quality raw material is used.

12. SITE SERVICES

Site service activities shall be carried out at in stages as per requirement or front availability at site, and hence multiple visits for completion of work are envisaged as per site requirements hence any claim in this regards shall not be admissible on account of multiple mobilization or idling during project execution stage.

12.1. SUPERVISION AT SITE

1. Supervision of complete installation / erection of GIS with LCC & its Accessories are in the scope of bidder.
2. Scope also includes verification of materials for proper storage with due

instructions/ training to site persons for long storage.

3. Standard storage instruction manual specifically specifying the item detailed with details of type of storage.
4. Supervision for reconciliation and spares / accessories and handing over to customer.
5. Final documentation including AS BUILT documents

12.2. TESTING & COMMISSIONING

1. The complete GIS System shall be subjected to the site tests as per technical specifications, IEC-62271-203. Bidder to submit site acceptance testing (SAT) procedures and get the same approved from BHEL / Customer before carrying out the site testing at site.
2. Carrying out successful HV/ Power Frequency Testing of GIS as per IEC shall be in scope of bidder, which includes HV test kit with operator, accessories & tools required for completion of HV testing. Bays may be commissioned separately.
3. BHEL shall provide extend support and assistance at site for smooth conduction of HV Testing including unloading, assembling of HV test kit, dismantling, packing & loading back for transportation.
4. Complete Field testing and commissioning of GIS system with LCC & its Accessories are under the scope of Bidder.
5. Bidder supplied special equipment, T&P if required OEM supervision, the same is to be arranged by bidder, cost of the same shall be deemed inclusive of respective item.
6. Bidder/ OEM shall coordinate with manufacturers of other equipment wherever required and shall freely and readily supply all technical information for this purpose as and when called for.
7. ETC work schedule for all the GIS may vary according to readiness of site. Respective dates for the commencement of erection, testing and commissioning activities of GIS shall be communicated to manufacturers from time to time as per the readiness of site.

13. TESTING KITS, TOOLS & TACKLES

1. All the Instruments/ Testing kits including HV Test Kit, SF6 Gas handling Equipments required for successful installation, testing, commissioning, maintenance of offered GIS are to be arranged by bidder on **returnable** basis. Cost of the same shall be deemed inclusive in the offer.
2. Special tools & tackles for installation, maintenance, testing & commissioning of GIS shall be in bidder's scope, it shall be brought at site on **returnable** basis only.
3. The general Tools and Tackles shall be provided by BHEL, list of the requirement i.e. general tools-tackle, spanners, gauges, slings and other lifting devices, crane, welding machines, drills, general instruments and appliances necessary for the installation of GIS is to be submit by bidder along the technical bid. In case bidder fails to convey the same along with technical bid, BHEL decision on interpretation of general tools tackle shall be considered final and any tools & tackles required shall be brought at site by bidder without any claim.
4. Bidder to furnish detailed BOQ for non-returnable special Tools and Tackles, if applicable along with unit prices to be handed over to ultimate customer. The prices for the same shall be considered during evaluation.

14. SPARES

1. Any equipment which is not supplied as main equipment or part of main equipment, mandatory spare for that is not applicable.
2. In case contractor offers circuit breaker, dis-connector, current transformer, SF6/Air Bushing etc. under main equipment of higher rating than equipment rating specified in the specifications, the mandatory spare of same higher rating offered by contractor identical to main equipment offered in the package shall be required to be supplied against spares without any cost implication.
3. The Mandatory Spares shall be included in the bid proposal by the bidder. The prices of these spares shall be given by the Bidder in the relevant schedule of Bid Price Schedule and shall be considered for evaluation of bid. It shall not be binding on the Employer to procure all of these mandatory spares.
4. The bidder is clarified that no mandatory spares shall generally be used during the commissioning of the equipment.
5. Start-up & Commissioning spares are included in bidder’s scope of supply and

shall be included in the base price. Adequate stock of start-up & commissioning spares shall be made available at the site such that the start-up and commissioning of the equipment /systems, performance testing and handing over the equipment/ systems to the Purchaser can be carried out without any hindrance or delays. The unutilized Start-up & Commissioning spares brought for commissioning purpose by bidder shall be taken back by the bidder.

6. Wherever spares in BPS / BOQ/Technical Specification have been specified as "each type/each rating/each type & rating": If the offered spare/spares is sufficient to replace the respective main equipment of all types/ratings, then such offered spare/spares shall be acceptable. It implies that common spare/spare set fulfilling the spare requirement of all types/ratings shall also be acceptable, provided it is configurable at site itself without special assistance of OEM.
7. Mandatory Spares, wherever mentioned, are envisaged for the equipment/items being supplied under the main equipment heads under present scope meeting the requirements of Technical Specifications. The component/sub-component of an equipment/item specified in BPS / BOQ under Mandatory Spare, which is not applicable as per the offered design of respective main equipment, shall not be referred to.
8. Bidder to submit price break-up of spares during tender stage. It shall not be binding on the BHEL to procure all of these mandatory spares.
9. Bidder/ vendor shall ensure the availability of spare parts and maintenance support services for the offered equipment at least for 15 years from the date of supply. Bidder shall give a notice of at least one year to the Customer & BHEL (both) before phasing out the products/spares to enable the owner for placement of order for spares and services.

15. PACKING AND DISPATCH

1. The equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and for any damage during transportation, transit and storage. Packing of the equipment shall be suitable for long storage (minimum 1 year).
2. The GIS transport units shall be shipped in the largest factory assembled units within transport and loading limitations and considering handling facilities on site to reduce the erection and installation work on site to a minimum. Where possible all items of equipment or factory assembled units shall be boxed in substantial

crates or containers to facilitate handling in a safe and secure manner.

3. Each individual piece to be shipped, whether crate, container or large unit, shall be marked special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., and other details as per purchase order & technical specification.
4. The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains and high ambient temperature.
5. Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the equipment of which each gas section shall be sealed and pressurized prior to shipping. Dry nitrogen/air or dry SF6 gas (in full compliance to technical requirement) shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment.
6. All blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site shall be provided. Any seals, gaskets, `0' rings, etc. that will be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Vendor to provide quantity of components accordingly considering permanent installation and commissioning.

16. SPECIFIC- EXCLUSIONS (NOT IN BIDDER'S SCOPE)

The following items are specifically excluded from the bidder's scope of supply & services, irrespective of the same if covered under any section of technical specification other than Section-1 (PART-B). If specific requirement mentioned in the Section-1(PART-B) of technical specification shall overrule this specific exclusion.

1. Any scope of supply / services mentioned in Section-2 or Section-3 of technical specification but not having any relationship with GIS, LCC & its Accessories and not covered in Section-1(PART-B) or BPS / BOQ shall be deemed excluded from bidder's scope.

2. Installation / Erection of GIS with LCC & its Accessories except supervision work.
3. Cable laying & terminations, however supervision work & termination of special cables shall be in bidder's scope.
4. Open & Closed stores at site. (Bidder to provide space requirement in tech bid)
5. Local transportation/ conveyance for bidder's engineers shall be arranged by BHEL between local stay and site.
6. Office assistance shall be provided BHEL including sitting facility etc.
7. Receipt & unloading of material at site except supervision work
8. Terminal connector for SF6 to Air Bushing to conductor or any other interfacing equipment.
9. Watch & Ward of GIS material at BHEL Store
10. Civil Works i.e. GIS Hall, civil works requirement for GIS System. (Please refer clause "Structure-Steel" for bidder's scope of supply)
11. EOT crane, Air Conditioning & Ventilation System, Illumination System & Fire detection & alarm system, however complete input shall be provided for EOT and other system
12. Control Relay & Protection Panels, Numerical Relays, Bus Bar Protection Panel, SAS & ECS system, ACDB, DCDB, Battery & Charger
13. Earthing material i.e. 40 mm MS Rod, 50X6 GI Flat & 75X12 GI Flat for earthing
14. Outdoor AIS Equipments
15. Power & Control cable beyond LCC towards ACDB, DCDB, CRP, SAS etc
16. BHEL / Customer / BHEL appointed 3rd party inspector travel, lodging & boarding charges during testing / inspection.

Rev Number	Date	Initiated by	Reviewed by	Approved by	Updates
Rev.0	19 Feb 2022	JAIK	SKS	AG	
Rev.1	04 March 22	JAIK			Clause 4.1 revised Clause 3.9 added Clause 5 900 gm/sq.m for coastal area
Rev.2	09 March 22	JAIK			Clause 5 updated (yellow highlight)
Rev.3 & 4	22 March 24	JAIK / DKS			Clarification on Copper Grounding Mesh. Ref clause 2.10 & other clauses
Rev.5	07/10/2024	JAIK/DKS			

This technical specification is required for Pre-bid tie-up before participation in the following tender:

Name of the Customer	Delhi Transco Ltd. (DTL)
Name of Main Contractor	Bharat Heavy Electricals Limited
Name of the Project/ Tender	Pre-Bid Tie up for, Design, Engineering, Supply, Erection, Testing & Commissioning of 400/220/66kV GIS Tikrikhurd Sub-Station with complete civil works & automation on Turnkey Basis.
Locations	Tikri Khurd, Delhi

[1] SPECIFIC TECHNICAL PARAMETERS

1. Please refer **Section 1/ Section 2** for Specific Technical Parameters.

[2] BILL OF QUANTITIES

1. Please refer following Annexures for Bill of quantities: **ANNEXURE_BOQ_GIS_TIKRIKHURD**
2. During tender stage, no of GIS bays may vary and hence it shall be finalized after receipt of firm order from Customer.

[3] SPECIFIC TECHNICAL REQUIREMENTS

1. Please follow Project specific requirements, as detailed in document **Annexure: Section Project.**

2. Technical Specification of GIS shall be as per **Section-2.**

[4] OTHER TECHNICAL REQUIREMENTS for GIS WITH ITS ACCESSORIES

1. Factor of safety for design of equipment structures and foundations shall be as below:

    a. Factor of safety for design of equipment structures shall be 1.5 under normal condition and 1.2 under short-circuit condition.
    b. Factor of safety for design of equipment foundation shall be 1.5 in both normal and short circuit condition as per IS 456.
    c. Factor of safety for stability of equipment foundation like overturning shall be 2 (without wind or seismic), 1.5 (with wind or seismic) for normal and short circuit condition as per IS 1904."

2. LT Auxiliary Supply

    a. AC 415 V (± 10%), 50Hz (± 5%), 3 phase, 4 wire solidly earthed
    240 V (± 10%), 50Hz (± 5%), 1 phase, 2 wire solidly earthed
    b. DC 190 V to 220 V, DC, 2 wire, isolated

50 V, DC, 2 wire, positive earthed

[5] TECHNICAL QUALIFYING REQUIREMENTS

The Technical Qualifying Requirement/ criterion shall be as per **Annexure-Technical Qualifying Requirement.**

Bidder to submit complete supporting documents required for technical qualifying requirement along with technical bid.

[6] TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

The offered GIS equipment shall conform to the type tests as per IEC-62271-203. Contractor shall submit type test reports for the following type tests & additional type tests.

1. Tests to verify the insulation level of the equipment and dielectric test on auxiliary circuits
2. Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit
3. Tests to prove the ability of the main and earthing circuits to carry the rated peak and rated short time withstand current.
4. Tests to verify the making and breaking capacity of the included switching Devices.
5. Tests to prove the satisfactory operation of the included switching devices.
6. Tests to prove the strength of the enclosures.
7. Gas tightness tests.
8. Tests on partitions.
9. Tests to prove the satisfactory operation at limit temperatures
10. Tests to assess the effects of arcing due to internal fault
11. Verification of the degree of protection of the enclosure
12. Tests to prove performance under thermal cycling and gas tightness tests on Insulators.
13. Additional tests on auxiliary and control circuits
14. Reactor current switching test for Reactive Current switching capability as per Clause 6.4.1.
15. Test to demonstrate the Power frequency withstand capability of breaker in open condition at lock out pressure
16. Electromagnetic compatibility tests (if applicable)
17. Radio inference voltage tests

The test reports of the above type tests for GIS (including type test report on Circuit breaker, Disconnect Switch, Grounding switches, Current and Voltage transformers as per relevant IEC and type tests of SF6/ Air & Oil bushing as per IEC 60137, if applicable shall be submitted for approval as per **Section 3 GTR, Section 2 Technical Specification.**

The validity of type test reports shall be as per the latest CEA guidelines for the validity period of type test(s) conducted on major electrical equipment in Power Transmission system. In case the item/equipment is not listed in the CEA guidelines, the validity of the respective items/ equipment shall be as per TS.

Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost and delivery implication to BHEL/ customer.

Note:
Type test report shall be reviewed for approval in detailed engineering stage only. However, for evaluation purpose, the test reports are to be submitted along with the technical bid.

[7] ENCLOSED DOCUMENTS WITH SECTION-1

1. SECTION PROJECT
2. BILL OF QUANTITIES
3. DESCRIPTION OF GIS BAY MODULE & EQUIPMENT
4. Technical Qualifying Requirement for Annexure-TQR
5. Tentative Layout & SLD of 400/220/66kV Switchyard

SECTION-I

PROJECT

1.0 GENERAL

Preamble:

1.1 Delhi Transco Ltd. hereinafter termed as DTL or Owner/Purchaser is a company incorporated under Company Act 2013, fully owned by govt. of NCT of Delhi.

1.2 Delhi Transco Ltd. (DTL) is State Transmission Utility and responsible for Bulk Power Transmission of Electrical Energy in National Capital Delhi.

1.3 Delhi Transco Ltd. (DTL) is now establishing 400/220/66kV Gas Insulated Substation at Tikri Khurd, Delhi (India).

2.0 INTENT OF SPECIFICATION:

2.1 The specification covers the design, engineering, manufacture, fabrication, testing at manufacturers works, delivery, unloading at site, storage, erection, testing and commissioning at site of the complete 400/220/66kV switchyard including indoor SF6 gas insulated metal enclosed switchgear (GIS), 400/220/33kV - 500MVA Transformers, 220/66/11kV -160 MVA Transformers & 125 MVAR Shunt reactor with fire protection system (NIFPES) and associated civil works, Lightning Arrestors, Integration and Connectivity of 500MVA, 160MVA 220/66/11kV Power Transformers & 125MVAR Shunt Reactor with GIS Transformer Bays along with associated equipments and associated works. Substation Automation with Relay & Protection, CCTV and remote monitoring, optical fiber equipments & Communication (Converter) Equipments, FOTE, associated civil works, internal roads, drains, necessary buildings etc and other electrical and mechanical auxiliary systems on turnkey basis. The Bus Duct/cable connection should be such that it is possible to remove transformer for repair/maintenance conveniently. Bidder shall also ensure GIS compatibility for line feeder/cable termination and provide the ancillary equipment required for the same. 11kV switchgear along with cable and room for Discom (if required) shall be in the scope of Bidder.

2.2 The supply will include all supporting structures, auxiliary equipments, mechanical linkages, hydraulic piping (if applicable) for control devices with pumps, SF6 gas piping, auxiliary circuits wiring, interlocking devices, current and voltage transformers, cable end boxes and SF6 bus ducts.

2.3 It is the intent of this specification to describe primary features, materials, and design & performance requirements and to establish minimum standards for the work.

2.4 The specification is not intended to specify the complete details of various practices of manufactures/ bidders, but to specify the requirements with regard to performance, durability and satisfactory operation under the specified site conditions.

3.0 SCOPE OF WORK

I. 400 kV SYSTEM

The new 420kV SF6 Gas Insulated Switchgear shall have sectionalized double bus bar arrangement as under:

S No.	Bay Description	Quantity in Nos.
1.	Transformer bay	05 (including 01 no future bay)
2.	Reactor bays	01
3.	Feeder bays	08
4.	Tie Bay	07
5.	Bus Section Bay	02

The SF6 gas insulated switchgear rated for 400kV, three 1-phase, 50 Hz shall be of indoor metal-enclosed Double Bus Bar type, comprising of following items:

(A) Double bus bar arrangement, three 1-phase (isolated) units, 4000A SF_6 gas insulated, metal enclosed bus bar, each bus comprising of:

a. Metal enclosed Bus bars each enclosed in three individual bus enclosures running along the length of the switch gear to interconnect each of the circuit breaker bay modules.
b. Three single phase voltage transformers/PTs.
c. One 3- phase, single pole, group operated isolator/disconnector switches, complete with manual and motor driven operating mechanisms.
d. Two 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
e. GIS duct with gas monitoring devices, barriers, pressure switches, UHF based partial discharge measurement sensors etc. as required.
f. Local control cubicle (if required).

(B) Tie Bay Module, each comprising of :

a. One 3150 A, 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.
b. Three Nos, 1-Phase, 5-core, multi ratio, current transformers on one side of circuit breaker.
c. Three Nos. 1-Phase, 5-core, multi ratio, current transformers on other side of circuit breaker.
d. Two 3- phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
e. Four 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
f. GIS duct with gas monitoring devices, barriers, pressure switches, UHF based partial discharge measurement sensors etc. as required.
g. Local Control Cubicle (if required).

(C) Transformer Circuit Breaker Bay Modules, each comprising of:

a. One 3150 A, 3-phase, SF_6 gas insulated circuit breaker, complete with operating mechanism.
b. Three, 5-core, single phase current transformers.
c. Three 3-phase, single pole, group operated isolator switches, complete with manual

and motor driven operating mechanisms.

d. Three 3-phases, single pole group operated safety grounding switches, complete with group operated manual and motor driven operating mechanisms.
e. Gas insulated terminal connection for connecting transformer with GIS through SF6/Air bushings, SF6 bus duct etc. to complete transformer bay module.
f. GIS Bus duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc as required.
g. Local control cubicle (if required).

(D) Reactor Circuit Breaker Bay Modules, each comprising of:

a. One 3150 A, 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.
b. Three, 5-core single phase current transformers.
c. Three 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
d. Three 3-phases, single pole group operated safety grounding switches, complete with group operated manual and motor driven operating mechanisms.
e. Gas insulated terminal connection for connecting reactor with GIS through SF6/Air bushings, SF6 bus duct etc. to complete reactor bay module.
f. GIS Bus duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc as required.
g. Local control cubicle (if required).

(E) Feeder Circuit Breaker bay modules, each comprising of:

a. One 3150 A, 3-phase, SF6 insulated circuit breaker, complete with operating mechanism.
b. Three 5-core single phase current transformers.
c. Three 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
d. Two 3-phases, single pole group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
e. One 3-phase, single pole, high speed fault make grounding switch, complete with group operated manual and motor driven operating mechanisms.
f. Three single phase voltage transformers/ PT.
g. Three single phase, surge arresters.
h. Gas insulated terminal connection for connecting Overhead line with GIS through SF6/Air bushings, SF6 bus duct etc. to complete feeder bay module.
i. GIS duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
j. Local control cubicle (if required).

(F) Bus Sectionalize Bay Module, each comprising of:

a. One 3150 A, 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.
b. Three Nos, 1-phase, 5 core, multi ratio current transformers on one side of circuit breaker.
c. Three Nos, 1-phase, 5 core, multi ratio current transformers on other side of circuit breaker.
d. Two 3- phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
e. Two 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
f. GIS duct with gas monitoring devices, barriers, pressure switches, UHF based partial discharge measurement sensors etc. as required.

g. Local Control Cubicle (if required).

(G) 420kV, 3150A, 63kA for 1 Second, SF6 Gas insulated Bus Duct (GIB) for Line/Transformer/ reactor feeder modules outside GIS hall with support structure (along with Gas monitoring devices, barriers, pressure switches UHF based partial discharge measurement sensors etc. as required) and SF6/Air bushing for interconnecting it with respective overhead gantry/ equipment.

(H) The connection of 500MVA, 400/220/33kV Transformer (400kV side), feeders and 125MVA Reactor shall be through GIS Duct / SF6 Air Bushing. The connection of the 220kV side of the 500MVA Transformer shall be through Double run cable including indoor/ outdoor termination.

(I) Scope of work also includes 390kV Gapless Surge Arrestor with surge/discharge counter along with ampere meter, suitable terminal connectors, corona ring etc., 400kV BPI with corona ring, steel for support structure for surge arrester, Gantry structure etc. and 4" IPS aluminum tube along with fitting and ACSR Bersimis conductor for connecting equipments.

(J) The Switchgear shall be complete with all necessary terminal boxes, SF6 gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment and piping, support structures and UHF based partial discharge measurement sensors, etc.

(K) Scope of work also include supply, ETC of 390kV outdoor LA for 4x500MVA transformer, 8x400kV Feeder and 01x125MVAR Reactor are required to complete the connections.

(L) Scope of work also include supply, ETC of SF6 to air bushing is required for 5x500MVA Transformer Bay, 8x400kV feeder bay and 01x125MVA Reactor Bay to complete the GIS bay.

II. 220kV SYSTEM

The 245kV SF6 gas insulated switch gear shall have Sectionalized double bus bar arrangement as under:

S No.	Bays Description	Quantity in Nos.
1.	500 MVA Transformer I/C bays	05 (including 01no future bay)
2.	160 MVA Transformer bay	04 (including 01no future bay)
3.	Reactor bays	02
4.	Feeder bays	14
5.	Bus-Coupler bays	02
6.	Bus-Sectionaliser bays	02

The SF6 gas insulated switchgear rated for 220kV, 3-phase/three 1-phase, 50 Hz shall be of indoor metal-enclosed Double Bus Bar type, comprising of following items:

(A) Double bus bar arrangement, 3-phase/three 1-phase (isolated) units, 2500A SF_6 gas insulated, metal enclosed bus bar, each bus comprising of:

a. Bus bar enclosures running along the length of the switch gear to interconnect each

of the circuit breaker bay modules in double main bus system.

b. Three single phase voltage transformers/PTs.
c. One 3- phase, single pole, group operated isolator/disconnector switches, complete with manual and motor driven operating mechanisms.
d. Two 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
e. GIS duct with gas monitoring devices, barriers, pressure switches, UHF based partial discharge measurement sensors etc. as required.
f. Local control cubicle (if required).

(B) Bus Coupler bay module, each comprising of :

a. One 2500 A, 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.
b. Three 5 core single phase current transformers.
c. Two 3- phase, single pole, group operated isolator switches 2500A, complete with manual and motor driven operating mechanisms.
d. Two 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
e. GIS duct with gas monitoring devices, barriers, pressure switches, UHF based partial discharge measurement sensors etc. as required.
f. Local Control Cubicle (if required).

(C) Bus Sectionaliser Bay Module, each comprising of :

a. One 2500 A, 3-phase, SF6 gas insulated circuit breaker, complete with operating mechanism.
b. Three Nos 1-Phase, 5 core, multi ratio current transformers on one side of the circuit breaker.
c. Three Nos 1-Phase, 5 core, multi ratio current transformers on other side of the circuit breaker.
d. Two 3- phase, single pole, group operated isolator switches 2500A, complete with manual and motor driven operating mechanisms.
e. Two 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
f. GIS duct with gas monitoring devices, barriers, pressure switches, UHF based partial discharge measurement sensors etc. as required.
g. Local Control Cubicle (if required).

(D) Transformer I/C Circuit Breaker Bay Modules, each comprising of:

a. One 2500 A, 3-phase, SF_6 gas insulated circuit breaker, complete with operating mechanism.
b. Three 5 core single phase current transformers.
c. Three 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
d. Three 3-phases, single pole group operated safety grounding switches, complete with group operated manual and motor driven operating mechanisms.
e. Gas insulated terminal connection (cable housing) for connecting double run 1200 sq.mm 220kV XLPE cable (from ICT) directly indoor type GIS cable termination with structure to complete transformer incomer bay module.
f. GIS Bus duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc as required.
g. Local control cubicle (if required).

(E) Transformer Bay Module, each comprising of:

a. One 1600 A, 3-phase, SF_6 gas insulated circuit breaker, complete with operating

mechanism.

b. Three 5 core single phase current transformers.
c. Three 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
d. Three 3-phases, single pole group operated safety grounding switches, complete with group operated manual and motor driven operating mechanisms.
e. Gas insulated terminal connection for connecting transformer with GIS through SF6/Air bushings, SF6 bus duct etc. to complete transformer bay module.
f. GIS Bus duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
g. Local control cubicle (if required).

(F) Reactor Circuit Breaker Bay Module, each comprising of:

a. One 1600 A, 3-phase, SF_6 gas insulated circuit breaker, complete with operating mechanism.
b. Three 5 core single phase current transformers.
c. Three 3-phase, single pole, group operated isolator switches, complete with manual and motor driven operating mechanisms.
d. Three 3-phases, single pole group operated safety grounding switches, complete with group operated manual and motor driven operating mechanisms.
e. Gas insulated terminal connection (cable housing) for connecting reactor with GIS through indoor cable termination etc. to complete reactor bay module.
f. GIS Bus duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
g. Local control cubicle (if required).

(G) Feeder Circuit Breaker Bay modules, each comprising of:

a. One 1600 A, 3-phase, SF6 insulated circuit breaker, complete with operating mechanism.
b. Three 5 core single phase current transformers.
c. Three 3-phase, single pole, group operated isolator switches (1600A), complete with manual and motor driven operating mechanisms.
d. Two 3-phases, single pole group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
e. One 3-phase, single pole, high speed fault make grounding switch, complete with group operated manual and motor driven operating mechanisms.
f. Three, 3-core, single phase voltage transformers/ PTs with 3-phase, single pole, group operated isolator switch, complete with manual and motor driven operating mechanisms.
g. Three single phase, surge arresters.
h. Gas insulated terminal connection for connecting feeder with GIS through SF6 to Air bushings, SF6 bus duct etc. to complete feeder bay module.
i. GIS duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
j. Local control cubicle (if required).

(H) 245kV, 1600A, 50kA for 1 Second, SF6 Gas insulated Bus Duct (GIB) for feeder & Transformer Bay modules outside GIS hall with support structure (along with Gas monitoring devices, barriers, pressure switches UHF based partial discharge measurement sensors etc. as required) and SF6 to Air bushing for connecting GIS with respective gantry/ equipment.

(I) The connection of 160MVA, 220/66/11kV Transformer (220kV side) shall be through GIS Duct / SF6 Air Bushing. The connection of the 66kV side of the 160MVA

Transformer shall be through cable.

(J) Scope of work also includes 216kV, outdoor Lightning Arrestor (L.A.) with surge/discharge counter, milli-ampere meter and suitable terminal connectors etc. 220kV BPI with fittings, steel for support structure for surge arrester, BPI, Gantry structure, cable support structure etc. and 4" IPS aluminum tube along with fitting for connecting transformers.

(K) The Switchgear shall be complete with all necessary terminal boxes, SF6 gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment and piping, support structures and UHF based partial discharge measurement sensors, etc.

(L) Scope also includes supply of 220kV, 1200 Sq.mm single core XLPE cable. 220kV outdoor type & indoor type complete cable end termination kit suitable for double run 1200 sq.mm XLPE cable with all accessories for connecting 220kV side of 04 no. 500MVA ICT with 220kV GIS.

(M) Scope of work also include supply, ETC of 220kV outdoor type LA for 04x500MVA incomer, 4x220kV feeders and 03x 160MVA transformer.

(N) Scope of work also include supply, ETC of SF6 air bushing is required for 14 no. 220kV feeder bay and 04 no. 160MVA Power Transformer Bay to complete the GIS bay.

III. 66kV System

The 72.5kV SF_6 Gas Insulated Switchgear shall have Double Bus Bar arrangement as detailed below:

S No.	Bays Description	Quantity in Nos.
1.	Transformer/ I/C bay	04
2.	Bus-coupler bay	02
3.	Bus-Sectionaliser bay	02
4.	Feeder bay	22

The SF_6 gas insulated switchgear rated for 66kV, 3-phase, 50 Hz shall be of the indoor metal-enclosed type, comprising of following items:

(A) Double bus bar arrangement (3000A), 3-phase/three 1-phase (isolated) units SF_6 gas insulated, metal enclosed bus bars, each bus comprising of:

a. Bus bar enclosures running along the length of the switchgear to interconnect each of the circuit breaker bay modules in double main bus system.
b. Three, 3-core, single phase voltage transformers/ PTs.
c. One 3-phase, single pole, group operated isolator/disconnector with two 3-phase, single pole, group operated earthing switches with manual and motor driven operating mechanisms.
d. Gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
e. Local control cubicle (if required).

(B) Bus Coupler Bay module comprising of:

a. One 2500 A, 3-phase, SF6 Circuit Breaker, complete with operating mechanism.

b. Three 3-core single phase current transformers.
c. Two 3-phase, single pole, group operated isolator switches each with three phase single pole group operated Earthing switch complete with manual and motor driven operating mechanisms.
d. Gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
e. Local control cubicle (if required).

(C) Bus-Sectionaliser bay module comprising of :

a. One 2500 A, 3-phase, SF6 Circuit Breaker, complete with operating mechanism.
b. Three 3-core single phase current transformers.
c. Two 3-phase, single pole, group operated isolator switches each with three phase single pole group operated Earthing switch complete with manual and motor driven operating mechanisms.
d. Gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
e. Local control cubicle (if required).

(D) 72.5kV bays for Incomer from 220/66kV Transformer, each comprising of :

a. One 2000/ 2500A, 3-phase, SF6 circuit breaker, complete with operating mechanism for incomer bay from 220/66 kV transformer.
b. Three 4-core single phase current transformers.
c. One 2000/ 2500A, 3-phase, single pole, group operated isolator without earthing switch, complete with manual and motor driven operating mechanisms.
d. One 2000/ 2500A, 3-phase, single pole, group operated isolator with one 3-phase, single pole, group operated earthing switch, complete with manual and motor driven operating mechanisms.
e. One 2000/ 2500A, 3-phase, single pole, group operated isolator with one normal and one high speed fault make 3-phase, single pole, group operated earthing switch, complete with manual and motor driven operating mechanisms.
f. Three single phase Surge Arrester.
g. Gas insulated terminal connection (cable housing) for connecting 66kV side of Transformer through XLPE cable with suitable run and size, cable end box, cable termination enclosure and accessories with GIS to complete the transformer bay.
h. Gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
i. Local control cubicle (if required).

(E) Feeder Circuit Breaker bay modules, each comprising of :

a. One 2000A, 3-phase, SF6 circuit breaker, complete with operating mechanism for outgoing feeder.
b. Three 3-core, single phase current transformers.
c. One 2000 A, 3-phase, single pole, group operated isolator without earthing switch, complete with manual and motor driven operating mechanisms.
d. One 2000A, 3-phase, single pole, group operated isolator with one 3-phase, single pole, group operated earthing switch, complete with manual and motor driven operating mechanisms.
e. One 2000 A, 3-phase, single pole, group operated isolator with one normal and one high speed fault make 3-phase, single pole, group operated earthing switch, complete with manual and motor driven operating mechanisms.
f. Three, 3-core, single phase voltage transformers/ PTs with 3-phase, single pole, group operated isolator switch, complete with manual and motor driven operating mechanisms.
g. Three single phase-Surge Arrester.
j. Gas insulated terminal connection (cable housing) for connecting XLPE cable of suitable

size and run with cable termination enclosure and accessories with GIS to complete the feeder bay module.

h. Gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.

i. Local control cubicle (if required).

(F) The scope of work also covers Power Cable with termination kit on 66 kV side for connecting 03 No. transformer to 66KV GIS (Suitable size & Run) and connecting outgoing feeders (Suitable size & Run) to H pole arrangement, Steel structure for H-Pole arrangement for termination of 66 KV feeders and petty items for completion of job. Steel structure for 66kV H pole and other support structures. BPI along with accessories etc.

(G) 66kV outdoor type single phase LA with discharge counter, milliampere meter and terminal connector etc. 66kV outdoor type LA are required for 03 no. 160MVA Transformer.

IV. Scope includes supply, erection, Testing & Commissioning of 04 no. 400/220/33kV, 500 MVA Power Transformer with first filling of oil along with 10% extra oil, Nitrogen injection fire prevention & extinguishing system (NIFPES), NCT's, RTCC panel, terminal connectors, control cable & power cables.

V. Scope includes supply, erection, Testing & Commissioning of 03 no. 220/66/11kV, 160 MVA Power Transformer with first filling of oil along with 10% extra oil, Nitrogen injection fire prevention & extinguishing system (NIFPES), NCT's, RTCC panel, terminal connectors, control cable & power cables.

VI. Scope includes supply, erection, testing & commissioning of 01 no. 400 KV, 125 MVAR, 3 phase Shunt Reactor with first filling of oil with 10% extra oil, Nitrogen injection fire prevention & extinguishing system (NIFPES), NCT's, bushings and other accessories as per technical specification.

VII. The scope also include supply, erection, testing & commissioning 02no. 1000kVA, 11kV/433V LT three phase Transformer having 170kVp BIL at 11kV side including bushings, accessories and first filling of oil. The transformers shall be to feed the substation auxiliaries. One LT transformer shall be connected through overhead conductor to the tertiary of any one of the 160 MVA power transformer and shall be located near the power transformer while another LT transformer shall be located in LT station area and HT side shall be connected with Discom supply through 11kV HT Cable. These auxiliary transformers should not be used for construction purposes.

VIII. Supply of Oil Storage Tank as per the specification.

IX. The connection of 66KV cable with the 66 KV bushings of transformers will be made through Al/Cu bus bar.

X. The cables before making connection into the GIS bays will be affixed through the cable holding structures near the entry point of the GIS bays for which proper cable holding

structures will be provided in the GIS building.

XI. Sub-station automation (SAS)/ SCADA/ HMI/FOTE for inclusion of automation and control of proposed GIS work for following bays (bay as defined in technical specification, section _ sub-station automation):

- 400kV: 23 bays
- 220kV: 29 bays
- 66 kV : 30 bays

The sub-station should have the provision to be controlled from a remote location and mode of communication shall be optical fiber for all voltage levels. Bidder shall provide FOTE equipments alongwith Tele-protection cards for remote end sub-station also. FO cable inside the substation and FODB alongwith patch chord at local and remote ends for successful operation are in contractor's scope. FOTE for both ends shall also have provision for eight command tele-protection and two current differential protection interface. The protection requirement shall be fulfilled by the contractor for successful commissioning. Location details to be made available during detailed engineering. Suitable Converters/provision shall be made by Contractors for commissioning of FOTE system and only 220V Battery System shall be used.

List of testing & maintenance equipment under Automation & SCADA has been considered as under:

a) Optical Time Domain Reflected Meter
b) Fibre Splicing Machine
c) Test Plug for testing & Isolation of Relay for testing
d) Manufacture's Specific Maintenance tool.

XII. Complete relay and protection system.

XIII. Steel for gantry structure for 400kV circuits, 220kV circuits, 66kV H pole, support structure for Surge arrester/ LA, ACSR Conductor, Hardware Fittings, etc.

XIV. Bus post Insulators, insulator strings and hardwares, clamps & connectors, terminal connector, C-Wedge Connectors, Cu-Al Bus Bar, HDPE Pipes Conductor, earth wire and earthing materials, tubular conductor, spacers, cable supporting angles/channels, Cable trays & covers, Junction box, buried cable trenches etc if required.

XV. Fire Protection of GIS building, control room cum administrative building, storeroom etc. as well as Heat/ Smoke fire detection system. (refer Annexure-IV)

XVI. Air Conditioning System with stabilizer and all accessories as per specification in section substation automation system.

XVII. Ventilation system for 400kV, 220kV and 66kV GIS hall. The requirement of ventilation system shall be as per Technical Specification

XVIII. LT switchgear.

XIX. 250KVA, 440V Outdoor Silent type DG Set along with control panel.

XX. 220kV Batteries & Battery Charges system.

XXI. 1.1kV grade Power & Control cables along with complete accessories.

XXII. Earth mat (Measurement of resistivity is in the scope of contractor).

XXIII. Complete lighting and illumination of the installation. This shall include the illumination for GIS Building, control room cum administrative building, Store room including switchyard/ street lights system (high mast lighting system). The illumination shall be LED base/ Metal halide lamp. The specification for control room GIS building illumination shall be as per Annexure-III.

XXIV. Provision of CCTV camera for complete supervision of 400kV/220kV/66kV GIS hall, store room, main entrance gate of substation, battery charger room, LT room, outdoor camera for monitoring of transformers, reactor and switchyard equipments from control room as well as from remote location other than substation. The cameras should be installed in such a way that the complete substation should be visible from remote for unmanned operation. The provision of Online viewing of camera from remote substation should be made by contractor.

XXV. Special Equipments for testing and maintenance.

XXVI. Bidder shall arrange suitable provision for testing of 220kV and 66kV cables after isolation from the main GIS. In addition, one set of each size of test bushing/plug shall also be provided for testing purpose. Provision for space for termination of cable/ Overhead line shall be kept during designing stage.

XXVII. Purchaser's site office with furniture and stores are in the scope of the bidder along with adequate illumination and air conditioning.

XXVIII. Mandatory Spares.

XXIX. 11kV protection IEDs shall have integration with SCADA. ACDB, DCDB and battery charger shall be communicable and integrated with SCADA.

XXX. The work to be done under this specification comprises the provision of all labour, plant, equipment and material and the performance of all work necessary for the complete installation and commissioning of switchyard. It is hereby required that the contractor should provide all apparatus, appliances, material and labour etc. not specifically mentioned or included, but are necessary to complete the entire work or any portion of the work in compliance with the requirements implied in this specification is deemed to be included in the scope of contractor.

XXXI. The scope of work shall cover in complete conformity with the specifications, the

followings:-

A single line schematic of the 400kV, 220kV and 66kV SF6 gas insulated switchgear with double bus bar arrangement is enclosed with the specification. In case any additional equipment is required, the same should be included in the scope of the supply and the offer should be complete and comprehensive. In addition all necessary platforms, supports, ladders and catwalks etc. for operation & maintenance work shall also be supplied. A tentative layout of the switchyard is enclosed with this specification. Bidder may adopt similar arrangement or optimize the same further without affecting any of the functional requirements specified.

XXXII. Any other equipment/material required for completing the specified scope.

XXXIII. The watch and ward of complete site shall be in the scope of the bidder.

XXXIV. Lightening Mast / GI Shield wire.

XXXV. EOT Crane for 400kV, 220kV, 66kV GIS Room and GIS storeroom.

XXXVI. The location of the site for the transformer may undergo change within Delhi if so required by the employer.

XXXVII. Civil works – The work shall include but not limited to the following: -

1. Foundations for

a. 500MVA, 400/220/33kV, Transformers (including NIFPES) with accessories, soak pit and sump pit etc.
b. 160 MVA, 220/66/11kV, Power Transformers (including NIFPES) with accessories, soak pit and sump pit etc.
c. 125 MVAR Shunt reactor (including NIFPES) with accessories, soak pit and sump pit etc.
d. 160MVA Power Transformer Tertiary loading equipment's.
e. 17.5kV Neutal Current transformer 800-400/1A for 220kV neutral of Transformer and 2000-1000/1A for 66/33kV neutral of transformer.
f. 1000 KVA, 11/0.433 kV LT Transformer.
g. 390kV Surge Arrestor.
h. 400 KV SF6/ Air Bushing.
i. 216kV Surge arrester.
j. 66kV LA
k. 220kV SF6 to air Bushing
l. 400kV BPI
m. 220kV Outdoor termination of the cable
n. 220kV indoor termination of the cable
o. H pole arrangement for 66kV feeders
p. 400kV Gantry as per layout
q. 220kV gantry as per layout
r. RCC in foundation including earth work in excavating disposal of surplus earth PCC, RCC reinforcement steel, for structures and equipments.

s. Cable Trench including all types of crossings.
t. 250kVA DG set.

2. Soil Investigation.
3. Site surfacing (gravelling) & Anti weed Treatment including yard development.
4. Roads (including all crossings), Main road infront of ICTs with connecting rail, approach road of substation.
5. Storm Water drainage & rainwater harvesting system.
6. Main Gates and Switchyard fencing along with gates.
7. **Buildings**

a. Construction of 400kV GIS building measuring 1700 sq.m (tentative) complete including foundation, superstructure, finishing, furniture, U/G water tank, pump house, submersible pump, etc as per design requirement, technical specifications complete in all respect.

b. Construction of 220kV GIS building complete measuring 1200 sq.m (tentative) including foundation, superstructure, finishing etc as per design requirement, technical specifications.

c. Construction of 66kV GIS building measuring 600sq.m (tentative) including foundation, superstructure, finishing etc. complete as per design requirement, technical specifications.

d. Construction of control room cum administrative building (G+2) measuring 2036sq.m (tentative) including foundation, superstructure, finishing etc. all complete as per design, drawing requirement, technical specifications.

e. Store Room measuring 1700 sq.m (tentative) complete as per design requirement.
f. Pump house along with pump etc.
g. Security rooms along with toilets etc, site offices and parking

8. Transformer fire walls.
a. For 500MVA Transformers
b. For 160MVA Transformers

9. Horticulture work including landscaping and plantation as per design requirement.
10. RCC frame Boundary wall with brick panneling including gates etc.
11. Supply and filling earth at site is layer not exceeding 20cm in depth consolidating each deposit layer by ramming, watering etc including royalty, excavation at source, transportation of earth by mechanical transport including all leads and lifts etc complete, the work will be carried out in phase manner.

12. Demolition of boundary wall, fencing, tree cutting/ shifting etc.

13. **Furniture of Reputed make for complete control room cum admin building, office space, conference hall etc.**

a. Control room table.
b. Tables for executives.
c. High back chairs
d. Conference room equipped with projector & screen of latest configuration along with conference table with chairs for 10 persons.

14. Any other work required for functional requirement of establishment of the substation.

3.1 Before proceeding with the construction work of the substation, the Contractor shall fully familiarize himself with the site conditions and General arrangements & scheme etc. Though the Purchaser shall endeavor to provide the information, it shall not be binding for the Purchaser to provide the same. The bidders are advised to visit the substation sites and acquaint themselves with the topography, infrastructure and also the design philosophy. The bidder shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the construction and successful commissioning, operation & maintenance of the substation in all respects. All materials required for the Civil and construction/installation work shall be supplied by the Contractor. The cement and steel shall also be supplied by the Contractor.

The complete design **(unless specified otherwise in specification elsewhere)** and detailed engineering shall be done by the Contractor based on conceptual tender drawings.

3.2 The Contractor shall also be responsible for the overall co-ordination with internal/external agencies, project management, training of Purchaser's manpower, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the substation/switchyard.

3.3 Design of substation and its associated electrical & mechanical auxiliaries systems includes preparation of single line diagrams and electrical layouts for extension area, erection key diagrams, electrical and physical clearance diagrams, design calculations for Earth mat, control and protection schematics, wiring and termination schedules, civil designs (as applicable) and drawings, design of fire fighting system and air conditioning system, indoor/ outdoor lighting/illumination and other relevant drawings & documents required for engineering of all facilities under the scope of this contract.

3.4 Water based firefighting and reservoir are not envisaged.

Pump and pump house is required for evacuation of surface/rain water or water logging in substation premises, primarily for water accumulated in trenches/drains/Cellar. Moreover, Pump will also function for regulating water to water harvesting system.

3.5 Specific Exclusions

The following items of work are specifically excluded from the scope of the specifications for substation:

1. Road outside Boundary Wall.
2. Scope of solar panel.

3.6 Any other items not specifically mentioned in the specification but which are required for erection, testing and commissioning and satisfactory operation of the substation are deemed to be included in the scope of the specification unless specifically excluded.

3.7 Purchaser has standardized its technical specification for various equipments and works for different voltage levels. Items, which are not applicable for the scope of this package as per schedule of quantities described in Bid Price Schedule, the technical specification for such items should not be referred to.

4.0 PHYSICAL AND OTHER PARAMETERS

4.1 **Location of the Substation** – The location of substation is indicated below:

Name of Substation	Name of State	Nearest Railway station	Railway Head

Tikri Khurd	Delhi Region	Delhi	Northern Railways

4.2 **Meteorological data**

The meteorological data of the substation shall be handed over to successful bidder However for design purposes, ambient temperature and altitude shall be considered as 50 degree centigrade and less than 1000 mtr above MSL, respectively.

4.3 **Soil Data**

The bidder shall be responsible for carrying out the required tests and should fully satisfy himself about the nature of soil expected to be encountered prior to the submission of bid. Any variation of soil data during detailed engineering or construction stage shall not constitute a valid reason in affecting the terms and conditions of the bid.

5.0 SCHEDULE OF QUANTITIES

The requirement of various items/equipments and civil works are indicated in Bid price Schedules.

All equipments/items and civil works for which quantities has been given in the price schedule shall be payable on unit rate basis. During actual execution, any variation in such quantities shall be paid based on the unit rate under each item incorporated in the letter of award.

Wherever the quantities of items/works are not indicated, the bidder is required to estimate the quantity required for entire execution and completion of works and incorporate their price in respective Bid price schedules.

The detailed bill of quantities of the mandatory spares with break up is given in the Annexure-I.

Bidder should include all such items in the bid proposal sheets, which are not specifically mentioned but are essential for the execution of the contract. Item which explicitly may not appear in various schedules and required for successful commissioning of substation shall be included in the bid price and shall be provided at no extra cost to Purchaser.

6.0 BASIC REFERENCE DRAWINGS

6.1 400/220/66 kV Tikri Khurd GIS Sub-station (DTL) is a new Gas Insulated Substation. For 400kV, 220kV and 66kV voltage level, Double bus switching scheme layout arrangement shall be used. Single line diagram and layout arrangements are enclosed with the bid documents, which shall be further engineered by the bidder.

The drawings enclosed in Annexure-II shall give the basic scheme, layout of substation, substation building, associated services etc. In case of any discrepancy between the drawings and text of specification, the requirements of text shall prevail in general. However, the Bidder is advised to get these clarified from the Purchaser.

7.0 ORDER OF PRECEDENCE OF DIFFERENT SECTIONS OF TECHNICAL SPECIFICATION

In case of any discrepancy between section Project, Bill of Material, GTP, equipment Technical Specification, single line diagram, Section-Project shall prevail over all other sections and the order of precedence shall be as follows:

Section-I, Vol-II: Section Project
Section-4 of Vol-III: Price Schedules
Section-2 to Section 24, Vol-II
Single line Diagram

Layout
For the purpose of present scope of work, the order of precedence between various sections of Volume-II (technical specification) shall be as under and they should be read in conjunction with each other

1) Section-1 : Project
2) Section-2 : Gas Insulated Switchgear GIS
3) Section-3 : General Technical Requirement (GTR)
4) Section-4 : Special Equipments
5) Section-5 : Fire Protection System
6) Section-6 : LT Switchgear
7) Section-7 : Battery and Battery Charger
8) Section-8 : Lighting System
9) Section-9 : LT transformer
10) Section-10 : Diesel Generator
11) Section-11 : Switchyard
12) Section-12 : Civil Works
13) Section-13 : Substation Automation System
14) Section-14 : Control and Relay Panels
15) Section-15 : Power and Control Cables
16) Section-16 : Visual Monitoring
17) Section-17 : Fiber Optic Terminal Equipment (FOTE)
18) Section-18 : Lightning Arrestor (LA)
19) Section-19 : Reactor
20) Section-20 : Power Transformer
21) Section-21 : Nitrogen Injection Fire Prevention Cum Extinguishing System (NIFPES)
22) Section-22 : 220kV XLPE Cable
23) Section-23 : 33kV & 66kV XLPE Cable
24) Section-24 : TS XLPE Joints & End Terminations.

In case of any discrepancy between Section-PROJECT, Section- GTR and other technical specifications on scope of works, Section-PROJECT shall prevail over all other sections.
In case of any discrepancy between Section-GTR and individual sections for various equipments, the requirement of individual equipment section shall prevail.

8.0 MANDATORY SPARES

Mandatory Spares shall be included in bid proposal by the bidder. Prices of these spares shall be given by the Bidder in relevant price schedule and shall be considered for evaluation of bid. It shall not be binding on the Purchaser to procure all of these mandatory spares.

The bidder clarified that no mandatory spares shall be used during commissioning of the equipment. Any spares required for commissioning purpose shall be arranged by the Contractor. The unutilized spares, if any brought for commissioning purpose shall be taken back by the contractor.

9.0 SPECIAL TOOLS AND TACKLES

The bidder shall include in his proposal the deployment of all special tools and tackles required for erection, testing, commissioning and maintenance of equipment. However, a list of all such devices should be indicated in the relevant price schedule. In addition to this the Contractor shall also furnish a list of special tools and tackles for the various equipment in a manner to be referred by the Purchaser during the operation of these equipment.

10.0 FACILITIES TO BE ARRANGED BY THE CONTRACTOR

10.1 For construction purpose, the Contractor shall arrange suitable electricity supply from the Distribution Utility at his own cost and in case of failure of power due to any unavoidable circumstances, the contractor shall make his own necessary arrangements like diesel generator sets etc., at his own cost so that progress of work is not affected and Employer shall in no case be responsible for any delay in works because of non-availability of power.

10.2 The contractor shall make his own arrangement for water supply at his own cost and the Employer shall in no case be responsible for any delay in works because of non-availability or inadequate availability of water.

11.0 TERTIARY WINDING (TRANSFORMER)

One of the auxiliary transformer of rating 1000KVA, 11/0.433 kV (170kVp-BIL) shall be used to feed the substation auxiliaries which shall be connected through overhead conductor to the tertiary of any one of the 160MVA Power Transformers and shall be located near the power transformer. This auxiliary transformer should not be used for construction purpose. The details of equipment associated with loading tertiary winding are enclosed as Annexure-VI.

12.0 SPECIFIC REQUIREMENT

12.1 Training of Owner's Personnel
The successful tenderer shall also arrange the training of owner's/purchaser's engineers at the manufacturer's works/facility from where the equipment is being supplied for 120-man days in Design, Manufacturing and Testing of equipment being supplied. To & fro air fare including boarding and lodging shall be borne by the owner/purchaser and no separate charges for training shall be paid.

12.2 Bidder shall conduct type tests on equipments other than GIS if required in their respective section.

12.3 The equipment to be supplied for 400kV and 220kV system shall be suitable for system fault current of 63KA & 50 KA for 1 second as specified elsewhere in the specification.

12.4 The contractor shall place their panels i.e. Bay level units, bay mimic, relay and protection panels etc in an enclosure for 400kV, 220kV and 66kV in respective GIS hall. The enclosure shall be air-conditioned and the requirement of air-conditioning shall be as detailed in section Sub-station Automation System clause no. 4.3.

12.5 Control, monitoring and protections (over current and open delta protections) for Auxiliary transformer and associated equipments shall be from auxiliary BCU to be provided as per section sub-station automation.

12.6 As 400kV, 220kV and 66kV GIS are proposed to be extended in near future, the contractor shall make available all details such as cross section, gas pressure etc required to design adapter in future for extension of GIS during detailed engineering.

12.7 The bidder shall be responsible for safety of human and equipment during the working. It will be the responsibility of the Contractor to co-ordinate and obtain Electrical Inspector's clearance before commissioning. Any additional items, modification due to observation of such statutory authorities shall be provided by the Contractor at no extra cost to the Purchaser.

12.8 In Section-GTR and other technical specifications, the word ‘Employer’ and/or ‘Owner’ may be read as ‘Purchaser’.

12.9 Vendor has to ensure minimum clearance in and around GIS hall to ensure proper safety, maintenance and movement for equipments and personnel.

12.10 Provision of separate /different trenches for power cable and control cable are to be made as far as possible.

12.11 The bidder shall submit all the applicable type test reports of the equipment in line with latest edition of IS/IEC and validity of the type test reports shall be as per latest CEA guidelines. The type test reports shall be submitted along with the bid. If any applicable type test has not been conducted by the bidder, then the same shall be conducted by the bidder free of cost and without affecting the completion period of the project/tender. In case the item/equipment is not listed in the CEA guidelines, the validity of the respective items/equipments shall be as per TS.

Annexure-I

MANDATORY SPARES FOR GAS INSULATED SWITCHGEAR (GIS)

SI. No.	Description	Quantity
A.	**SPARES FOR 400KV, 220KV & 66KV GIS**	For each voltage class
1.1	Cable end termination connection & enclosure, compatible with the main Circuit	1 set (1-ph)
1.2	SF6 gas Pressure Relief Devices, 03Nos. of each type	2 sets
1.3	SF6 Pressure gauge cum switch OR Density monitors cum switch as applicable (3 no. of each type)	1 set complete for 1 bay + bus bar, Bus duct.+ CB
1.4	Coupling device with pressure gauge for connecting Gas handling plant including GIS & Cylinder both	2 sets
1.5	Rubber Gaskets, "O" Rings and Seals for SF6 gas of each type	1 set
1.6	Molecular filter for SF6 gas with filter bags	20% of total quantity
1.7	All types of Control Valves for SF6 gas of each type	1 set
1.8	SF_6 gas	20% of total quantity
1.9	**Covers along with all accessories necessary to close a compartment in case of dismantling of any part of the Enclosure to ensure the sealing of this compartment.**	
1.9.1	For 3 Phase Enclosure	2 Nos.
1.9.2	For Single phase enclosure	3 Nos.
1.10	Bus Support insulator of each type for 3 phase/single phase enclosure.	5% of installed/ used population
1.11	SF6 to air bushing of each type rating including fixing arrangement	3 No.
2.0A	**400 KV SF6 CIRCUIT BREAKER:**	
2.1	Circuit Breaker pole of each type & rating complete with interrupter, main circuit, enclosure and Marshalling Box with operating mechanism	1 No.
2.2	Fixed, moving and arcing contacts including insulating nozzles 3 Nos. of each type/rating of CB	1 set (3 No.)
2.3	Rubber gaskets, `O' rings and seals for SF6 gas of each type	1 set
2.4	Trip coil assembly (with resistor, if applicable), 3 Nos. of each rating of CB	2 sets
2.5	Closing coil assembly (with resistor if applicable, 3 Nos. of each rating of CB	2 sets

2.6	Corona rings/ cover (if applicable)	1 set
2.7	Power contactors, push buttons, timers/relay & MCBs etc of each type & rating	1 set
2.8	Closing valve assembly, 3 Nos. of each type	2 sets
2.9	Trip valve assembly, 3 Nos. of each type	2 sets
2.10	Auxiliary switch assembly, 3 Nos. of each type	1 set
2.11	Operation Counter, 3 Nos. of each rating	1 sets
2.12	Rupture disc, 3 Nos. of each type	1 sets
2.13	Spring operated closing mechanism, 1 No. of each rating (if applicable)	1 set
2.14	**For Hydraulic Operated Mechanism, if applicable**	1 set
2.14.1	Hydraulic operating mechanism with drive motor, 3 Nos. of each type	1 set
2.14.2	Hydraulic filter, 3 Nos. of each type	1 set
2.14.3	Hose pipe, 3 Nos. of each type	1 set
2.14.4	N2 Accumulator, 3 Nos. of each type	1 set
2.14.5	Pressure transducer, 3 Nos. of each type	1 set
2.14.6	Valves 3 Nos. of each type	1 set
2.14.7	Pipe length (copper & steel) 3 Nos. of each size & type	1 set
2.14.8	Pressure switches 3 Nos. of each type	1 set
2.14.9	Pressure gauge with coupling device, 3 Nos. of each type	1 set
2.14.10	Hydraulic oil	20% of total qty. used
2.14.11	Pressure Relief Device, 3 Nos. of each type	2 sets
2.0 B	**220 KV SF6 CIRCUIT BREAKER:**	
2.1	Circuit Breaker pole complete of each type & rating complete with interrupter, main circuit, enclosure and Marshalling Box with operating mechanism	3 Nos.
2.2	Fixed, moving and arcing contacts including insulating nozzles 3 Nos. of each type/rating of CB	1 set (3 No.)
2.3	Rubber gaskets, `O' rings and seals for SF6 gas of each type	1 set
2.4	Trip coil assembly with resistor as applicable, 3 Nos. of each rating of CB	2 sets
2.5	Closing coil assembly with resistor as applicable, 3 Nos. of each rating of CB	2 sets
2.6	Corona rings/cover if applicable	1 set
2.7	Relays, Power contactors, push buttons, timers & MCBs etc of each type & rating	1 set
2.8	Closing valve assembly, 3 Nos. of each type	2 sets
2.9	Trip valve assembly, 3 Nos. of each type	2 sets

2.10	Auxiliary switch assembly, 3 Nos. of each type	1 set
2.11	Operation Counter, 3 Nos. of each type	1 set
2.12	Rupture disc, 3 Nos. of each type	1 set
2.13	Spring operated closing mechanism, 1 Nos. of each type, if applicable	1 set
2.14	**For Hydraulic Operated Mechanism, if applicable**	
2.14.1	Hydraulic operating mechanism with drive motor, 3 Nos. of each type	1 Set
2.14.2	Hydraulic filter, 3 Nos. of each type	1 Set
2.14.3	Hose pipe, 3 Nos. of each type	1 Set
2.14.4	N2 Accumulator, 3 Nos. of each type	1 Set
2.14.5	Pressure transducer, 3 Nos. of each type	1 Set
2.14.6	Valves 3 Nos. of each type	1 Set
2.14.7	Pipe length (copper & steel) 3 Nos. of each size & type	1 Set
2.14.8	Pressure switches 3 Nos. of each type	1 Set
2.14.9	Pressure gauge with coupling device, 3 Nos. of each type	1 Set
2.14.10	Hydraulic oil	20% of total qty. used
2.14.11	Pressure Relief Device, 3 Nos. of each type	2 Set
2.0 c	**66 KV SF6 CIRCUIT BREAKER**	
2.1	Three phase, Circuit Breaker interrupting chamber complete with all necessary apparatus.	1 no. of each rating
2.2	Rubber gaskets, 'O' rings and seals	1 set
2.3	Trip coils with resistor.	3 nos.
2.4	Closing coils with resistor	3 nos.
2.5	Relays, Power contactors, push buttons, timers & MCB etc.	1 set
2.6	Closing valve assembly (3 nos. of each type)	1 no.
2.7	Trip valve assembly (3 nos. of each type) --	1 no.
2.8	Auxiliary switch assembly	1 no.
2.9	Operation Counter	1 no.
2.10	Rupture disc/diapharm	1 no.
3.0A	**400KV GIS ISOLATOR**	
3.1	Complete set of 3 nos. of single phase / one no. of 3-phase dis-connector including main circuit, enclosure, driving mechanism etc.	1 set
3.2	3 no. of single phase / one no of 3-phase Earthing switch of including main circuit, enclosure, driving mechanism etc.	1 set
3.3	Copper contact fingers for dis-connector male & female contact – for one complete (3 phase) dis-connector of each type and	1 set

	rating.	
3.4	Copper contact fingers for dis-connector male & female contact – for one complete (3 phase) dis-connector of each type and rating	1 set
3.5	Open / Close contactor assembly, timers, key interlock for one complete (3 phase) dis-connector and (3 phase) earthing switch of each type and rating	1 set
3.6	Push button switch. -each type, as applicable	1 set
3.7	Limit switch and Aux. Switches for complete 3 phase equipment	1 set
3.8	Motor with gear assembly for complete 3 phase equipment	1 set
3.9	Hinge pins for complete 3 phase equipment	1 set
3.10	Relays, Power contactors, resistors, fuses, push buttons & MCBs (complete for one 3 phase equipment)	3 No.
3.11	Aux. switch assembly (complete) with 10 NO & 10 NC OR more contacts for both isolator & earth switch	1 set
3.0 B	**220KV GIS ISOLATOR**	
3.1	Complete set of 3 nos. of single phase / one no. of 3-phase dis-connector including main circuit, enclosure, driving mechanism etc.	1 Set
3.2	3 no. of single phase / one no of 3-phase Earthing switch including main circuit, enclosure, driving mechanism etc.	1 Set
3.3	Copper contact fingers for dis-connector male & female contact – for one complete (3 phase) dis-connector of each type and rating.	1 Set
3.4	Copper contact fingers for earthing switch male & female contacts, for one complete (3 phase) earthing switch of each type and rating	1 Set
3.5	Open / Close contactor assembly, timers, key interlock for one complete (3 phase) dis-connector and (3 phase) earthing switch of each type and rating	1 Set
3.6	Push button switch. -each type, as applicable	1 Set
3.7	Limit switch and Aux. Switches for complete 3 phase equipment	1 Set
3.8	Motor with gear assembly for complete 3 phase equipment	1 Set
3.8.1	For isolator	3 Set
3.8.2	For earth switch	1 Set
3.9	Hinge pins for complete 3 phase.	1 Set
3.10	Relays, Power contactors, resistors, fuses, push buttons & MCBs (complete for one 3 phase equipment)	3 No.
3.11	Aux. switch assembly (complete) with 10 NO & 10 NC OR more contacts for both isolator & earth switch	1 Set
3.0 C	**66 KV GIS ISOLATORS & E/Switch**	

3.1	Three ph, Disconnecting Switch internal parts, complete with all necessary gaskets, mounting hardware, etc.	1 set.
3.2	Three ph, Disconnecting Switch operating mechanism, complete with all necessary connecting apparatus.	1 set.
3.3	Three ph., Grounding Switch internal parts, complete with all necessary gaskets, mounting hardware etc.	1 set.
3.4	Three ph., Grounding Switch operating mechanism, complete with all necessary connecting apparatus.	1 set.
4.0 A	**400KV GIS CURRENT TRANSFORMER**	
4.1	Complete CT of each type and rating with packing	2 Nos.
4.2	Secondary Terminal bushing of each type	2 Sets
4.0 B	**220KV GIS CURRENT TRANSFORMER**	
4.1	Complete CT of each type and rating with packing.	2 Nos.
4.2	Secondary terminal bushing of each type	2 Sets
4.0 C	**66KV GIS CURRENT TRANSFORMER**	
4.1	Single phase current transformers of each rating with packing.	3 no. of each rating
5.0 A	**400KV GIS Voltage Transformer**	
5.1	Complete VT of each type and rating	1 No.
5.0 B	**220 kV GIS Voltage Transformer**	
5.1	Complete VT of each type and rating	1 No.
5.0 C	**66 kV GIS Voltage Transformer**	
5.1	Three phase VT complete with all Gaskets and mounting hardware.	1 no. of each rating
6.0 A	**400KV GIS SURGE ARRESTOR**	
6.1	Complete L.A. of each type and ratings with all accessories as applicable.	1 No.
6.2	Surge counter/ monitor	1 No.
6.0 B	**220kV GIS SURGE ARRESTOR**	
6.1	Complete L.A. of each type and ratings with insulating base, terminal connector, Surge counter & accessories	1 No.
6.2	Surge counter/ monitor	1 No.
6.0 C	**66kV GIS SURGE ARRESTOR**	
6.1	Complete L.A. including insulating Base with Surge counter & accessories.	3 No.
6.2	Surge counter/ monitor	3 No.
7.0 A	**DG Set**	
7.1	Set of Fuel filter (each type)	1 set
7.2	Solenoid Coil Assembly	1 No.
7.3	Self-Starter assembly with clutch engaging and disengaging arrangements complete with motors	1 No.
7.4	Lube Oil pressure safety control	1 No.

7.5	High water temp. safety control	1 No.
8.0 A	**BATTERIES**	
8.1	Spare Battery Cell	05 No.
8.2	Terminal connectors with nuts & bolts	10 No.
9.0 A	**BATTERY CHARGER**	
9.1	Set of control cards (All PCB cards)	1 set
9.2	Set of relays	1 set
9.3	Set of contractor	1 set
9.4	Micro-switches (if applicable)	1 set
9.5	Filter Capacitor	1 set
9.6	Three phase full wave bridge rectifier (Thyristor/Diode)	1 set
9.7	Set of wound resistor (if applicable)	1 set
9.8	Set of switches	1 set
9.9	Potentiometer	1 set
9.10	Fuses of Thyrister with indicator	1 set
10.0	**Relay & Protection Spare (for each voltage class)**	
10.1	**Breaker Relay Panel**	
10.1.1	Breaker failure Relay	1 No
10.1.2	Trip Circuit Supervision Relay	2 No
10.1.3	Self reset Trip Relay of each type (if applicable)	1 No
10.1.4	Timer Relay of Each type (if applicable)	1 No
10.1.5	DC Supervision Relays (if applicable)	1 No
10.2	**Line Protection Panel Equipments Spares**	
10.2.1	Main 1 Numerical Distance Relay (Excluding External Trip Relays)	1 No.
10.2.2	Main 2 Numerical Distance Relay (Excluding External Trip Relays)	1 No.
10.3	**Transformer Protection Panel**	
10.3.1	Transformer Differential Protection Relay including all AUX. CTs (if applicable)	1 No
10.3.2	Restricted Earth Fault Protection Relay with Non Linear Resitor (if applicable)	1 No
10.3.3	Backup Protection Relay with Three O/C and E/F Element	1 No
10.3.4	Over Fluxing Relay (if Stand alone)	1 No
10.3.5	CVT selection relay (if stand alone)	1 No
10.3.6	Over Load Relay with Timer (if Stand Alone)	1 No
11.0	**Sub-station Automation System Spare**	
11.1	Bay Control Unit (of each type)	1 No
11.2	Ethernet Switch of Each type	1 No
11.3	optical cable with end terminations of each length/type	5 set
12.0	**Fire Fighting System**	1 LS
13.0	**Illumination System**	1 LS
14.0	**LT Switchgear**	1 LS

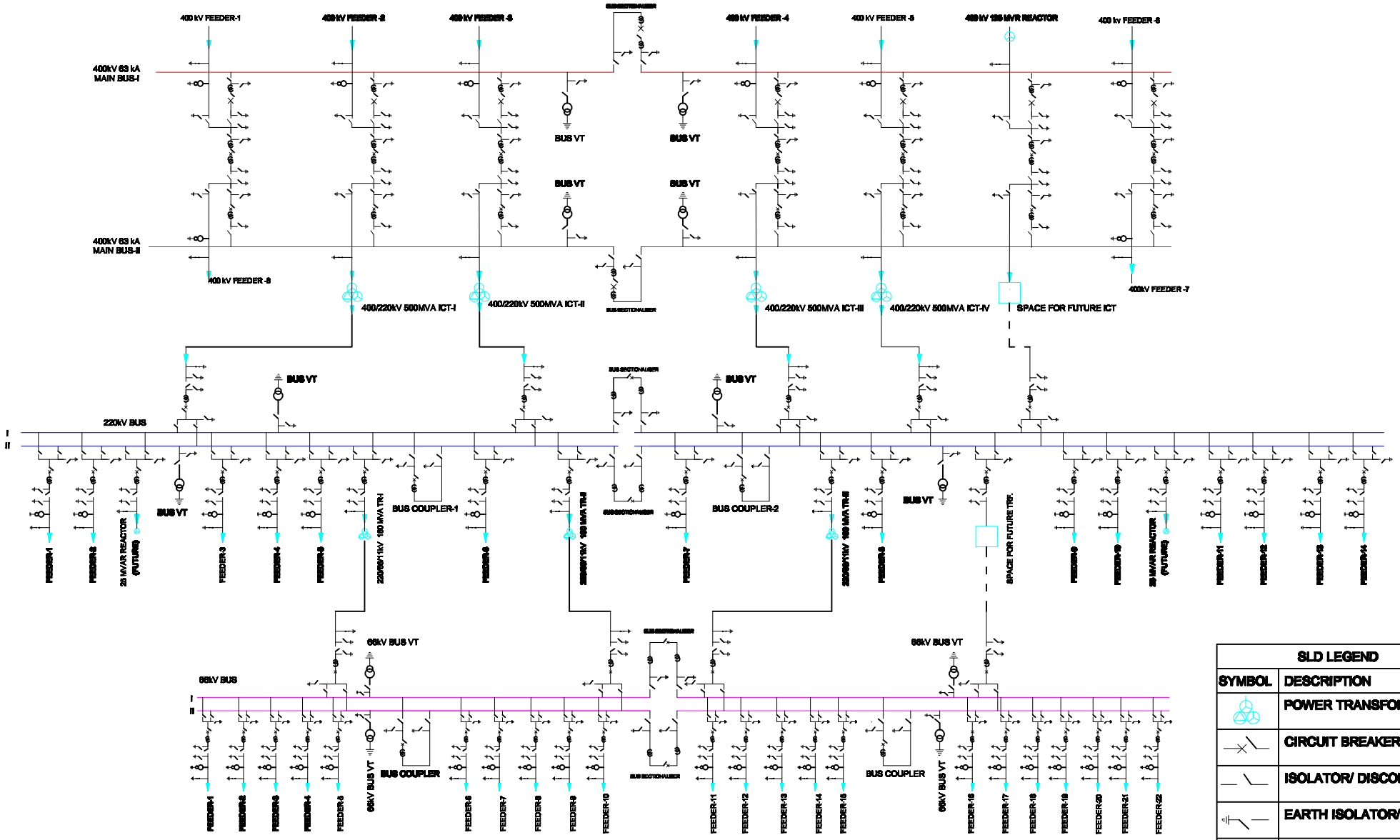
Annexure-II

List of Drawings for 400/220/66kV Gas Insulated Sub-Station Tikri Khurd

1. Tentative Single Line Diagram of 400/220/66kV GIS Sub-station **(Annexure-IIA).**
2. Tentative Layout Plan of 400/220/66kV GIS Sub-station -**(Annexure-IIB)**.
3. Tentative Floor Plan for Ground, First, Second & Third Floor. **(Annexure-IIC)**
4. Sub-vendor approved list **(Annexure-IID)**
5. Tentative SAS Architecture (In section: Substation Automation)

Annexure-IIA

TENTATIVE SINGLE LINE DIAGRAM (SLD) OF 400/220/66 kV GIS S/STN. AT TIKRI KHURD

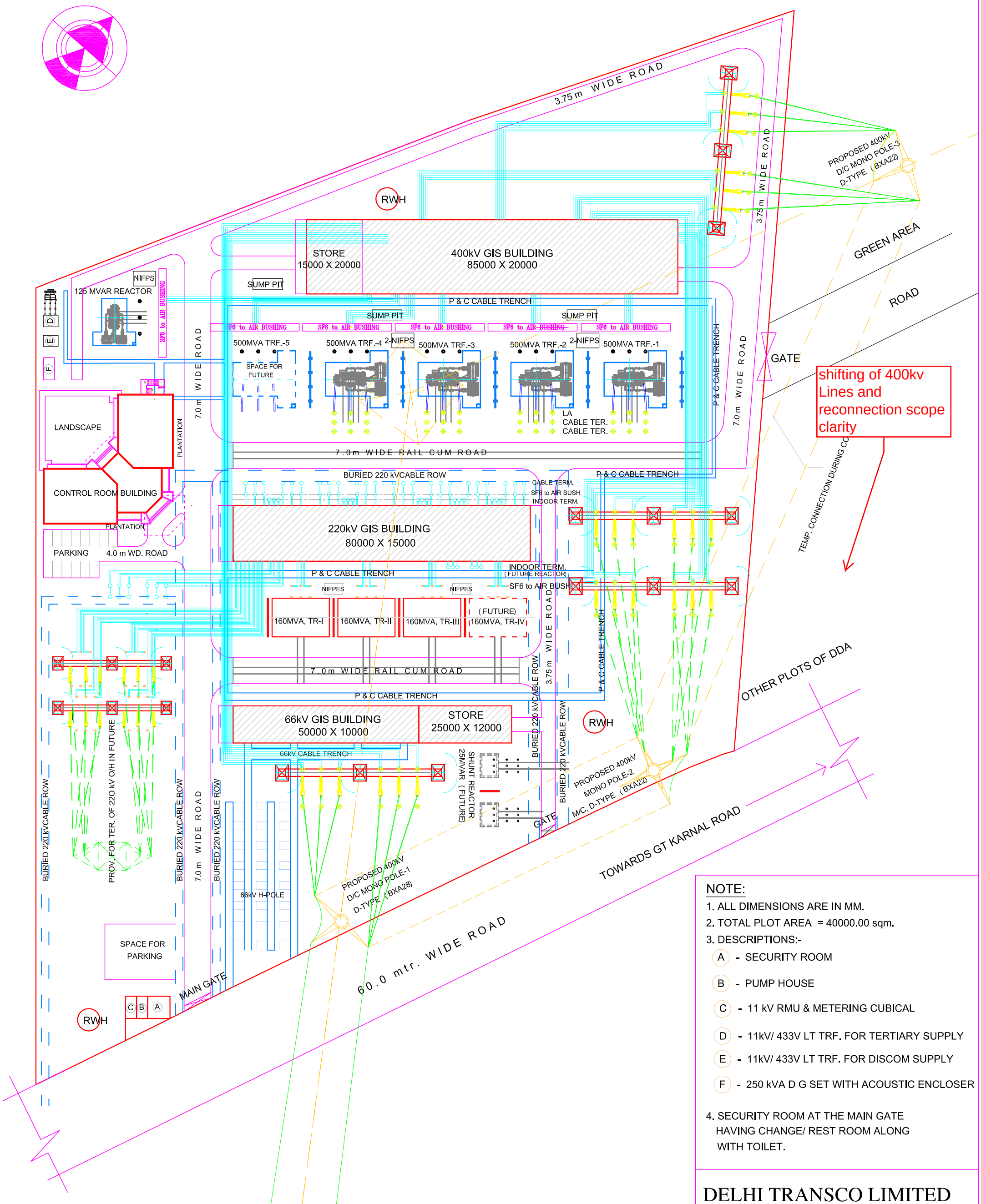


SLD LEGEND	
SYMBOL	DESCRIPTION
	POWER TRANSFORMER
	CIRCUIT BREAKER
	ISOLATOR/ DISCONNECTOR
	EARTH ISOLATOR/ SWITCH
	VOLTAGE TRANSFORMER
	CURRENT TRANSFORMER
	SURGE ARRESTOR
	SHUNT REACTOR

NOTE:-

THE SLD IS TENTATIVE AND SHALL BE FINILISED AT DETAIL ENGINEERING STAGE AS PER TECHNICAL SPECIFICATION.

Annexure-IIB



TENTATIVE LAYOUT OF 400/220/66 kV GIS SUB STATION AT TIKRI KHURD

NOTE:

1. ALL DIMENSIONS ARE IN MM.
2. TOTAL PLOT AREA = 40000.00 sqm.
3. DESCRIPTIONS:-
   - (A) - SECURITY ROOM
   - (B) - PUMP HOUSE
   - (C) - 11 kV RMU & METERING CUBICAL
   - (D) - 11kV/ 433V LT TRF. FOR TERTIARY SUPPLY
   - (E) - 11kV/ 433V LT TRF. FOR DISCOM SUPPLY
   - (F) - 250 kVA D G SET WITH ACOUSTIC ENCLOSER
4. SECURITY ROOM AT THE MAIN GATE HAVING CHANGE/ REST ROOM ALONG WITH TOILET.

DELHI TRANSCO LIMITED

400/220/66kV SUB STN. TIKRI KHURD

DRG NO.	SHEET NO.	REV.
SCALE N.T.S.	DATE	
DRAWN BY DEEPAK ARCHITECTURAL ASSTT.	CHECKED BY	

Annexure-IIC

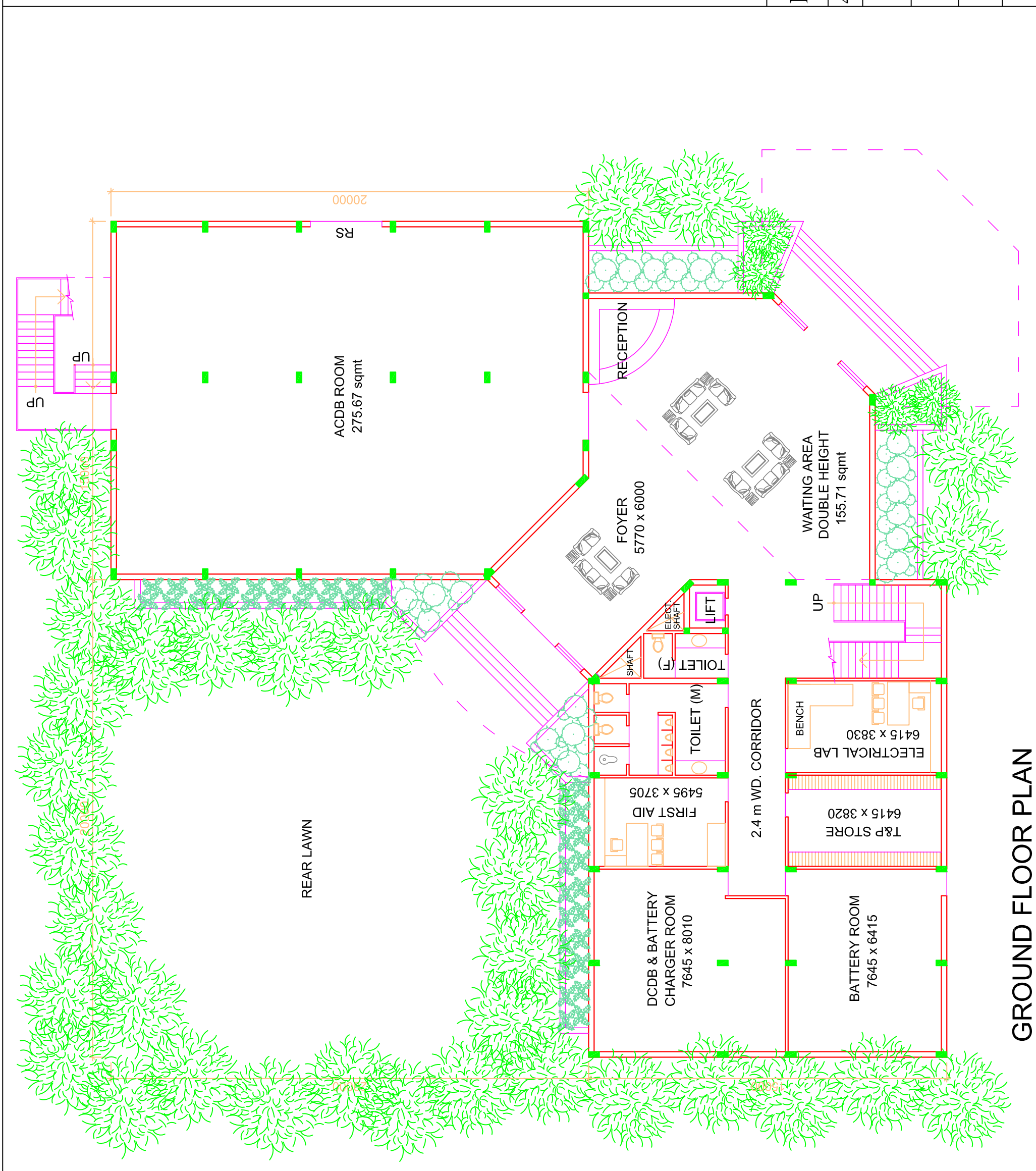
DELHI TRANSCO LIMITED

400/220/66 KV S/STN TIKRI KHURD

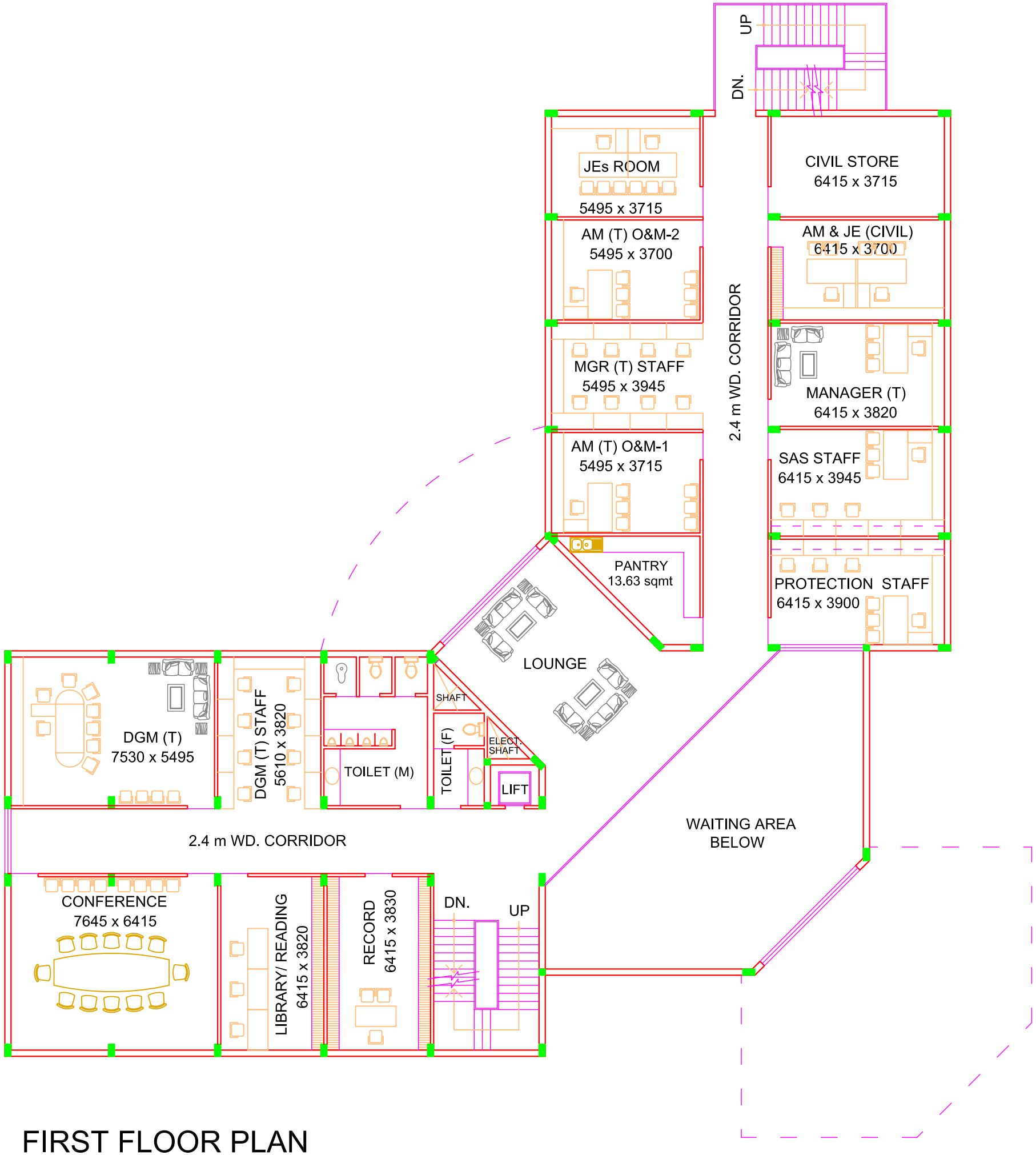
PROJECT

TITLE
PROPOSED FLOOR PLANS

DRG NO.	SHEET NO.	REV.
SCALE N.T.S.	DATE	
DEALT BY DEEPAK TYAGI ARCHITECTURAL ASSTT.	CHECKED BY	



GROUND FLOOR PLAN



FIRST FLOOR PLAN

DELHI TRANSCO LIMITED

400/220/66 KV S/STN TIKRI KHURD

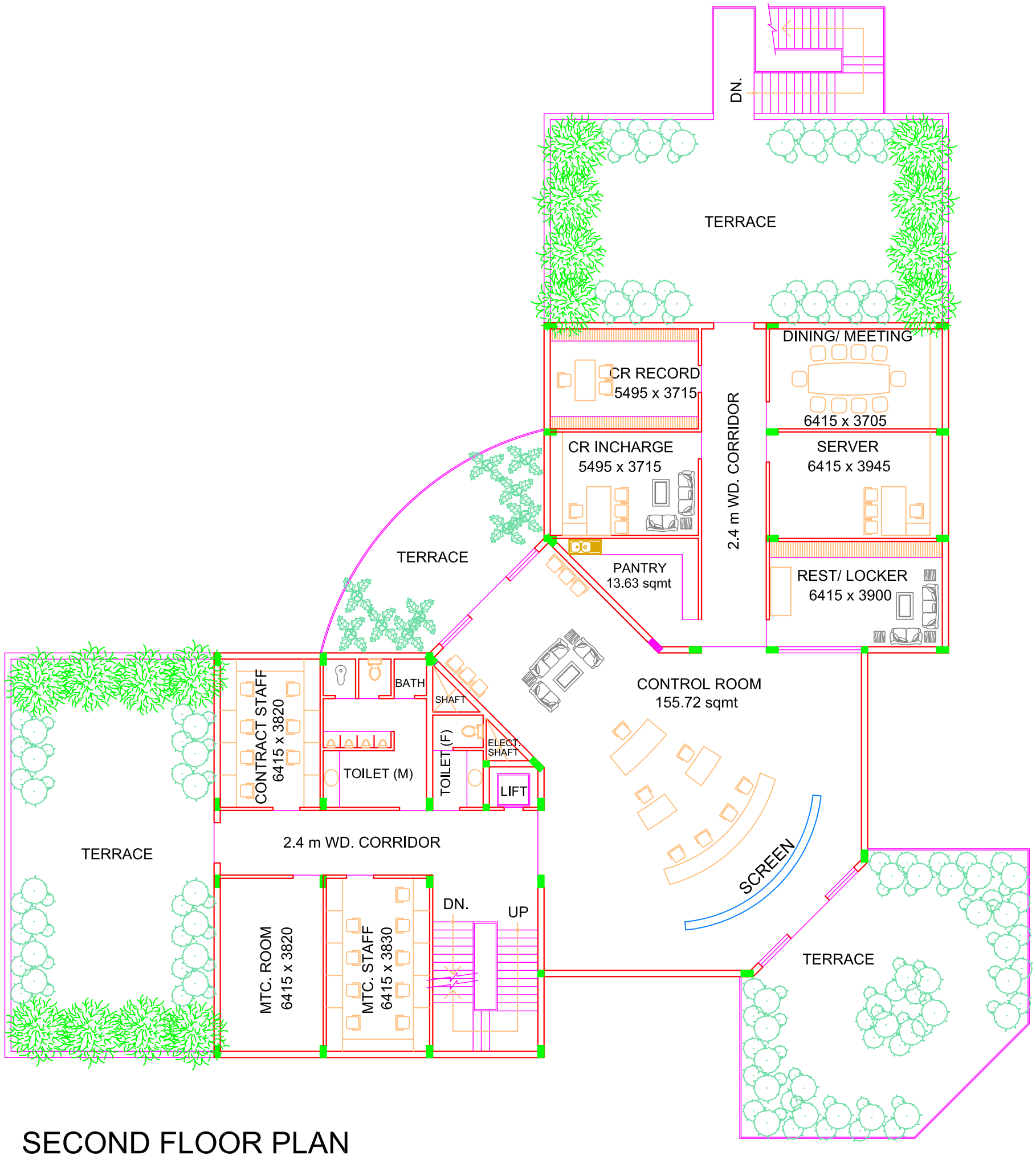
PROJECT

TITLE
PROPOSED FLOOR PLANS

DRG NO.	SHEET NO.	REV.

SCALE	DATE
N.T.S.	

DEALT BY	CHECKED BY
DEEPAK TYAGI ARCHITECTURAL ASSTT.	



SECOND FLOOR PLAN

DELHI TRANSCO LIMITED

400/220/66 KV S/STN TIKRI KHURD

PROJECT

TITLE
PROPOSED FLOOR PLANS

DRG NO.	SHEET NO.	REV.

SCALE	DATE
N.T.S.	

DEALT BY	CHECKED BY
DEEPAK TYAGI ARCHITECTURAL ASSTT.	

Annexure-IID

Approved Sub-Vendor List.

S. No.	Category	Name of Equipment/Material	Name of sub-Vendor	Date of approval
1	AC	AIR CONDITIONING	AON ENGINEERS	03.01.2019
2		2.0TR Split AC	Mark Engineerig Inc.	04.10.2023
3		AC System	Mark Engineering	24.12.2021
4		AHU & AIR CONDITIONING UNIT	AON ENGINEERS & CONSULTANT PVT LTD.	28.07.2017
5		AHU,VENTILATION SYSTEM	AON ENGINEERS	03.01.2019
6		Air Conditiong System	Voltas	23.09.2021
7		Air conditioning System (Volts make) & Ventilation System (Edgetech air system Pvt Ltd make)	Aon Engineers and Consultants Pvt.Ltd.	08.01.2021
8		AIR CONDITIONING,VENTILATION DB AND DCDB	SHIVALIC POWER CONTROL	20.12.2018
9		Split AC & AHU	Aon Engineers and Consultants Pvt Ltd	25.11.2021
10		Ventillation System	Mark Engineering	08.10.2021
11		Ventillation System	Wollaque Ventillation & Conditioning Pvt Ltd	10.06.2021
12	Battery	BATTERY CHARGER	HBL	03.01.2019
13		Battery Bank	HBL Power Systems Ltd	23.12.2021
14		Battery Bank	Exide Industries Limited	27.08.2021
15		BATTERY BANK	HBL	03.01.2019
16		Battery Charger	Chloride Power Systems & Solutions Ltd	17.08.2021
17		Battery Charger	Statcon Energia Pvt Ltd	23.12.2021
18	Bushing	220 KV,1250 AMP RIP BUSHINGS	MOSER GLASER, SWITZERLAND	01.04.19
19		220kV RIP Bushing	MGC (Moser Glaser)	25.01.2021
20		33 KV 3150A HV PORCELAIN BUSHING, M-TYPE OLTC	EASON MR	21.06.2017
21		33 KV,3150 AMP BUSHINGS	CJI, KHURJA	01.04.19
22		33kV LV Bushing	CJI Porcrlian (P) Limited	17.02.2021
23		1.1kV , 1Cx630 Sqmm XLPE, Armoured Power Cable & 1.1kV, 1Cx150Sqmm PVC, Armoured Power Cable	KEI Industries Ltd	15.10.2020
24		1.1kV ,10Cx2.5Sqmm FRLS Control Cable & 1.1kV , 6Cx2.5Sqmm FRLS Control Cables	KEI Industries Ltd	15.10.2020
25		1.1KV 3CX50 SQ.MM POWER CABLE	SURAJ CABLES	06.08.2018
26		1.1kV FRLS, AL, PVC, Armoured Control & Power Cables	KEI Industries Ltd	31.12.2020
27		1.1kV Grade PVC Power & Control Cables	Cords Cable Industries Ltd	27.07.2021
28		1.1kV LT Cable	Gemscab Industries Ltd.	25.09.2023

29	Cable	1.1kV LT Power & Control cable	Gemscab Industries Limited	27.12.2021
30		1.1kV Power & Control cables	KEI Industries Limited	14.10.2021
31		1.1KV POWER & CONTROL CABLES	CORDS CABLE INDUSTRIES LTD	17.10.2017
32		1.1KV XLPE & PVC POWER & CONTROL CABLES	KEI	15.01.2019
33		1.1kV, 3.5cX300Sq.mm. AL XLPE Power Cable	KEI Industries Limited	06.07.2021
34		220kV , 1000Sq.MM XLPE Cable	KEC International Limited	08.03.2021
35		220kV 1000 Sq.mm. XLPE Cable	LS Cable India Pvt. Ltd.	10.10.2024
36		33kV XLPE cable	KEI Industries Limited	03.11.2021
37		33kV, 3X400 Sq.mm XLPE Power Cable & 1.1kV, 10x2.5 Sq.mm FRLS Control Cable	KEI Industries Ltd	10.02.2021
38		66kV , XLPE , 1x1200Sqmm Power Cables	KEI Industries Ltd	15.10.2020
39		66KV XLPE 1Cx1000 SQ. MM CABLE	KEI	09.01.2019
40		66KV,1200 SQ.MM. XLPE CABLE, COPPER CONDUCTOR	UNIVERSAL CABLE LTD	11.10.2017
41		CONTROL CABLE 10 CORE 2.5 SQ MM	CORDS CABLE	10.05.2018
42	Capacitor Bank	33kV , 10MVAR Capacitor Bank	Universal Cables Ltd	21.10.2020
43	CB	33KV CB	CG POWER	17.08.2017
44		220 KV CB	GE T&D	13.02.2018
45		220kV & 66kV SF6 CB	Siemens Ltd.	10.06.2020
46		220KV CB	CG POWER	01.08.2018
47		220kV CB	ABB India Ltd	21.10.2020
48		220kV SF6 CB	Siemens Ltd.	23.12.2020
49		33kV CB	CG Power and Industries Solutions Ltd	12.01.2021
50		33kV CB	Siemens Ltd.	29.09.2020
51		33KV O/D CB	CG POWER	17.08.2017
52		33KV SF6 O/D CB	CG POWER	21.01.2019
53		400 KV CB	GE T&D	13.02.2018
54		400kV CB	Siemens Ltd.	24.02.2021
55		66kV CB	Siemens Ltd.	12.02.2021
56		66kV O/D SF6 CB	Siemens Ltd	19.08.2021
57		66kV SF6 CB	Siemens Ltd	07.09.2021
58		66KV SF6 CB	CG POWER	19.12.2017
59		72.5kV SF-6 Circuit Breaker	CG Power and Industrial Solutions Ltd.	22.09.2023
60		CB (22KV & 66KV)	CG POWER	15.05.2018
61	CCTV	CCTV	Delcom Telesystems Pvt Ltd	16.09.2021
62		CCTV	Siemens Ltd.	29.09.2020
63		CCTV ALONG WITH ITS ACCESSORIES	DELCOM	25.01.2019
64		400KV CLAMPS CONNECTOR	PRECICAST	04.05.2018

65	Clamp	Clamp , Connector & Hardware fitting	Legion Energy	19.01.2021
66		Clamps & Connectors	Precicast	05.08.2021
67		Clamps & Connectors	Legion Energy	08.12.2021
68		CLAMPS, CONNECTORS	PRECICAST	11.04.19
69		CLAMPS, CONNECTORS	NOOTAN	13.06.19
70		CLAMPS, CONNECTORS	LEGION ENERGY	17.07.19
71		C-WEDGE CONNECTOR	RPG RAYCHEM	27.06.2018
72		Terminal Connectors	Legion Energy	23.09.2021
73	Conductor	EARTH WIRE	CABCON	19.12.2017
74		4" DIA IPS TUBE	SUDAL INDUSTRIES LIMITED	05.10.208
75		4" IPS AL tube	Alom Extrusions Limited	20.12.2021
76		ACSR ZEBRA CONDUCTOR	HARYANA CONDUCTOR	06.03.2019
77		ACSR Zebra Conductor	Mahavir Transmission Limitd	08.09.2021
78		ACSR Zebra Conductor	Cabcon India Ltd	08.12.2021
79		ACSR ZEBRA CONDUCTOR	LUMINO LTD.	15.03.2018
80		ACSR ZEBRA CONDUCTOR	CABCON	25.04.2018
81		ACSR Zebra Conductor	Haryana Conductor Pvt Ltd	23.12.2020
82		Bersimis Conductor	Gupta Power Infrastructure Limited	01.12.2020
83		EARTH WIRE	BHARAT WIRE ROPE	15.03.2018
84		OPGW	ZTT LTD.	15.03.2018
85	Crane	EOT Crane	Reva Industries Limited	23.12.2020
86	CT	17.5 KV NCT	MEHRU ELECTRICAL & MECHANICAL ENGINEERING PVT LTD.	07.06.2017
87		17.5kV, 800-400/1 A NCT	Kapco Electric Ltd	01.01.2021
88		220 KV CT 1600-800/1/1/1/1/1 A	MEHRU ELECTRICAL	16.08.19
89		220kV CT	Mehru Electricals and Mechanical Engginers Pvt Limited	01.12.2020
90		220KV CT	HEPTA CARE	14.09.2018
91		245kV CT, 1600-800/1-1-1-1-1	ABB India Ltd	05.10.2020
92		33 kv GIS Sectionlizer CT	Narayan Powertech Pvt. Ltd., India	16.12.2021
93		33kV CT	Mehru Electrical & Mechanical Engineering Pvt Ltd	08.10.2021
94		33kV CT	Kapco Electric Ltd	25.03.2021
95		33kV GIS Bus Coupler CT	Zelisko	13.10.2021
96		33kV GIS CT (bus sectionalizer)	Zelisko	20.12.2021
97		33kV GIS CT, PT & LA	Zelisko & Narayan Powertech Pvt. Ltd., India & RITZ, Germany & Nexans Euromould, Belgium	22.12.2021
98		400 KV CT	GE T&D	08.03.2018
99		400kV CT	Mehru Electricals and Mechanical Engginers Pvt Limited	23.12.2020

100		66 KV CT	MEHRU ELECTRICAL & MECHANICAL ENGINEERING PVT LTD.	29.02.2018
101		66kV NCT	Mehru Electricals and Mechanical Engginers Pvt Limited	04.12.2020
102		NCT	HEPTACARE	03.06.19
103		NCT	Kapco Electric Ltd	06.08.2021
104	CVT	220KV CVT	CG POWER	01.08.2018
105		220kV & 66kV CVT	Mehru Electricals and Mechanical Engginers Pvt Limited	12.06.2020
106		220KV CVT	MEHRU	25.04.2018
107		66KV CVT	CG POWER	25.04.2018
108		66kV O/D CVT	Mehru Electrical & Mechanical Engineering Pvt Ltd	08.10.2021
109	DG	AMF PANEL	JAKSON	16.01.2019
110		250 KVA DG SET	ELMECH ENGINEERS LTD	01.08.2017
111		250 KVA DG SET	SUDHIR POWER LTD.	19.06.19
112		250kVA DG Set	Jakson Ltd	08.02.2021
113		250kVA DG SET	Electro Equipments	17.02.2021
114	DTS	DTS System	A P Sensing Gmbh, Germany	22.09.2021
115	Earthing Material	Earthing Material & Structural Steel	Good Luck Steel Tubes Limited	10.06.2021
116		Earthing Material, Steel Structure and Cable Tray	HS Engineering Works	06.11.2023
117	Fire fighting	Fire Detection & Alarm system	3D Fire & Safety Private Limited	01.12.2020
118		Fire Extingushers	3D Fire and safety Private Limited	20.12.2021
119		Fire Fighting System	Bhartiya Caccianlanza Fire System Ltd	09.12.2021
120		FIRE PREVENTION & EXTINGUISHING SYSTEM	3D FIRE & SAFETY	03.01.2019
121		Fire Prevention System & Extingushers	3D Fire and safety Private Limited	16.09.2021
122		FIRE PROTECTION SYSTEM	3D FIRE & SAFETY	22.01.2018
123		NIFPES	CTR	01.04.19
124		NIFPES	CTR Manufacturing Industries Ltd	17.02.2021
125	Fitting	HARDWARE FITINGS AND CLAMP CONNECTORS	LEGION ENERGY	19.06.2018
126		400KV & 220KV TOWER HARDWARE FITTING	SRI RAM ENGINEERING	17.04.2017
127		Hardware and Accessories	IAC Electricals	26.02.2021
128		Hardware Fitting	Legion Energy Products Pvt. Ltd.	19.09.2023
129		Hardware Fitting of HTLS conductor	Sicame India Connector Pvt. Ltd.	22.07.2024
130		HARDWARE FITTING, ACCESSORIES FOR HTLS	SICAME INDIA CONNECTOR PVT LTD	04.04.2018

131	Fitting	HARDWARE FITTINGS	LEGION ENERGY	16.10.2018
132		HARDWARE FITTINGS	SICAME INDIA CONNECTORS	18.07.19
133		HARDWARE FITTINGS OPGW	LEGION ENERGY	12.10.2018
134		HARDWARE FITTINGS(400KV&220KV)	LEGION ENERGY	01.06.2018
135		Hardware Items(Tesnion, Suspension, Bus Bar Spacers and Equipment Clamps)	Legion Energy	07.08.2020
136		STRING HARDWARE FITTINGS	INTERNATIONAL TRANSMISSION LTD.	18.07.19
137	GIS	220kV GIS	Siemens Ltd.	29.09.2020
138		33kV GIS	Schneider Electric Infrastructure Ltd	28.01.2021
139		66kV GIS	GE T&D India Limited	31.07.2020
140	Illumination	Illumination System	Bajaj	23.09.2021
141		Light Cum Lightening Mast	Bajaj	22.09.2023
142		Lighting Fixtures	Bajaj	27.08.2021
143		LIGHTING MAST	TRANSRAIL	23.01.2018
144		Lighting Mast	Bajaj	24.12.2021
145	Insulator	11KV 120 KN ANTI-FOG DISC INSULATOR	IEC	19.02.2018
146		66KV PORCELAIN INSULATORS	IEC	19.12.2017
147		11kV ,120kN Disc Insulators & 33kV BPI	IEC	28.10.2021
148		11kV, 120KN Anti Fog Disc Insulators	Aditya Birla Insulators Pvt Ltd	01.02.2021
149		160 KN LONG ROD POLYMER INSULATOR	SRI RAM ENGINEERING	09.05.2017
150		220kV & 66kV BPI and Disc Insulator	IEC	22.07.2020
151		220KV & 66KV INSULATOR	IEC	25.04.2018
152		220kV BPI	Aditya Birla Insulators Pvt Ltd	23.12.2020
153		33 KV BPI	ADITYA BIRLA INDUSTRIES	02.08.19
154		33kV & 66kV BPI	Aditya Birla Insulators	17.08.2021
155		33kV BPI	IEC	29.09.2020
156		400kV BPI	Aditya Birla Insulators Pvt Ltd	23.12.2020
157		90KN LONG ROD POLYMER INSULATOR	SRI RAM ENGINEERING	09.05.2017
158		Disc Insulator	IEC	27.07.2020
159		DISC INSULATOR, 160KN & 90 KN	IEC	22.10.2018
160		LONG ROD POLYMER INSULATOR	SHREE RADHE INDUSTRIES	02.09.2019
161		Long Rod Polymer Insulator	Olectra Green Tech limited	03.07.2020
162		LONG ROD POLYMER INSULATOR	DECCAN ENTERPRISES	09.10.2018
163		POLYMER INSULATOR	SPARK INSULATOR	15.03.2018
164		POST INSULATORS	ADITYA BIRLA	24.11.2017
165		SOLID CORE INSULATORS	IEC	01.11.2018

166	Isolator	220 KV ISOLATOR	G NANDY & CO.	05.10.208
167		220kV Isolators	G.R.Power Switchgear Ltd	01.12.2020
168		33kV Isolator	GR Power Switchgear Ltd	14.10.2021
169		33kV Isolator	Switchgear Manufacturing Company (SMC) Private Limited	27.05.2021
170		33kV O/D Isolator	G.K.Electricals	17.02.2021
171		33KV,630 AMP,O/D ISOLATOR	G K ELECTRICAL	12.10.2017
172		400 KV & 220 KV ISOLATOR	GR POWER	28.02.2018
173		400 KV & 220 KV SOLID CORE POST INSULATOR	CG POWER	19.02.2018
174		400kV Isolator	G.R.Power Switchgear Ltd	23.12.2020
175		66kV Isolator	GR Power Switchgear Ltd	21.09.2021
176		72.5kV Isolators	G.R.Power Switchgear Ltd	07.09.2020
177		ISOLATOR(220KV & 66KV)	G NANDY & CO.	19.07.2018
178	Joint	11KV I/D &O/D TERMINATION KIT	3M ELECTRO & COMMUNICATION	03.10.2017
179		220KV I/D GIS TERMINATION KIT	RAYCHEM(P) LTD	14.09.2017
180		220kV Indoor & Outdoor Termination Kit	Reychem RPG Ltd	08.01.2021
181		33KV I/D &O/D TERMINATION KIT	3M ELECTRO & COMMUNICATION	03.10.2017
182		33KV END TERMINATION KIT	RAYCHEM RPG	16.08.2017
183		33KV GIS TERMINATION KIT	RAYCHEM/ TYCO ELECTRONE	16.08.2017
184		33kV O/D & 11kV I/D & O/D Termination kits	3M Electro & Communication India Pvt Ltd	20.12.2021
185		33kV O/D touch proff Termination kit	Nexans Euromould	21.12.2021
186		66kV Indoor Termination Kit	3M Electro & Communication India Pvt Ltd	15.06.2021
187		66KV O/D & I/D TERMINATION KIT	RPG RAYCHEM	01.11.2018
188		66KV O/D TERMINATION KIT	3M ELECTRO & COMMUNICATION	03.10.2017
189		66kV Outdoor Termination Kit, 33kV Indoor & outdoor Termination Kit	3M Electro & Communication India Pvt. Ltd	15.10.2020
190		Cable Link Box	Peace Power	02.09.2021
191		CABLE LINK BOX &CABLE CLEAT	PEACE POWER	23.05.2018
192		LINK BOX	ALFA ELMECH	04.06.2018
193		O/D &I/D TERMINATION AND STRAIGHT THROUGH	NKT GERMANY	19.02.2018
194		Out Door Termination Kit	3M Electro & Communication India Pvt Ltd	14.10.2021
195		Out Door Termination Kit	Raychem RPG	29.11.2021
196		Straight through joints	Bruggkabel	26.10.2021
197		STRAIGHT THROUGH JOINTS,220KV, 630 SQ.MM	BRUGG KABEL AG, SWITZERLAND	23.07.2018

198		Termination Kit	3M Electro & Communication India Pvt. Ltd	17.07.2020
199		Termination Kit	NKT Cables Gmbh, Germany	27.07.2021
200		TERMINATION KIT , 66KV I/D	RAYCHEM RPG (P) LTD	10.10.2017
201		TERMINATION PART MALE FOR 33KV XLPE CABLE	PFISTER	05.12.2017
202	LA	11KV SURGE ARRESTOR	OBLUM ELECTRICAL INDUSTRIES PVT LTD	07.06.2017
203		400 KV & 220 KV LA	CG POWER	19.02.2018
204		11kV LA	Lamco Industries Pvt Ltd	12.02.2021
205		220KV LA	CG POWER	07.08.2018
206		220kV LA	Lamco Industries Pvt Ltd	22.12.2020
207		33kV GIS LA	Nexans Euromould, Belgium	18.10.2021
208		33kV LA	Lamco Industries Pvt Ltd	14.12.2020
209		400kV LA	Lamco Industries Pvt Ltd	01.12.2020
210		66kV LA	Lamco Industries Pvt Limited	06.09.2021
211		66KV LA	CG POWER	19.12.2017
212		LA 198 KV & 60 KV	LAMCO	20.11.2018
213	Machine	OIL FILTERATION PLANT, 6000 LPH	CEE DEE VACCUM EQUIPMENT PVT LTD	17.06.2017
214		OIL STORAGE TANK	CEE DEE VACUUM EQUIPMENT PVT. LTD.	01.04.19
215		OIL STORAGE TANK	SUMESH PETROLEUM	11.03.2019
216		TRF. OIL STORAGE TANK	VACCUM PLANT & INSTRUMENTS	27.02.2018
217	OFC	OFC	VINDHYA TELELINK LTD.	19.02.2018
218		48F & 4F Optical Fibre Cable (OFC)	Vindhya Telelinks Ltd	12.08.2021
219		4F and 48F OFC	Aksh Optifibre Ltd.	10.10.2024
220		OFC,48F SINGLE MODE ARMOURED CABLE	PARAMOUNT	28.08.2017
221	Oil	Oil for Reactor	Savita Oil Technologies Ltd	12.03.2021
222		Oil for Reactor	APAR Industries Limited	16.02.2021
223		Tranformer Oil	APAR Industries Limited	04.08.2021
224		TRANSFORMER OIL	SAVITA OIL	13.05.19
225		TRANSFORMER OIL	APAR INDUSTRIES	16.05.19
226		Transformer Oil	Savita Oil Technologies Ltd	08.12.2020
227		Transformer Oil (Type-II Un-inhabited)	Columbia Petro Chem Pvt Ltd	27.10.2020
228		JB/ BMK	UNILEC ENGINEER	20.12.2017
229		11kV CRP	ABB India Ltd	26.02.2021
230		11kV Indoor Switchgear	CG Power and Industrial solution limited	15.06.2021
231		11kV Switchgear	Schneider Electric Infrastructure Ltd	14.12.2020
232		11KV SWITCHGEAR PANEL BOARD	CG POWER	21.01.2019
233		220 KV C&R PANEL	SHIFANG AUTOMATION	11.05.2018
234		220kV & 33kV CRP and SAS	Schneider Electric Infrastructure Ltd	08.12.2020

235		220kV & 33kV CRP and SAS	Schneider Electric Infrastructure Ltd	14.12.2020
236		220kV & 66kV C&R Panel	Siemens Ltd.	03.07.2020
237		220kV C&R Panel	Siemens Ltd.	23.12.2020
238		220KV CRP	SIEMENS	25.04.2018
239		400 KV & 220 KV C&R PANEL FOR TRANSFORMER	GE T&D	13.02.2018
240		400kV C&R Panel	Siemens Ltd	05.04.2021
241		415V MAIN SWITCH BOARD,ACDB,DCDB,MLDB,ELDB	SHIVALIC POWER CONTROL	20.12.2018
242		66 KV C&R PANELS	SIFANG AUTOMATION (I) PVT LTD	16.03.2018
243		66kV C&R panel	Siemens Ltd	07.12.2021
244	Panel	66kV CRP Panel	Siemens Ltd.	19.08.2020
245		66kV CRP Panel	GE T&D India Limited	31.07.2020
246		AC Koisk	SRD Building Products Ltd	07.01.2021
247		BMK & TK	NITYA ELECTRO CONTROL	14.09.2018
248		CRM	Scope	14.08.2020
249		CRP & SAS	Schneider Electric Infrastructure Ltd	13.10.2021
250		FOTE	Siemens Ltd.	04.12.2020
251		FOTE	GE T&D India Limited	31.07.2020
252		JB & BMK	Nitya Electrocontrols Pvt Ltd	10.07.2020
253		LT SWITCHGEAR	NITYA ELCTRO CONTROLS PVT. LTD.	21.05.19
254		LT Switchgear	Ultima Switchgears Ltd	09.07.2021
255		LT Switchgear	Nitya Electrocontrols Pvt Ltd	20.12.2021
256		MARSHALLING BOX FOR 400 KV CVT	ADOBE METAL PRODUCTS	30.08.19
257		SAS	GE T&D India Limited	31.07.2020
258		Terminal Kiosk	Nitya Electrocontrols Pvt Ltd	17.11.2021
259		TERMINAL KIOSK(TK)	NITYA ELECTRO CONTROL	05.10.208
260		Terminal Kisok / BMK	Nitya Electrocontrols Pvt Ltd	01.12.2020
261	Pipe	HDPE Pipe 250mm & 50mm dia	Trupati structures Ltd.	10.10.2024
262		HDPE Pipe 250mm dia	Flow Well Profile	10.10.2024
263		PE 80 PN06 250MM HDPE Pipe	Flow Well Profiles	04.12.2020
264	PT	11KV PT	MEHRU ELECTRICAL & MECHANICAL ENGINEERING PVT LTD.	07.06.2017
265		11KV PT	KAPCO ELECTRIC(P) LTD	09.01.2019
266		33kV Class, 170kVp, O/D,11kV ratio PT	Mehru Electrical & Mechanical Engineering Pvt Ltd	06.07.2021
267		33kV Class, 170kVp, O/D,11kV ratio PT	Kapco Electric Ltd	12.07.2021
268		33kV GIS PT	RITZ, Germany	18.10.2021

269		33kV PT	Mehru Electrical & Mechnical Engg. Pvt. Ltd.	07.12.2023
270		PT & LA (Components of 220kV GIS)	Shandong Taikai High Volt Sitchgear Co Ltd	07.07.2021
271	Slab	RCC cable Cover	Anmol Products/ Accurate Electrotech India Pvt. Ltd.	10.10.2024
272		RCC Cover Slab	Anmol Products	09.03.2021
273		RCC Cover Slab	Accurate Electrotech India Pvt Ltd.	21.09.2021
274		RCC Cover Slab, Route & Joint Marker	J K Spun Pipes	01.10.2021
275		RCC Cover Slab, Route & Joint Marker	Accurate Electrotech India Pvt Ltd.	16.02.2021
276		RCC SLAB	ANMOL PRODUCTS	18.09.2018
277		Route Marker	Anmol Products/ Accurate Electrotech India Pvt. Ltd.	10.10.2024
278	Structure	Structural Steel	H S Engineering	22.09.2021
279		Anti Theft Nut Bolts	Nexo Industries Ltd	02.09.2021
280		Anti Theft Nuts & Bolts	Capital Bolts and Hardwares	24.11.2020
281		EARTHING & TOWER & BEAM MATERIAL	HS ENGINEERING	13.12.2018
282		FABRICATION & SUPPLY OF TOWER PARTS A-TYPE SUSPENSION NARROW BASE TOWER	NEXO INDUSTRIES PRIVATE LIMITED	14.02.2019
283		FABRICATION & SUPPLY OF TOWER PARTS A-TYPE SUSPENSION NARROW BASE TOWER	SAWARIA PIPES PRIVATE LIMITED	30.01.2019
284		GI Angle	HS Engineering	28.08.2020
285		GI STEEL FOR SUPPORTING STRUCTURE	HS ENGINEERING	26.05.2017
286		GI STRUCTURE	HS ENGINEERING	05.10.208
287		Glavanised Structure & Earthing Materials	H S Engineering	17.02.2021
288		Grounding/Earthing and Pipe / Lattice Structure	HS Engineering	01.12.2020
289		LATTICE STRUCTURE & EARTHING MATERIAL	HS ENGINEERING	19.12.2017
290		LATTICE STRUCTURE&EARTHING MATERIAL	H S ENGINEERING	25.04.2018
291		NUT & BOLTS	BHARTI OVERSEAS	15.03.2018
292		Steel Structure	HS Engineering	02.09.2021
293		Structural Steel & Foundation Bolts	HS Engineering	29.09.2020
294		STUB & TOWER PARTS	ANIL STEEL PRIVATE LIMITED	09.10.2018
295		TOWER ACCESSORIES	AISHA TRANSMISSION	15.03.2018
296		TOWER PARTS	UTKARSH LTD.	15.03.2018
297		3-PHASE RELAY TESTING KIT	DOBBLE ENGINEERING (P) LTD	24.01.2018
298		CB operational Analyser	Doble	14.08.2020
299		Dew Point Meter	Phymetrix	14.08.2020

300	Testing Kit	DEW POINT METER	BEACON ENERGY SOLUTION PVT LTD	11.07.2017
301		Fiber Splicing Machine	Keith Electronics Pvt. Ltd. (Fujikura make)	24.09.2024
302		Gas Mask	3M	14.08.2020
303		Gas Mask	3M	19.09.2023
304		LEAKAGE DETECTOR	BEACON ENERGY SOLUTION PVT LTD	11.07.2017
305		OTDR	Agmatel India Pvt. Ltd.(VIAVI Make)	24.09.2024
306		Partial discharge monitoring kit	Om Technical Solutions (Make- Qualitrol)	25.09.2023
307		Partial Discharge Monitoring system	Qualitrol	14.08.2020
308		Primary Injection Kit	Kamtron System Pvt. Ltd.(Megger Make)	19.09.2023
309		SF6 FILLING & EVACUATING EQUIPMENT	BEACON ENERGY SOLUTION PVT LTD	11.07.2017
310		SF-6 Gas Analyzer	Wika Instruments India Pvt. Ltd.	25.01.2024
311		SF6 Gas Filling and Evacuation Plant	DILO	01.12.2020
312		SF-6 Gas Filling and Evacuation Plant	WIKA	23.09.2024
313		SF6 Leakage detector	Enervac	14.08.2020
314		Warning Tape	V4 You Group	06.10.2021
315	Transformer	220kV , 25MVAR Shunt Reactor	Transformers & Rectifiers India Ltd	28.10.2020
316		400 KVA TRANSFORMER	TBEA	15.01.2018
317		400kVA, 11/0.433kV LT Transformer	Svasca Industries India Ltd	06.07.2021
318		630 KVA, 11/0.433 KV,170 KVP LT TRANSFORMER	TOSHIBA	01.11.2018
319		800kVA LT Transformer	Tesla Transformers (India) Ltd	23.09.2020
320		Bucholz Relay, SPR & PRV/PRD	VIAT Instruments Pvt Ltd (ATVUS)	08.04.2021
321		OLTC	Easun MR Tap Changers(P) Ltd	03.12.2020
322		OLTC	CTR Manufacturing Industries Ltd	11.08.2021
323		PRV	VIAT Instruments Pvt Ltd (ATVUS)	04.08.2021
324		Series Reactor	Shrihans Electricals Pvt Ltd	23.12.2021
325		WTI & OTI	Precimeasure Controls Pvt. Ltd.	04.08.2021

ANNEXURE_BOQ_GIS_TIKRIKHURD

ANNEXURE BOQ_400kV GIS_SUPPLY_DTL TIKRI
REV No: 00
DATE: 27.01.2025

Sl. No.	Item Description	Unit	Qty.	Remarks
1	**SUPPLY- GIS : 420KV, 63KA FOR 1S, GAS INSULATED SWITCHGEAR (GIS) AS PER TS**			
1.01	GIS BAY SUPPLY: Transformer bay module : 420kV, 3150A, SF6 gas insulated ICT feeder bay module each comprising of SF6 gas insulated circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting ICT with GIS through SF6 to Air Bushing/duct etc., to complete transformer bay module .	Set	5	
1.02	GIS BAY SUPPLY: Reactor Bay module : 420kV, 3150A SF6 Bus Reactor bay module comprising of SF6 gas insulated circuit breaker, current transformer, disconnectors switches, safety grounding switches, SF6 gas monitoring system for the complete bus reactor bay for connecting reactor with GIS through SF6 to Air Bushing/duct etc., to complete Reactor bay module .	Set	1	
1.03	GIS BAY SUPPLY: Feeder Bay Module : 420kV, 3150A, SF6 gas insulated Line feeder bay module each comprising of SF6 gas insulated circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, high speed fault making grounding switch, surge arrestor, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting Overhead line through SF6 to Air Bushing/SF6 Ducts etc. to complete feeder bay module.	Set	8	
1.04	GIS SUPPLY: Bus Bars : 420kV, 4000A, 3 single phase (isolated), SF6 gas insulated, metal enclosed bus bars each enclosed in three individual bus enclosures running along the length of the switchgear to interconnect each of circuit breaker bay module. Each bus bar set shall be complete with voltage transformer, disconnector with grounding switches, SF6 gas monitoring system for the complete bus etc.	Set	2	
1.05	GIS BAY SUPPLY: Tie Bay Module : 420kV, 3150A, SF6 gas insulated tie bay module each comprising of SF6 gas insulated circuit breaker, current transformer, disconnectors switches, safety grounding switches, SF6 gas monitoring system for the complete bay etc.	Set	7	
1.06	GIS BAY SUPPLY: Bus section Module 420kV, 3150A, SF6 gas insulated bus sectionaliser bay module comprising of SF6 gas insulated circuit breaker , current Transformer, two disconnectors with safety grounding switches, SF6 Gas monitoring system for complete bay etc.	Set	2	
1.07	GIS SUPPLY: 400kV, 3150A, SF6/Air Bushing for Connecting GIS to AIS, single phase	No.	42	
1.08	GIS SUPPLY: 400kV, 3150A, 1 Phase SF6 GIS Bus duct	Meter	5300	
1.09	GIS SUPPLY: 400kV, GIS Bus duct support structure	MT	330	
1.10	GIS SUPPLY: GIS SUPPLY: Local Control Cubicles (LCC)	SET	23	
2	**SUPPLY- GIS : SPECIAL TOOLS AND TESTING & MAINTENANCE INSTRUMENTS AS PER TS**			
2.01	SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS -SF6 Gas filling and evacuating plant	Set	1	
2.02	SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS -SF6 Gas Analyser	Set	1	
2.03	SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS -SF6 gas leak detector	Set	1	
2.04	GIS SUPPLY: Online Partial Discharge Monitoring System as per Technical Specification	SET	1	
2.05	SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS -Gas masks	Nos.	10	
2.06	SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS -Contact resistance meter	Set	1	
2.07	SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS -Circuit Breaker Operational Analyser with DCRM	Set	1	
2.08	SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS -Digital Insulation test kit,10 kV	Set	1	
2.09	SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS -Clamp on meter suitable for measuring the secondary current of CT in mA and load current upto 300 A	Set	1	
2.10	SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS -Digital Earth resistance meter complete with all accessories	Set	1	
2.11	SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS -Thermoscanning camera for transmission line and substations upto 400 kV	Set	1	
3	**SPARES- GIS : 420KV, 63KA FOR 1S, GAS INSULATED SWITCHGEAR (GIS) AS PER TS**			
3.01	GIS SPARES: 400 KV GIS	LS	1	LS=Lump Sum/LOT
3.02	GIS SPARES: 400kV CB	LS	1	LS=Lump Sum/LOT
3.03	GIS SPARES: 400kV CT (single phase current transformers of each rating)	LS	1	LS=Lump Sum/LOT
3.04	GIS SPARES: 400kV VT (Single phase VT complete with all Gaskets and mounting hardware)	LS	1	LS=Lump Sum/LOT
3.05	GIS SPARES: 400kV Isolators & ES	LS	1	LS=Lump Sum/LOT
3.06	GIS SPARES: 400 kV Surge arrestor	LS	1	LS=Lump Sum/LOT
4	SPARES- GIS : **REFERENCE UNIT PRICE FOR ADDITION / DELETION** OF SUPPLY ITEMS (Unit Prices of Individual Equipment included here or in manadatory spares are required for any Addition/Deletion of Equipment and replacement of damaged items. Bidder to ensure that the unit prices have a logical relationship with prices of assemblies in main items. Quoting for unit prices is mandatory and shall be considered for evaluation)			
4.01	SPARES: 400KV GIS- GIS METALLIC ENCLOSURE	KG	50	
4.02	SPARES: 400KV GIS- EXPANSION BELLOWS/ JOINTS	SET	1	1 SET= For Single Phase of any type and any rating.

ANNEXURE_BOQ_GIS_TIKRIKHURD

Sl. No.	Item Description	Unit	Qty.	Remarks
4.03	SPARES: 400KV GIS- TEE BEND	SET	1	1 SET= For Single Phase of any type and any rating.
4.04	SPARES: 400KV GIS- L BEND	SET	1	1 SET= For Single Phase of any type and any rating.
4.05	SPARES: 400kV, 3150A, 1 Phase SF6 GIS Bus duct	Meter	1	
4.06	SPARES: 400 kV Surge arrestor	Set	1	1 SET= For complete 3 phase Surge Arrester.
4.07	SPARES: Controlled Switching Device 3-ph Circuit Breaker	No.	1	

ANNEXURE_BOQ_GIS_TIKRIKHURD

ANNEXURE BOQ_400kV GIS_SERVICES_DTL TIKRI
REV No: 00
DATE: 27.01.2025

Sl. No.	Description	Unit	Quantity	Remarks
5	**SERVICES- GIS : 400KV, 63KA FOR IS, GAS INSULATED SWITCHGEAR (GIS) AS PER TS**			
5.01	SERVICES- 400kV GIS: SUPERVISION OF ERECTION OF GIS	Bays	23	Supervision of erection of GIS with main bus, complete as per TS in all respect including LCC, its accessories and CSD (if applicable). It also includes verification of materials for proper storage at site for final storage. Earthing, SF6 Gas Fiiling works, Internal Cabling from GIS to LCC, interfacing of CSD (if applicable) with GIS/CRP, including Structure Works are covered under this item. GIS Bus Duct & SF6 to Air Bushing (SAB) are not covered in this BOQ item.
5.02	SERVICES- 400kV GIS: SUPERVISION OF ERECTION OF GAS INSULATED BUS DUCT	Meter	5300	Supervision of erection of GIB complete as per TS in all respect.Gas Insulated Bus Duct (GIB) length of bus duct outside the GIS BAY MODULE shall be considered for mode of measurement from the end of Bay equipment (VT, LA etc.) to end equipment (SF6 to air bushing / SF6 to oil bushing/ Cable connection module etc.). This includes both indoor & outdoor GIB, including any TEE bends/L bends/ elbows/etc. Earthing, SF6 Gas Fiiling works, Internal Cabling from GIS to LCC, including Structure Works are covered under this item.
5.03	SERVICES- 400kV GIS: SUPERVISION OF ERECTION OF SF6 TO AIR BUSHING	SET	42	Earthing & Structural Works are covered under this item.
5.04	SERVICES- 400kV GIS: TESTING & COMMISSIONING OF GIS	Bays	23	Testing and commissioning of complete GIS system including main bus, LCC and associated system is to be executed by bidder. All the special testing instruments, kits, T&P etc. are to be arranged by bidder on returnable basis. Please refer relevant section of technical specification for details.
5.05	SERVICES- 400kV GIS : TESTING & COMMISSIONING OF GAS INSULATED BUS DUCT	Meter	5300	Gas Insulated Bus Duct (GIB) length of bus duct outside the GIS BAY MODULE shall be considered for mode of measurement from the end of Bay equipment (VT, LA etc.) to end equipment (SF6 to air bushing / SF6 to oil bushing/ Cable connection module etc.). This includes both indoor & outdoor GIB, including any TEE bends/L bends/ elbows/etc. All the special testing instruments, kits, T&P etc. are to be arranged by bidder on returnable basis. Please refer relevant section of technical specification for details.
5.06	SERVICES- 400kV GIS : TESTING & COMMISSIONING OF SF6 TO AIR BUSHING	SET	42	
5.07	SERVICES- 400kV GIS : FINAL SUCCESSFUL HV/ POWER FREQUENCY TESTING OF GIS INCLUDING ARRANGING OF HV TEST KIT ALONG WITH OPERATOR	Bays	23	Carrying out successful HV/ Power Frequency Testing of GIS as per IEC including Arrangement of HV Test kit with operator (on returnable basis) shall be in scope of bidder, which includes charges of HV test kit with operator, accessories & tools required for completion of HV testing. The quoted price shall include GIS bays including Main Bus, GIB & SAB and other common items as per TS complete in all respect. In this BOQ item, mobilization and demobilization for HV test kit is considered for once. In case of more, for reasons not attributable to bidder, same shall be paid extra as per BOQ Item.
5.08	SERVICES- 400kV GIS : INSULATION CO-ORDINATION STUDIES FOR GIS SYSTEM	LOT	1	1 Lot means Complete study report as per technical specification, Including VFTO report.
5.09	SERVICES- 400kV GIS : TRAINING FOR GIS AT SITE	MANDAYS	40	Refer the specific clause of technical specification for scope and curriculum of training.
5.10	SERVICES- 400kV GIS : TRAINING FOR GIS AT MANUFACTURER WORKS	MANDAYS	20	Refer the specific clause of technical specification for scope and curriculum of training. Lodging & boarding of participants are not in bidder's scope.
5.11	SERVICES- 400kV GIS : SUPERVISION OF ERECTION OF ONLINE PD MONITORING SYSTEM	LOT	1	Scope includes supervision of Erection of complete Online Partial Discharge Monitoring System (PDM) for 400kV GIS along with interfacing with SAS. To be done by OPDM OEM.
5.12	SERVICES- 400kV GIS :TESTING & COMMISSIONING OF ONLINE PD MONITORING SYSTEM	LOT	1	Scope includes testing & commissioning of complete Online Partial Discharge Monitoring System (PDM) for 400kV GIS along with interfacing with SAS. To be done by OPDM OEM.

6	SERVICES- GIS : **REFERENCE UNIT PRICE FOR ADDITION / DELETION** OF SERVICES: (UNIT PRICES OF INDIVIDUAL SERVICES INCLUDED HERE ARE REQUIRED FOR ANY ADDITION/DELETION OF EQUIPMENT AND REPLACEMENT OF DAMAGED ITEMS. VENDOR TO ENSURE THAT THE UNIT PRICES HAVE A LOGICAL RELATIONSHIP WITH PRICES OF ASSEMBLIES IN MAIN ITEMS. QUOTING FOR UNIT PRICES IS MANDATORY AND SHALL BE CONSIDERED FOR EVALUATION)			
6.01	SERVICES- 400kV GIS: REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - **SERVICES FOR SUPERVISION OF ERECTION OF GIS**	MANDAY	10	Charges for repetition of services - (if required due to reasons not attributed to the bidder) This item will be executed only if repetition of services is required by BHEL.

ANNEXURE_BOQ_GIS_TIKRIKHURD

Sl. No.	Description	Unit	Quantity	Remarks
6.02	SERVICES- 400kV GIS: REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT **- SERVICES FOR TESTING & COMMISSIONING OF GIS**	MANDAY	10	Charges for repetition of services - (if required due to reasons not attributed to the bidder) This item will be executed only if repetition of services is required by BHEL.
	DEMOBILIZATION AND REMOBILIZATION CHARGES			
6.03	SERVICES- 400kV GIS: DEMOBILIZATION AND REMOBILIZATION CHARGES FOR GIS **ERECTION SUPERVISION TEAM**	Set	2	THIS BOQ ITEM SHALL BE EXECUTED IF REQUIRED FOR REASONS NOT ATTRIBUTABLE TO BIDDER.
6.04	SERVICES- 400kV GIS: DEMOBILIZATION AND REMOBILIZATION CHARGES FOR GIS **TESTING & COMMISSIONING TEAM**	Set	2	BOQ ITEM SHALL BE PAYABLE IF REQUIRED FOR REASONS NOT ATTRIBUTE TO BIDDER. HV TESTING IS NOT PART OF THIS ITEM.
6.05	SERVICES- 400kV GIS: DEMOBILIZATION & REMOBILIZATION CHARGES OF **HV TEST KIT** ALONG WITH OPERATOR	Lot	1	In this BOQ item, mobilization and demobilization chages for HV test kit is considered for second time or more , for reasons not attributable to bidder. HV testing charges shall be paid per bay basis as per main HV testing charge.

ANNEXURE_BOQ_GIS_TIKRIKHURD

ANNEXURE BOQ 220kV GIS SUPPLY DTL TIKRI
REV No: 00
DATE: 27.01.2025

Sl. No.	Item Description	Unit	Qty.	Remarks
1	**SUPPLY- GIS : 220KV, 50KA FOR 1S, GAS INSULATED SWITCHGEAR (GIS) AS PER TS**			
1.01	500MVA Transformer I/C Bay Module : 245kV, 2500 A, SF6 gas insulated 500MVA transformer incomer bay module each comprising of SF6 gas insulated circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting ICT with GIS through double run cable directly indoor type GIS cable termination., to complete transformer incomer bay module.	Set	5	
1.02	160MVA Transformer Bay Module: 245kV, 1600 A, SF6 gas insulated 160/100 MVA transformer bay module each comprising of SF6 gas insulated circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting transformer with GIS through duct/SF6 to Air bushing etc. to complete transformer bay module.	Set	4	
1.03	Feeder Bay Module : 245kV, 1600A, SF6 gas insulated Line feeder bay module each comprising of SF6 gas insulated circuit breaker, current transformer, two bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, high speed fault making grounding switch, surge arresters, SF6 gas monitoring system for complete bay, PT, disconector switch for PT, gas insulated terminal connection for connecting feeders through SF6 to Air Bushing/duct. to complete feeder bay module.	Set	14	
1.04	Reactor Bay Module: 245kV, 1600 A, SF6 gas insulated reactor bay module each comprising of SF6 gas insulated circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting reactor with GIS throughindoor cable termination bay module.	set	2	
1.05	Bus Coupler Bay : 245kV, 2500A, SF6 gas insulated bus coupler bay module comprising of SF6 gas insulated circuit breaker, current transformer, disconnectors switches, safety grounding switches, SF6 gas monitoring system for the complete bay etc.	Set	2	
1.06	Bus sectionaliser Bay Module: 245 kV 2500A SF6 gas insulated bus sectionaliser bay module comparising of SF6 gas insulated circuit breaker , current Transformer, two disconnectors with safety grounding switches, SF6 Gas monitoring system for complete bay etc.	Set	2	
1.07	Bus Bars : 245kV, 3-phase or single phase encapsulated unit, SF6 gas insulated, metal enclosed 2500A bus bars each enclosed in bus enclosures running along the length of the switchgear to interconnect each of circuit breaker bay module. Each bus bar set shall be complete with voltage transformer, disconnector with grounding switches, SF6 gas monitoring system for the complete bus etc.	Set	2	
1.08	245kV, 1600A, SF6/Air Bushing for Connecting GIS to AIS alongwith support structure, single phase	No.	54	
1.09	245kV, 1600A, 1 Phase SF6 GIS Bus duct	Meter	1900	
1.10	GIS SUPPLY: 220kV, GIS Bus duct support structure	MT	60	
1.11	GIS SUPPLY: Local Control Cubicles (LCC)	SET	29	
1.12	Portable Partial Discharge Monitoring System as per Technical Specification	SET	1	
2	**SPARES- GIS : 220KV, 50KA FOR 1S, MANDATORY SPARES AS PER TECHNICAL SPECIFICATION**			
2.01	220 KV GIS	LS	1	LS=Lump Sum/LOT
2.02	245kV CB	LS	1	LS=Lump Sum/LOT
2.03	245kV CT (single phase current transformers of each rating)	LS	1	LS=Lump Sum/LOT
2.04	245kV VT (Single phase VT complete with all Gaskets and mounting hardware)	LS	1	LS=Lump Sum/LOT
2.05	245kV Isolators & ES	LS	1	LS=Lump Sum/LOT
2.06	220 kV Surge arrestor	LS	1	LS=Lump Sum/LOT
3	**SPARES- GIS : 220KV, 50KA FOR 1S, REFERENCE UNIT PRICE FOR ADDITION / DELETION OF SUPPLY ITEMS** (Unit Prices of Individual Equipment included here or in manadatory spares are required for any Addition/Deletion of Equipment and replacement of damaged items. Bidder to ensure that the unit prices have a logical relationship with prices of assemblies in main items. Quoting for unit prices is mandatory and shall be considered for evaluation)			
3.01	SPARES: 400KV GIS- GIS METALLIC ENCLOSURE	KG	50	
3.02	SPARES: 220KV GIS- EXPANSION BELLOWS/ JOINTS	SET	1	1 SET= For Single Phase of any type and any rating.
3.03	SPARES: 220KV GIS- TEE BEND	SET	1	1 SET= For Single Phase of any type and any rating.
3.04	SPARES: 220KV GIS- L BEND	SET	1	1 SET= For Single Phase of any type and any rating.

3.05	SPARES: 220kV, 1 Phase SF6 GIS Bus duct	Meter	1	
3.06	SPARES: 220 kV Surge arrestor	Set	1	1 SET= For complete 3 phase Surge Arrester.
3.07	SPARES: 220kV, GIS Bus duct support structure	MT	1	
3.08	SPARES: Controlled Switching Device 3-ph Circuit Breaker	No.	1	

ANNEXURE_BOQ_GIS_TIKRIKHURD

ANNEXURE BOQ 220kV GIS SERVICE DTL TIKRI
REV No: 00
DATE: 27.01.2025

Sl. No.	Description	Unit	Quantity	Remarks
4	**SERVICES- GIS : 220KV, 50KA FOR IS, GAS INSULATED SWITCHGEAR (GIS) AS PER TS**			
4.01	SERVICES- 220kV GIS: SUPERVISION OF ERECTION OF GIS	Bays	29	Supervision of erection of GIS with main bus, complete as per TS in all respect including LCC, its accessories and CSD (if applicable). It also includes verification of materials for proper storage at site for final storage. Earthing, SF6 Gas Fiiling works, Internal Cabling from GIS to LCC, interfacing of CSD (if applicable) with GIS/CRP, including Structure Works are covered under this item. GIS Bus Duct & SF6 to Air Bushing (SAB) are not covered in this BOQ item. Complete GIS bay module including Gas insulated terminal connection (cable housing), if appplicable, is included in scope.
4.02	SERVICES- 220kV GIS: SUPERVISION OF ERECTION OF GAS INSULATED BUS DUCT	Meter	1900	Supervision of erection of GIB complete as per TS in all respect.Gas Insulated Bus Duct (GIB) length of bus duct outside the GIS BAY MODULE shall be considered for mode of measurement from the end of Bay equipment (VT, LA etc.) to end equipment (SF6 to air bushing / SF6 to oil bushing/ Cable connection module etc.). This includes both indoor & outdoor GIB, including any TEE bends/L bends/ elbows/etc. Earthing, SF6 Gas Fiiling works, Internal Cabling from GIS to LCC, including Structure Works are covered under this item.
4.03	SERVICES- 220kV GIS: SUPERVISION OF ERECTION OF SF6 TO AIR BUSHING	SET	54	Earthing, SF6 Gas Fiiling works, Internal Cabling from GIS to LCC, including Structure Works are covered under this item.
4.04	SERVICES- 220kV GIS: TESTING & COMMISSIONING OF GIS	Bays	29	Testing and commissioning of complete GIS system including main bus, LCC and associated system is to be executed by bidder. All the special testing instruments, kits, T&P etc. are to be arranged by bidder on returnable basis. Please refer relevant section of technical specification for details.
4.05	SERVICES- 220kV GIS : TESTING & COMMISSIONING OF GAS INSULATED BUS DUCT	Meter	1900	Gas Insulated Bus Duct (GIB) length of bus duct outside the GIS BAY MODULE shall be considered for mode of measurement from the end of Bay equipment (VT, LA etc.) to end equipment (SF6 to air bushing / SF6 to oil bushing/ Cable connection module etc.). This includes both indoor & outdoor GIB, including any TEE bends/L bends/ elbows/etc. All the special testing instruments, kits, T&P etc. are to be arranged by bidder on returnable basis. Please refer relevant section of technical specification for details.
4.06	SERVICES- 220kV GIS : TESTING & COMMISSIONING OF SF6 TO AIR BUSHING	SET	54	
4.07	SERVICES- 220kV GIS : FINAL SUCCESSFUL HV/ POWER FREQUENCY TESTING OF GIS INCLUDING ARRANGING OF HV TEST KIT ALONG WITH OPERATOR	Bays	29	Carrying out successful HV/ Power Frequency Testing of GIS as per IEC including Arrangement of HV Test kit with operator (on returnable basis) shall be in scope of bidder, which includes charges of HV test kit with operator, accessories & tools required for completion of HV testing. The quoted price shall include GIS bays including Main Bus, GIB & SAB and other common items as per TS complete in all respect. In this BOQ item, mobilization and demobilization for HV test kit is considered for once. In case of more, for reasons not attributable to bidder, same shall be paid
4.08	SERVICES- 220kV GIS : INSULATION CO-ORDINATION STUDIES FOR GIS SYSTEM	LOT	1	1 Lot means Complete study report as per technical specification, Including VFTO report.
4.09	SERVICES- 220kV GIS : TRAINING FOR GIS AT SITE	MANDAYS	20	Refer the specific clause of technical specification for scope and curriculum of training.
4.10	SERVICES- 220kV GIS : TRAINING FOR GIS AT MANUFACTURER WORKS	MANDAYS	10	Refer the specific clause of technical specification for scope and curriculum of training. Lodging & boarding of participants are not in bidder's scope.

5	SERVICES- GIS : 220KV, 50KA FOR 1S, **REFERENCE UNIT PRICE FOR ADDITION / DELETION** OF SERVICES: (UNIT PRICES OF INDIVIDUAL SERVICES INCLUDED HERE ARE REQUIRED FOR ANY ADDITION/DELETION OF EQUIPMENT AND REPLACEMENT OF DAMAGED ITEMS. VENDOR TO ENSURE THAT THE UNIT PRICES HAVE A LOGICAL RELATIONSHIP WITH PRICES OF ASSEMBLIES IN MAIN ITEMS. QUOTING FOR UNIT PRICES IS MANDATORY AND SHALL BE CONSIDERED FOR EVALUATION)			
5.01	SERVICES- 220kV GIS: REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - **SERVICES FOR SUPERVISION OF ERECTION OF GIS**	MANDAY	10	Charges for repetition of services - (if required due to reasons not attributed to the bidder) This item will be executed only if repetition of services is required by BHEL.
5.02	SERVICES- 220kV GIS: REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - **SERVICES FOR TESTING & COMMISSIONING OF GIS**	MANDAY	10	Charges for repetition of services - (if required due to reasons not attributed to the bidder) This item will be executed only if repetition of services is required by BHEL.
	DEMOBILIZATION AND REMOBILIZATION CHARGES			
5.03	SERVICES- 220kV GIS: DEMOBILIZATION AND REMOBILIZATION CHARGES FOR GIS **ERECTION SUPERVISION TEAM**	Set	2	THIS BOQ ITEM SHALL BE EXECUTED IF REQUIRED FOR REASONS NOT ATTRIBUTABLE TO BIDDER.
5.04	SERVICES- 220kV GIS: DEMOBILIZATION AND REMOBILIZATION CHARGES FOR GIS **TESTING & COMMISSIONING TEAM**	Set	2	BOQ ITEM SHALL BE PAYABLE IF REQUIRED FOR REASONS NOT ATTRIBUTE TO BIDDER. HV TESTING IS NOT PART OF THIS ITEM.
5.05	SERVICES- 220kV GIS: DEMOBILIZATION & REMOBILIZATION CHARGES OF **HV TEST KIT** ALONG WITH OPERATOR	Lot	1	In this BOQ item, mobilization and demobilization chages for HV test kit is considered for second time or more , for reasons not attributable to bidder. HV testing charges shall be paid per bay basis as per main HV testing charge.

ANNEXURE_BOQ_GIS_TIKRIKHURD

ANNEXURE BOQ 66kV GIS SUPPLY DTL TIKRI
REV No: 00
DATE: 27.01.2025

Sl. No.	Item Description	Unit	Qty.	Remarks
1	**SUPPLY- GIS : 66KV, 31.5KA FOR 1S, GAS INSULATED SWITCHGEAR (GIS) AS PER TS**			
1.01	Transformer Bay Module : 72.5kV, 2000/2500A, SF6 gas insulated transformer bay module each comprising of SF6 gas insulated circuit breaker, current transformer, Two nos. of bus-bar disconnectors with common grounding switch, line disconnector with one normal & one high speed fault make grounding switch, surge arrestors, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting transformer through XLPE cable with cable end box and accessories with GIS, etc. to complete transformer bay module.	Set	4	
1.02	Feeder Bay Module : 72.5kV, 2000A, SF6 gas insulated feeder bay module each comprising of SF6 gas insulated circuit breaker(2000A), current transformer, two bus-bar disconnectors with one earthing switch, line disconnector with one normal & one high speed fault make grounding switch, surge arrestors, SF6 gas monitoring system for complete bay, PT, gas insulated terminal connection for connecting XLPE cable with cable termination enclosure and accessories with GIS, etc. to complete feeder bay module.	Set	22	
1.03	Bus Bars: 72.5kV, 3000A, 3-phase or single phase encapsulated unit, SF6 gas insulated, metal enclosed bus bars each enclosed in bus enclosures running along the length of the switchgear to interconnect each of circuit breaker bay module. Each bus bar set shall be complete with voltage transformer, disconnector with safety ground switches, SF6 Gas monitoring system etc for the complete bus	Set	2	
1.04	Bus Coupler Bay : 72.5kV, 2500A, SF6 gas insulated bus coupler bay module comprising of SF6 gas insulated circuit breaker, current transformer, two nos. of disconnectors with earthing switches, SF6 gas monitoring system for complete bay, etc.	Set	2	
1.05	Bus Sectionliser bay : 72.5kV, 2500A, SF6 gas insulated bus bus Sectionliser bay module comprising of SF6 gas insulated circuit breaker, current transformer, two nos. of disconnectors with earthing switches, SF6 gas monitoring system for complete bay, etc.	Set	2	
1.06	GIS SUPPLY: Local Control Cubicles (LCC)	SET	30	
1.07	Portable Partial Discharge Monitoring System as per Technical Specification	SET	1	
2	**SPARES- GIS : 66KV, 31.5KA FOR 1S, GAS INSULATED SWITCHGEAR (GIS) AS PER TS**			
2.01	66kV GIS	LS	1	LS=Lump Sum/LOT
2.02	66kV Circuit Breaker	LS	1	LS=Lump Sum/LOT
2.03	66kV Isolator	LS	1	LS=Lump Sum/LOT
2.04	66kV CT	LS	1	LS=Lump Sum/LOT
2.05	66kV Voltage transformer	LS	1	LS=Lump Sum/LOT
2.06	66kV SurgeArrestor	LS	1	LS=Lump Sum/LOT

3	SPARES- GIS :66KV, **REFERENCE UNIT PRICE FOR ADDITION / DELETION** OF SUPPLY ITEMS (Unit Prices of Individual Equipment included here or in manadatory spares are required for any Addition/Deletion of Equipment and replacement of damaged items. Bidder to ensure that the unit prices have a logical relationship with prices of assemblies in main items. Quoting for unit prices is mandatory and shall be considered for evaluation)			
3.01	SPARES: 66 KV GIS- GIS METALLIC ENCLOSURE	KG	50	
3.02	SPARES: 66 KV GIS- EXPANSION BELLOWS/ JOINTS	SET	1	1 SET= For Single Phase of any type and any rating.
3.03	SPARES: 66 KV GIS- TEE BEND	SET	1	1 SET= For Single Phase of any type and any rating.
3.04	SPARES: 66 KV GIS- L BEND	SET	1	1 SET= For Single Phase of any type and any rating.
3.05	SPARES: 66 kV Surge arrestor	Set	1	1 SET= For complete 3 phase Surge Arrester.

ANNEXURE_BOQ_GIS_TIKRIKHURD

ANNEXURE BOQ_66kV GIS_SERVICE_DTL TIKRI
REV No: 00
DATE: 27.01.2025

Sl. No.	Description	Unit	Quantity	Remarks
4	**SERVICES- GIS : 66KV, GAS INSULATED SWITCHGEAR (GIS) AS PER TS**			
4.01	SERVICES- 66kV GIS: SUPERVISION OF ERECTION OF GIS	Bays	30	Supervision of erection of GIS with main bus, complete as per TS in all respect including LCC and its accessories. It also includes verification of materials for proper storage at site for final storage. Earthing, SF6 Gas Fiiling works, Internal Cabling from GIS to LCC, including Structure Works are covered under this item. Complete GIS bay module including Gas insulated terminal connection (cable housing), if appplicable, is included in scope.
4.02	SERVICES- 66kV GIS: TESTING & COMMISSIONING OF GIS	Bays	30	Testing and commissioning of complete GIS system including main bus, LCC and associated system is to be executed by bidder. All the special testing instruments, kits, T&P etc. are to be arranged by bidder on returnable basis. Please refer relevant section of technical specification for details.
4.03	SERVICES- 66kV GIS : FINAL SUCCESSFUL HV/ POWER FREQUENCY TESTING OF GIS INCLUDING ARRANGING OF HV TEST KIT ALONG WITH OPERATOR	Bays	30	Carrying out successful HV/ Power Frequency Testing of GIS as per IEC including Arrangement of HV Test kit with operator (on returnable basis) shall be in scope of bidder, which includes charges of HV test kit with operator, accessories & tools required for completion of HV testing. The quoted price shall include GIS bays including Main Bus, GIB & SAB and other common items as per TS complete in all respect. In this BOQ item, mobilization and demobilization for HV test kit is considered for once. In case of more, for reasons not attributable to bidder, same shall be paid extra as per BOQ Item.
4.04	SERVICES- 66kV GIS : INSULATION CO-ORDINATION STUDIES FOR GIS SYSTEM	LOT	1	1 Lot means Complete study report as per technical specification, Including VFTO report.
4.05	SERVICES- 66kV GIS : TRAINING FOR GIS AT SITE	MANDAYS	20	Refer the specific clause of technical specification for scope and curriculum of training.
4.06	SERVICES- 66kV GIS : TRAINING FOR GIS AT MANUFACTURER WORKS	MANDAYS	10	Refer the specific clause of technical specification for scope and curriculum of training. Lodging & boarding of participants are not in bidder's scope.
5	SERVICES- GIS : 66KV, **REFERENCE UNIT PRICE FOR ADDITION / DELETION** OF SERVICES: (UNIT PRICES OF INDIVIDUAL SERVICES INCLUDED HERE ARE REQUIRED FOR ANY ADDITION/DELETION OF EQUIPMENT AND REPLACEMENT OF DAMAGED ITEMS. VENDOR TO ENSURE THAT THE UNIT PRICES HAVE A LOGICAL RELATIONSHIP WITH PRICES OF ASSEMBLIES IN MAIN ITEMS. QUOTING FOR UNIT PRICES IS MANDATORY AND SHALL BE CONSIDERED FOR EVALUATION)			
5.01	SERVICES- 66kV GIS: REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - **SERVICES FOR SUPERVISION OF ERECTION OF GIS**	MANDAY	10	Charges for repetition of services - (if required due to reasons not attributed to the bidder) This item will be executed only if repetition of services is required by BHEL.
5.02	SERVICES- 66kV GIS: REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - **SERVICES FOR TESTING & COMMISSIONING OF GIS**	MANDAY	10	Charges for repetition of services - (if required due to reasons not attributed to the bidder) This item will be executed only if repetition of services is required by BHEL.
	DEMOBILIZATION AND REMOBILIZATION CHARGES			
5.03	SERVICES- 66kV GIS: DEMOBILIZATION AND REMOBILIZATION CHARGES FOR GIS **ERECTION SUPERVISION TEAM**	Set	2	THIS BOQ ITEM SHALL BE EXECUTED IF REQUIRED FOR REASONS NOT ATTRIBUTABLE TO BIDDER.
5.04	SERVICES- 66kV GIS: DEMOBILIZATION AND REMOBILIZATION CHARGES FOR GIS **TESTING & COMMISSIONING TEAM**	Set	2	BOQ ITEM SHALL BE PAYABLE IF REQUIRED FOR REASONS NOT ATTRIBUTE TO BIDDER. HV TESTING IS NOT PART OF THIS ITEM.
5.05	SERVICES- 66kV GIS: DEMOBILIZATION & REMOBILIZATION CHARGES OF **HV TEST KIT** ALONG WITH OPERATOR	Lot	1	In this BOQ item, mobilization and demobilization chages for HV test kit is considered for second time or more , for reasons not attributable to bidder. HV testing charges shall be paid per bay basis as per main HV testing charge.

SECTION-II

GAS INSULATED SWITCHGEAR

This Technical Specification is applicable to 400kV, 220kV & 66kV voltage levels only. Purchaser has standardized its technical specification for various equipments and works for different voltage levels.

Items, which are not applicable for the scope of this package as per schedule of quantities described in Bid Price Schedule, the technical specification for such items should not be referred to.

Technical Specification of 400kV, 220kV, 66kV, 33kV Gas Insulated Switchgear (GIS)

1. General

The GIS manufacturer shall design, manufacture, test, deliver and guarantee the GIS components and services as defined in this Technical Specification. The complete GIS based on the Single Line Diagram and as defined in Section Project, shall be provided for connection to Power Transformers/Reactors/Lines feeders with associated circuit breaker, disconnect switch and grounding switch (maintenance and high speed), instrument transformers, and surge arrestor (if applicable) etc.

2. GENERAL CHARACTERISTICS

2.1 The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of its constituent parts. It should be designed for indoor application with meteorological conditions as specified.

2.2 All parts of the bus bar, switchgear and the bus ducts (for both indoor and outdoor applications) shall be as mentioned below:

400 kV GIS	Single phase enclosed
220 kV GIS	Single Phase/Three Phase enclosed
66 kV/33kV GIS	Three Phase enclosed

2.3 The design should be such that all parts subjected to wear and tear are easily accessible for maintenance purposes. The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall deemed to be included. The required overall system parameters of GIS are as per **Annexure -6**

3. REFERENCE STANDARDS

The GIS offered shall confirm to IEC 62271-203 and other relevant IEC standard except to the extent explicitly modified in the specification and shall be in accordance with requirement specified in GTR.

The metal-enclosed gas-insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the following International Electro-technical Commission (IEC) Publications including their parts and supplements as amended or revised as on date of bid opening

IEC 62271-203	Gas Insulated metal-enclosed switchgear for rated voltages above **5**2 kV
IEC 62271-207	Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52 kV
IEC 60376	New sulphur hexafluoride
IEC 62271-100	High voltage alternating current Circuit breakers
IEC 62271-1	Common clauses for high voltage Switchgear and control-gear

	Standards
IEC 62271-102	Alternating current Disconnect Switch (isolators) and earthing switches
IEC 61869	General Requirements Instrument Transformers
IEC 60137	Bushings for alternating voltages above 1000 V
IEC 62271-209	Cable connections for gas-insulated switchgear
IEC 60480	Guide to checking of sulphur hexafluoride taken from electrical equipment
IEC 60099 -1/4	Non-linear resistor type arresters for AC systems
IEC 60439	Factory-built assemblies of low-voltage switchgear and control Gear.
IEEE 80 2013	IEEE Guide for Safety in AC Substation grounding.
CIGRE-44	Earthing of GIS- an application guide. (Electra no.151,Dec'93).
IEC 62271-211	Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above.

The components and devices which are not covered by the above standards shall conform to, and comply with, the latest applicable standards, rules, codes and regulations of the internationally recognized standardizing bodies and professional societies as may be approved by the Employer. The manufacturer shall list all such applicable standards, codes etc and provide copies thereof for necessary approval.

In case the requirements laid down herein differ from those given in above standard in any aspect, the switchgear shall comply with the requirements indicated herein in regard thereto.

4. DEFINITIONS

4.1. **Assembly:** Assembly refers to the entire completed GIS equipment furnished under contract.

4.2. **Bay:** Bay refers to the area occupied by one Circuit Breaker and associated equipment used to protect one feeder/line/bus coupler in double bus scheme.

4.3. **Compartment:** When used in conjunction with GIS equipment, compartment refers to a gastight volume bounded by enclosure walls and gas tight isolating barriers.

4.4. **Enclosure:** When used in conjunction with GIS equipment, enclosure refers to the grounded metal housing or shell which contains and protects internal Power system equipment (breaker, disconnecting switch, grounding switch, voltage transformer, current transformer, surge arresters, interconnecting bus etc.)

4.5. **Manual Operation:** Manual operation means operation by hand without using any other source of power.

4.6. **Module:** When used in conjunction with GIS equipment, module refers to a portion of that equipment. Each module includes its own enclosure. A module can contain more than one piece of equipment, for example, a module can contain a disconnecting switch and a grounding switch.

4.7. **Reservoir**: When used in conjunction with GIS equipment reservoir refers to a larger gas-tight volume.

5. GENERAL DESIGN AND SAFETY REQUIREMENT

5.1. The GIS shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality control to meet the requirement stipulated in the technical specification. Adequate safety margin with respect to thermal, mechanical, dielectric stress and insulation coordination etc. shall be maintained during design, selection of raw

material, manufacturing process etc. so that the GIS provides long life with least maintenance.

The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear.

5.2. The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled (single phase design) with SF6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that maintenance on one feeder may be performed without de-energising the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment.

5.3. The switchgear, which shall be of modular design, shall have complete phase isolation. The conductors and the live parts shall be mounted on high graded epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be free of any voids and free of partial discharge at a voltage which is at least 5% greater than the rated voltage. These shall be designed to have high structural and dielectric strength properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF6 breakdown under arcing conditions.

5.4. All circuit breakers disconnect switches and other component of GIS having identical rating shall have identical and interchangeable parts and operating mechanism as far as possible.

5.5. Gas barrier insulators and support insulators shall have the same basis of design. The support insulators shall have holes on both sides for proper flow of gas.
Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. These shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Further, it is prohibited to work adjacent to a gas Compartment while it is fully pressurized on the other side. For such cases, the gas pressure in the adjacent compartments needs to be reduced.
Due to safety requirement for working on this pressurized equipment, whenever the pressure of the adjacent gas compartment is reduced during maintenance, this compartment shall be designed so that it shall remain in service to perform its intended duty. The gas tight barriers shall be clearly marked on the outside of the enclosures.
The bus enclosure should be sectionalized in a manner that maintenance work on any bus disconnector (when bus and bus disconnector are enclosed in a single enclosure) can be carried out by isolating and evacuating the small effected section and not the entire bus. The design of GIS shall be such that in case a circuit breaker module of a feeder is removed for maintenance, both busbars shall remain in service. For achieving the above requirements, adequate Mechanical support and number of intermediate gas tight compartments as required, shall be provided to ensure equipment and operating personnel's safety.

5.6. The switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high-voltage equipment installed inside gas-insulated metallic and earthed enclosures. GIS should be suitably sub-divided into individual arc and gas-proof compartments preferably for:

i. Bus bars
ii. Intermediate compartment

iii. Circuit breakers
iv. Feeder Disconnect Switch
v. Voltage Transformers
vi. Gas Insulated bus duct section between GIS and XLPE cable/Overhead Conductor.
vii. Gas Insulated bus section between GIS & Oil filled Transformer/ Reactor (if applicable)

5.7. **Service continuity requirement:**

The GIS equipment with the given bus switching arrangement is divided into different gas compartments. During the work such as a fault repair or major maintenance, requiring the dismantling of a gas compartment for which more than one compartments may need to be de-gassed.

Working conditions, method statements and procedures are to be furnished by the GIS manufacturer in order to ensure equipment and operating personnel's safety and to achieve following service continuity conditions to the extent possible:

5.7.1. For One & half breaker bus switching scheme during a fault in CB compartment, No bus bar and feeder is permitted out of service during maintenance and repair/replacement.

5.7.2. For Double Main bus switching scheme during a fault in CB compartment, No bus bar permitted out of service during maintenance and repair/replacement.

5.7.3. During a fault in GIS compartment other than CB compartment, maximum one bus bar and/or one feeder permitted out of service during maintenance and repair/replacement.

5.8. The material and thickness of the enclosures shall be such as to withstand an internal flash over without burns through for a period of 300 ms at rated short time withstand current. The material shall be such that it has no effect of environment as well as from the by-products of SF6 breakdown under arcing condition. This shall be validated with Type Test.

5.9. Each section shall have plug- in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the equipment. Inspection windows (View Ports) shall be provided for Disconnect Switch and both type of earth switches i.e. Maintenance and fast operating.

5.10. The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminum/ copper tubes of cross sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to temperature variation without imposing any mechanical stress on supporting insulators.

5.11. Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC-62271-203.

5.12. The maximum SF6 gas leakage shall not exceed 0.5% (half percent) per year for the whole equipment and for any individual gas compartment separately. The SF6 gas leakage should not exceed 0.5% per year and the leakage rate shall be guaranteed for at least 10 years. In case the leakage under the specified conditions is found to be greater than 0.5% after one year of commissioning, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based on actual leakage observed during the first year of operation after commissioning.

5.13. Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. The filters shall be capable of absorbing any water vapor which may penetrate into the enclosures as well as the by-products of SF6 during interruption. Each gas compartment shall be fitted with non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.

5.14. The switchgear when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated and fault conditions, shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external/internal reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.

5.15. The thermal rating of all current carrying parts shall be minimum for one sec. for the rated symmetrical short-circuits current.

5.16. The arrangement of the individual switchgear bays shall be such so as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.

5.17. The layout of the substation equipment, bus bars and switchgear bays shall preferably be based on the principle of “phase grouping”. Switchgear layout based on the “mixed phases” principle shall not be accepted without mutual agreement between supplier and employer. The arrangement of the equipment offered must provide adequate access for operation, testing, Repair and maintenance.

5.18. All the elements shall be accessible without removing support structures for routine inspections. The removal of individual enclosure parts or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays and LCC panels.

5.19. It should not be possible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force. All interlocks that prevent potentially dangerous mal-operations shall be constructed such that they cannot be operated easily, i.e. the operator must use tools or brute force to over-ride them.

5.20. In general the contours of energized metal parts of the GIS and any other accessory shall be such, so as to eliminate areas or points of high electrostatic flux concentrations. The surfaces shall be smooth with no projection or irregularities which may cause visible corona. No corona shall be visible in complete darkness which the equipment is subjected to specified test voltage. There shall be no radio interference from the energized switchgear at rated voltage.

5.21. The GIS shall be designed, so as to take care of the VFT over voltages generated as a result of pre-strikes and re-strikes during isolator operation. Maximum VFT over voltages peak shall not be higher than rated lightning impulse withstand voltage (LIWV) of the equipment. Necessary measures shall be under taken by GIS manufacture to restrict maximum VFT over voltages lower than the LIWV. Manufacturer shall submit the study report of VFTO generated for GIS installation.

5.22. The enclosure shall be of continuous design and shall meet the requirement as specified in of IEEE 80 2013 (special considerations for GIS).

The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.

5.23. The fabricated metal enclosures shall be of Aluminum alloy having high resistance to corrosion, low electrical loses and negligible magnetic losses. All joint surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall conform to metric system.

5.24. The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.

5.25. The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions. The average intensity of electromagnetic field shall not be more than 50 micro Tesla on the surface of the enclosure. The contractor shall furnish all calculations and documents in support of the above during detailed engineering.

5.26. The switchgear shall have provision for connection with ground mat risers through copper connections. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment.

5.27. Stairs, fixed ladder, platforms, and walkways for operation and maintenance access to the operating mechanism and monitoring devices should be provided to permit access. The structures shall be either aluminum or hot-dipped galvanized steel. All structures, stairs, platforms, and walkways shall conform to the relevant occupational health and safety regulations and designed in accordance with the latest industry standards and guidelines. The platforms and walkways shall have anti-skid surfaces that can be walked on. Handrails shall be provided where necessary. The GIS supplier shall provide 3-D arrangement drawing to show the location of equipment and access to it.

5.28. In addition to above suitable portable scissor lift shall be provided for access of distant portion of GIS installation.

5.29. New Gasket, sealant and desiccant shall be installed for permanent sealing of all site/field assembled joints. No gaskets are to be reused for any permanent seal broken or disturbed in the field/site.

5.30. The enclosure & support structure shall be designed such that person of 1780 mm in height and 80 Kg in weight is able to climb on the equipment for maintenance.

5.31. The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.

5.32. Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits.

Gas Insulating System:

i) Loss of Gas Density
ii) Any other alarm necessary to indicate deterioration of the gas insulating system.

Operating System:

i) Low operating pressure
ii) Loss of Heater power
iii) Loss of operating power
iv) Loss of control supply
v) Pole Discordance.

5.33. The equipment will be operated under the following ambient conditions (or as defined in the section project):

a) The ambient temperature varies between 0 degree-C and 50 degree-C. However, for design purposes, ambient temperature should be considered as 50 degree-C.
b) The humidity will be about 95% (indoors)
c) The elevation is less than 1000 meters

5.34 Temperature rise of all current carrying parts and enclosures shall be limited to the values stipulated in IEC-62271-1, under rated current and the climatic conditions as specified. The temperature rise for accessible enclosure shall not exceed 20 degree C above the ambient temperature of 50 degree C.

5.35. Wherever required, the heaters shall be provided for the equipment in order to ensure the proper functioning of the switchgear at specified ambient temperatures. All cabinet heaters shall be rated for 240V AC (1-phase) supply and shall be complete with thermostat, control switches and fuses, connected as a balanced 3-phase 4-wire load. The heaters shall be so arranged and protected as to create no hazard to adjacent equipment from the heat produced.

5.36. **Bellows or Compensating Units:-**Adequate provision shall be made to allow for thethermal expansion of the conductors & enclosures and for differential thermal expansion between the conductors and the enclosures. The bellows metallic(preferably stainless steel) with suitable provision for permitting the movement during expansion and contraction may be provided and shall be of following types:.

1. Lateral / Vertical mounting units: These shall be inserted, as required, between sections of busbars, on transformer, shunt reactor and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.
2. Axial compensators: These shall be provided to accommodate changes in length of busbars due to temperature variations.
3. Parallel compensators: These shall be provided to accommodate large linear expansions and angle tolerances.
4. Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerances.
5. Vibration compensators: These bellow compensators shall be provided for absorbing vibrations caused by the transformers and shunt reactors when connected to SF6 switchgear by oil- SF6 bushings.

The electrical connections across the bellows or compensating units shall be made by means of suitable connectors. For sliding type compensators, markers/pointers shall be provided to observe expansion or contraction during climatic conditions.

5.37. **Indication and verification of switch positions**: Indicators shall be provided on all circuitbreakers, isolators and earth-switches, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkages and shall be mounted in a position where they are clearly visible from the floor or the platform in the vicinity of the equipment.

Inspection windows shall also be provided with all isolators and earth switches so that the switch contact positions can be verified by direct visual inspection.

5.38. **Pressure relief device**: Pressure relief devices shall be provided in the gas sections toprotect the gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably in downward direction).

Pressure relief shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction.

If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided. Contractor shall submit to the owner the detailed criteria design regarding location of pressure relief devices/rupture diaphragms.

5.39. **Pressure vessel requirements**: The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the Pressure Vessel Code (ASME/CENELEC code for pressure Vessel.)

The bursting strength of Aluminum castings has to be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure.

Each enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute.

5.40. **Grounding:**

5.40.1. The grounding system shall be designed and provided as per IEEE-80-2013 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences.

5.40.2 The GIS supplier shall define clearly what constitutes the main grounding bus of the GIS. The contractor shall supply the entire material for grounding bus of GIS viz conductor, clamps, joints, operating and safety platforms etc. The contractor is also required to supply all the earthling conductors and associated hardware material for the following:

1. Connecting all GIS equipment, bus ducts, enclosures, control cabinets, supporting structure etc. to the ground bus of GIS.
2. Grounding of transformer, CVT/VT, SA and other outdoor switchyard equipments/structures etc.

5.40.3. The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected either internally or externally with Copper/Aluminum bonds of suitable size to bridge the flanges. Subassembly to subassembly bonding shall be provided to bridge the gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

5.40.4. Each marshaling box, local control panel, power and control cable sheaths and other non-current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.

5.40.5. The grounding connector shall be of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating. At least two grounding paths shall be provided to connect each point to the main grounding bus. Necessary precautions should be under taken to prevent excessive currents from being induced into adjacent frames, structures of reinforcing steel and to avoid establishment of current loops via other station equipment.

5.40.6. All flexible bonding leads shall be tinned copper. All connectors, for attaching flexible bonding leads to grounding conductors and grounding conductors to support structures shall be tinned bronze with stainless steel or tinned bronze hardware.

5.40.7. The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents due to by lightning strikes, operation of surge arrestor, phase to earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The contractor shall provide suitable barrier of non-linear resistor/ counter discontinued SF6/ Air termination, SF6/ Transformer or Reactor termination, SF6/ HV cable bushing etc. to mitigate transient enclosure voltage.

5.40.8 The bidders shall provide lightening mast/GS shield wire at suitable place for protection of whole sub-station including transformers, GIS cum control room building etc. The bidder shall submit detailed proposal for grounding system of whole substation including indoor and outdoor equipments with Earthmat using 40mm. dia MS rod for approval of purchaser. The riser shall be GS flat of size 75X12mm for outdoor equipments and 50X6mm for indoor.

The bidder shall submit detailed proposal for grounding system for approval of purchaser. Any provision to be made in the building design to take care of earthing requirement shall also be clearly spelt-out.

5.41. **UHF sensors for PD detection**:

Adequate number of UHF sensors shall be provided in the offered GIS for detection of Partial discharge (of 5 pC and above) as per IEC 60270. The number and location of these sensors shall be based on laboratory test on typical design of GIS as per recommendations of CIGRE Document No. 654 (*APPLICATION GUIDE FOR SENSITIVITY VERIFICATION for UHF PARTIAL DISCHARGE DETECTION SYSTEM FOR GIS*). Offered numbers and location of UHF sensors shall be submitted based on above said criteria along with attenuation calculation for approval of the employer. Further UHF sensors shall necessarily be provided in close proximity to VT compartments.

However adequacy of number of sensors and their location shall be verified at site as per recommendations of above CIGRE Document No. 654. In case during site testing, additional UHF sensors are required, the same shall also be supplied & installed to complete the technical requirement.

The calibration and frequency response of PD couplers shall be as per NGC Technical Guidance note TGN (T) 121, issue 1, 1997. Data sheet shall be submitted for the UHF couplers meeting this requirement.

5.42. **Gas Insulated Bus (GIB) layout :**

GIB shall be designed based on the following criteria

(1) Maximum weight of gas in a gas tight section of GIB shall not exceed 400 kg (for 400 kV)/ 250 kg (for 220 kV, 66 kV &33 kV).

(2) GIB shall be generally in horizontal layer. However in exceptional circumstance GIB in vertical layers can be provided with the approval of employer.

(3) The minimum vertical ground clearance of GIB at road crossing shall be 5.5 meters

(4) The horizontal clearance between GIB and GIS building /any other building wall shall be preferably three (3) meters.

(5) The GIB route inside the GIS Hall shall not obstruct easy access to GIS and control room buildings and shall not obstruct movement of crane, equipment including HV test equipment for maintenance works.

(6) The GIB clear height outside the GIS hall in switchyard area shall be minimum 3.5 meter, so as not to obstruct easy access to GIB, movement of crane for maintenance work.

(7) Optimization of outdoor GIB length using overhead AIS connection with Bus Post Insulator of respective voltage class is generally acceptable subject to meeting the electrical clearances as stipulated.

(8) For the maintenance of GIB of one circuit, only that circuit shall be isolated. Adequate clearance between bus ducts of two circuit shall be ensured by the contractor during layout finalization.

(9) GIS manufacturer as per their design shall preferably use maximum three standard straight horizontal outdoor bus duct lengths for entire GIS installation to optimize the spare requirement.

(10) The minimum outer to outer horizontal clearance between each GIS bus duct shall be 0.5 meter for 400kV, 220 kV, 66 kV & 33kV voltage level.

5.43. **Extension of GIS**

5.43.1. The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays.

5.43.2. As the GIS is likely to be extended in future, during detailed engineering stage, the contractor shall make available the complete design detail of interface module such as cross section, enclosure material, enclosure dimensions (inner & outer), Flange diameter (inner & outer), conductor cross-section & connection arrangement, bolt spacing & dimension, rated gas pressure, Gasket detail etc. Further GIS manufacturer supplying GIS under present scope shall furnish all the required details in addition to mentioned above necessary for design and successful implementation of an interface module during later stage while extending GIS by any other GIS manufacturer, without any help of GIS manufacturer who has supplied the GIS equipment in present scope.

5.43.3. The Interface module shall be designed to provide Isolating link with access hole on enclosure. The Isolating link shall be provided in such a way so that HV test can be performed on either side of the interface module separately, keeping other side of GIS remained isolated. Interface Module drawing with necessary detail shall be submitted for approval.

5.43.4. Further the contractor who is extending the existing GIS installation, it shall be his responsibility to provide interface module matching with the existing GIS interface module. The drawing of existing GIS interface/end piece module shall be provided by the employer. However it shall be the responsibility of contractor to verify the existing details during site visit.

5.43.5. The Contractor shall optimally utilize the space inside the GIS hall (including the extension portion) for accommodating the interface module being supplied under the contract and the space (along the length of the hall) inside the GIS hall for interface module shall preferably be limited to 1 meter for 400/220/66/33kV.

5.44. **SF6 GAS**

The SF6 gas insulated metal-clad switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC 60376, 60376A & 60376B, at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC & should be suitable in all respects for use in the switchgear under all operating conditions. Necessary statutory clearances from concerned authorities for import of the Gas and for storage of the Gas shall be obtained.

The high pressure cylinders in which SF6 gas is supplied & stored at site shall comply with the requirements of following standards & regulations:

IS : 4379 Identification of the contents of industrial gas cylinders.

IS : 7311 Seamless high carbon steel cylinders for permanent & high pressure liquefiable gases. The cylinders shall also meet latest Gas Cylinder Rules (PESO)

SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IEC: 60376, 60376A & 60376B and test certificates shall be furnished to the Employer indicating all test results as per IEC standards for each lot of SF6 gas. Further site tests for dew point and purity shall be done during commissioning of GIS. Gas bottles should be tested for leakage during receipt at site.

The contractor shall indicate diagnostic test methods for checking the quality of gas in the

various sections of GIS during service. The method proposed shall have as a minimum check the moisture content & the percentage of purity of the gas on annual basis.

The contractor shall also submit clearly the precise procedure to be adopted by maintenance personnel for handling equipment that are exposed to the products of arcing in SF6 Gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, method of disposal of cleaning utensils and other relevant matters.

The contractor shall also indicate the details and type of filters used in various gas sections, and should also submit the operating experience with such filters.

5.44.1. **SF6 gas monitoring devices and alarm circuits:** Dial type temperature compensated gas density monitoring devices with associated pressure gauge will be provided. The devices shall provide continuous & automatic monitoring of gas density. A separate device shall be provided for each gas tight compartment so that it can be monitored simultaneously as follows:-

Compartment/ Sl. No.	Compartments except CB	Circuit Breaker compartments
1	**"Gas Refill level:** This will be used to annunciate the need for the gas refilling. The contractor shall provide a contact for remote indication.	**'Gas Refill' level: This** will be used to annunciate the need for gas refilling. The contractor shall provide a contact for remote indication.
2	**"SF6 low level" :**This will be used to annunciate the need for urgent gas filling . A contact shall be provided for remote indication	**"SF6 low level":**This will be used to annunciate the need for urgent gas filling . A contact shall be provided for remote indication
3	**'Zone Trip' level:** This is the minimum level at which the Manufacturer will guarantee theinsulation rating of the assembly.	**Breaker Block' level :**This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker .At this level the breaker block contact shall operate and the closing & tripping circuit shall be blocked.
4	**Not Applicable**	**'Zone Trip' level:** This is the Minimum level at which the manufacturer will guarantee the insulation rating of the assembly.

The density monitor/pressure switch contacts shall be in accordance with the above requirement.

It shall be possible to test all gas monitoring relays/devices without de-energizing the primary equipment & without reducing pressure in the main section. It shall also damp the pressure pulsation while filling the gas in service, so that flickering of the pressure switch contacts does not take place.

5.44.2. **Gas Supply:** The contractor shall include the supply of all SF6 gas necessary for filling &putting into operation the complete switchgear installation being supplied. The empty gas cylinders shall be returnable to the contractor.

5.45. **Documentation**

The contractor shall prepare and submit to the employer, drawings; details that show the GIS design in order for the employer to verify the equipment conform to the specifications. The Design Document to be submitted for review and approval are as follows:

i. Design Review Document as per clause no. **19** of this specification
ii. Single Line Diagram
iii. Gas Schematic Diagram
iv. GTP-Guaranteed Technical Particulars
v. GIS layout (Plan and Section) including 3D drawing
vi. GIS Component Drawings
vii. Interface modules drawing for GIS extension
viii. Rating and Name Plate Drawing
ix. GIS/LCC Schematics Drawing
x. Foundation loading plan and detail
xi. GIS Support Structure Drawing
xii. GIS platforms and Walkway Drawing
xiii. GIS grounding plan and details along with design calculation for GIS grounding
xiv. GIS key Diagram enlisting and marking each and every GIS Module clearly and separately identifiable (indoor and outdoor). This separately identified module shall be complete along with its enclosure, gasket and all active parts such as conductor, conductor joints, corona shield etc.
xv. Method Statement along with sequential instruction for dismantling and assembling of all major components of GIS exhibiting service continuity requirement
xvi. Type Test Reports
xvii. Seismic Analysis Report
xviii. Study report of VFTO generated for GIS installation for 400 kV
xix. The general arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end
xx. The general arrangement drawing of Terminal connection arrangement to connect GIS duct to SF6/Oil bushing and duct mounting arrangement details
xxi. Gas handling procedure
xxii. The design & construction proposal of the building along with necessary information, data, and drawings according to the complete requirements
xxiii. Capacity calculation of EOT crane for GIS hall considering a factor of safety of 5
xxiv. Method statement/ procedure of ON SITE high voltage testing with PD measurement and Switching Impulse test.

xxv. **Additional CB data to be furnished during detailed engineering :**
   a) Design data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100 % fault currents to load currents of the lowest possible value without requiring any maintenance or checks.
   b) Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and hydraulic pressure.
   c) Contact Travel: Operating mechanism operating shaft travel and contact overlap of Circuit Breaker to be provided.

xxvi. PD Monitoring System
   a) The technical proposal for PDM system along with detailed design documentation.
   b) Data sheet for the UHF couplers.

c) The Sub-station GIS layout as a separate drawing indicating position of spacers, spread over of PD sensors with distance, sensor identification, the detector unit identification etc., total numbers of offered UHF Sensors along with attenuation calculation.
d) Guaranteed Technical Particulars & Data Sheet for various components used in the PDM system.
e) Electromagnetic compatibility Test Reports.
f) List of critical spares.

xxvii. Installation and Operation & Maintenance Manual

6. CIRCUIT BREAKERS

6.1. **General :**SF6 gas insulated metal enclosed circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-1 and other relevant IEC standards except to the extent explicitly modified in the specification and shall also be in accordance with requirements specified in Section-GTR.

Circuit breakers shall be equipped with the operating mechanism. Circuit breakers shall be of single pressure type. Complete circuit breaker with all necessary items for successful operation shall be supplied. The circuit breakers shall be designed for high speed single and three phase reclosing (as applicable) with an operating sequence and timing as specified.

6.2. **Duty Requirements:** Circuit breaker shall be C2 - M2 class as per IEC 62271-100.

6.3 Circuit breaker shall meet the duty requirements for any type of fault or fault location also for line charging and dropping when used on effectively grounded system and perform make and break operations as per the stipulated duty cycles satisfactorily.

6.4. The circuit breaker shall be capable of:

1. Interrupting the steady and transient magnetizing current shall be as follows:
Interrupting the steady and transient magnetizing current corresponding to 400 kV/220 kV, 220/66 kV and 220/33 kV class transformers of500 MVA, 315MVA, 160 MVA and 100 MVA ratings on 400 kV, 220 kV, and 66 kV & 33kV side.

2. Interrupting line/cable charging current as per IEC without re-strikes and without use of opening resistors. The breaker shall be able to interrupt the rated line charging current as per IEC-62271-100 with test voltage immediately before opening equal to the product of $U/\sqrt{3}$ and 1.4.

3. Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

4. Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.

5. The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of shunt reactor and/or series capacitor compensated lines with trapped charges.

6. Withstanding all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. shall be designed for 2 p.u. across the breaker continuously, for validation of which a power frequency withstand test conducted for a duration of at least 15 minutes is acceptable).

7. Circuit breakers shall be able to switch in and out the shunt reactor as detailed below:

Voltage Level	Reactor Rating (in MVAR)	Max. rise of overvoltage (in p.u.)
400 kV	50 to 125	2.3
220 kV	25 to 50	2.3

6.5. **Total Break Time :**The total break time shall not be exceeded under any of the following duties :

a) Test duties T10,T30,T60,T100 (with TRV as per IEC- 62271-100)

b) Short line fault L90, L75 (with TRV as per IEC-62271-100)

The Contractor may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage (70-110%), hydraulic pressure and SF6 gas pressure etc. While furnishing the proof for the total break time of complete circuit breaker, the contractor may specifically bring out the effect of non-simultaneity between poles and show how it is covered in the total break time.

The values guaranteed shall be supported with the type test reports.

6.6. **Constructional features :**

The features and constructional details of breakers shall be in accordance with requirements stated hereunder:

6.6.1. If multi-break interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/ test reports in support of the same shall be furnished. The thermal and voltage withstand rating of the grading elements shall be adequate for the service conditions and duty specified.

6.6.2. **Contacts:** All making and breaking contacts shall be sealed and free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacement due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

6.6.3. Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable of that of the breaker as a whole.

6.6.4. Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.

6.6.5. The gap between the open contacts shall be such that it can withstand at least the rated phase to ground voltage for eight hours at zero pressure above atmospheric level of SF6 gas due to its leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pressure continuously (i.e. 2 p.u. power frequency voltage across the breaker continuously)

6.6.6. In the interrupter assembly there shall be an adsorbing product box to minimize the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as to be fully compatible with SF6 gas decomposition products.

6.6.7. Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site. The contractor shall supply three set of transducer for each substation covered under the scope.

6.6.8. Circuit Breaker shall be supplied with auxiliary switch having additional 8 NO (normally open) and 8 NC (normally closed) contacts for future use over and above those required for switchgear interlocking and other control and protection function. These spare NO and NC contacts shall be wired upto the local control cubicle.

6.6.9. The CO (Close-open) operation and its timing shall be such as to ensure complete

travel/insertion of the contact during closing operation and then follow the opening operation.

6.7. **Operating mechanism**

6.7.1. General Requirements :

a) Circuit breaker shall be operated by spring charged mechanism or electro hydraulic mechanism or a combination of these. The mechanism shall be housed in a dust proof cabinet and shall have IP: 42 degree of protection.
b) The operating mechanism **box** shall be strong, rigid, rebound free and shall be readily accessible for maintenance.
c) The operating mechanism shall be suitable for high speed reclosing and other duties specified. During reclosing the breaker contacts shall close fully and then open. The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing.
d) The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause unwanted trip or closing operation of the Circuit Breaker.

e) A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.
f) Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.
g) The contractor shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker.

6.7.2. **Control**

a) The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.

b) Each breaker pole shall be provided with two (2) independent tripping circuits and trip coils which may be connected to a different set of protective relays.

c) The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the breaker control cabinet.
d) The trip coil shall be suitable for trip circuit supervision during both open and close position of breaker.

e) Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on circuit breakers shall be clearly brought out in the additional information schedules. In the absence of adequate details the offer is likely to be rejected.
f) Density meter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are

used then fail safe logic/schemes are to be employed. DC supplies shall be monitored for remote annunciations and operation lockout in case of dc failures.

g) The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

6.7.3. **Spring operated Mechanism**

a) Spring operated mechanism shall be complete with motor as per manufacturer practice. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.
b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.
c) After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.
d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it required preferably not more than 90 seconds for full charging of the closing spring.
e) Closing action of circuit breaker shall compress the opening spring ready for tripping.
f) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local control cabinet & SAS.
g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.
h) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position.
i) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.
j) The spring charging failure alarm shall be provided with a time delay relay having setting range from 0-3 minutes.
k) Separate MCBs shall be provided for each spring charging motor and the rating of MCBs shall be suitably selected to match the starting, running and stalling time.
l) An overload relay shall be provided for protection of the spring charging motor.

6.7.4. **Hydraulically Operated Mechanism :**

a) Hydraulically operated mechanism shall comprise of operating unit with power cylinder, control valves, high and low pressure reservoir, motor etc.
b) The hydraulic oil used shall be fully compatible for the temperature range to be encountered during operation.
c) The oil pressure switch controlling the oil pump and pressure in the high pressure reservoir shall have adequate no. of spare contacts, for continuous monitoring of low pressure, high pressure etc. at switchyard control room.
d) The mechanism shall be suitable for at-least two close open operations after failure of AC supply to the motor starting at pressure equal to the lowest pressure of auto reclose duty plus pressure drop for one close open operation.
e) The mechanism shall be capable of operating the circuit breaker correctly and performing the duty cycle specified under all conditions with the pressure of hydraulic operated fluid in the operating mechanism at the lowest permissible pressure before make up.
f) Trip lockout shall be provided to prevent operations of the circuit breaker below the

minimum specified hydraulic pressure. Alarm contacts for loss of Nitrogen shall also be provided.

g) All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage.

6.8. **Controlled Switching Device(CSD):**

6.8.1. 400 kV Circuit Breaker shall be equipped with controlled switching device with consequent optimization of switching behavior, when used in:

1. Switching of transformer (400 kV side circuit breakers only)
2. Switching of shunt reactor

6.8.2. The CSD shall be provided in 400 kV Circuit breakers for controlling transformers and reactors (ie for breakers of switchable line reactor and in Main& Tie circuit breakers of Transformers, Transmission lines with non-switchable line reactors and Bus reactors). The requirement of CSD shall be explicitly specified in price schedule

6.8.3. Technical Requirement for Controlled switching device:

a) The CSD shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified in section - GTR.

b) The CSD shall meet the requirements of IEC-61000-4 16 class IV regarding HF disturbance test and fast transient test shall be as per IEC-61000 – 4-4 level IV and insulation test as per 60255 – 5.

c) The CSD shall have functions for switching ON & OFF the circuit breakers.

d) The CSD shall get command to operate the breakers manually or through auto re-close relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.

e) The CSD shall have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command. In calculation of net operating time of the breaker the controller must consider all factors that may affect the operating time of the breaker such as, but not limited to, ambient temperature, control voltage variation, SF6 gas density variations etc. Schematic drawing for this purpose shall be provided by the contractor. The accuracy of the operating time estimation by the controller shall be better than + 0.5 ms.

f) The CSD shall have communication port to facilitate online communication of the control switching device with SCADA directly on 61850 or through gateway which shall be under present scope.

g) The CSD shall be PC compatible for the setting of various parameters and down loading of the settings and measured values date time of switching etc. Window based software for this purpose shall be supplied by the contractor to be used on the owner's PC.

h) The CSD shall be suitable for current input of 1 amp from the secondary of the CTs. and 110 V (Ph to Ph) from the CVTs. The controller shall withstand transient and dynamic state values of the current from the secondary of the CTs and CVTs.

i) The CSD shall have time setting resolution of 0.1 ms or better.

j) The CSD shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering the scheme.

k) The CSD shall also record and monitor the switching operations and make adjustments to the switching instants to optimize the switching behavior as necessary. It shall provide self-diagnostic facilities, signaling of alarms and enable downloading of data captured from the switching events.

l) The provision for bypassing the Controlled switching device shall be provided through

BCU and SCADA both so that whenever, the CSD is not healthy due to any reason (including auxiliary supply failure), uncontrolled trip/close command can be extended to the circuit Breaker. Alternatively, in case of any non-operation of the CSD after receiving a close/trip command after a pre-determined time delay, the CSD should automatically be bypassed so as to ensure that the trip and close commands are extended to the Trip/Close coils through subsequent command.

m) The CSD shall be provided with a communication port to facilitate online communication of the CSD with Substation automation system directly on IEC 61850 protocols. If the CSD does not meet the protocols of IEC 61850, suitable gateway shall be provided to enable the communication of CSD as per IEC 61850.

6.9. The technical parameters of circuit breakers are as per **Annexure –1**

6.10. **Tests**

6.10.1. **Type Tests**

i. In accordance with the requirements stipulated under Section GTR the circuit breaker along with its operating mechanism shall conform to the type tests as per IEC-62271-100.

ii. The type test report of Electromagnetic Compatibility Test (EMC) of CSD shall be submitted for approval

iii. Circuit breakers meant for controlled switching shall conform to requirements of IEC/TR-62271–302. The contractor shall submit test reports to demonstrate that the offered CB conforms to the requirements of performance verification tests and parameter definition tests as per IEC/TR 62271-302. The contractor shall also furnish the report for the re-ignition free arcing window for switching 3-phase shunt reactor as demonstrated in the shunt reactor switching test.

6.10.2. **Routine Tests:**

Routine tests as per IEC: 62271-100 shall be performed on all circuit breakers.

In addition to the mechanical and electrical tests specified by IEC, the following shall also be performed.

i. Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto reclosing and trip free operation under normal as well as limiting operating **control** voltage conditions. The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be **arranged by the contractor at his** own cost. After completion of site pre-commissioning test, 03 nos. travel transducer shall be handed over to DTL.

ii. During testing of CB, dynamic contact resistance measurement (DCRM) shall be carried out for close-open (CO) operations with delay of 300ms between close and trip operations. Minimum 100A current shall be injected for DCRM test. Travel characteristics, injected current, trip/close coil current shall also be recorded along with DCRM test. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be provided. The test for getting signature of the dynamic contact resistance measurement shall also be carried out at factory. The test result shall be treated as reference signature for condition monitoring in future.

iii. Routine tests on circuit breakers with controlled switching device as per IEC/TR 62271-302.

7. DISCONNECTORS (ISOLATORS)

Disconnectors shall be three-pole group operated or Single-pole individual operated (as per single line diagram of the substation) and shall be installed in the switchgear to provide electrical isolation. The disconnectors shall conform to IEC- 62271-102 and shall have the ratings as specified in BPS/ Project Section.

7.1. **Construction & Design**.

7.2.1. The disconnectors shall be operated by electric motor suitable for use on 220 Volt DC systems and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit.

7.2.2. Disconnectors shall be suitable to switch the bus charging currents during their opening and closing and shall confirm to all three test duties viz TD1,TD2 and TD3 as per Annexure –F of IEC: 62271- 102.They shall also be able to make and break rated bus transfer current at rated bus transfer voltage which appears during transfer between bus bars in accordance with Annexure –B of IEC: 62271-102. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by transient recovery voltages when these currents are interrupted.

7.2.3. The disconnect switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.

7.2.4. It shall be possible to operate the disconnect switches manually by cranks or hand wheels.

7.2.5. For motor-operated disconnect switches, the control should be electrically and/or mechanically uncoupled from the drive shaft when the switch is operated manually to prevent coincident power operation of the switch and the drive mechanism(s).

7.2.6. The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.

7.2.7. The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the Local Control Cabinet (LCC).

7.2.8. Remote control of the disconnectors from the control room/SAS shall be made by means of remote/ local transfer switch.

7.2.9. The disconnector operations shall be inter-locked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.

7.2.10. Each disconnector shall be supplied with auxiliary switch having additional 8 NO (Normally Open) and 8 NC (Normally Closed) contacts for future use over and above those required for switchgear interlocking and automation purposes. These spare NO and NC contacts shall be wired up to the local control cabinet.

7.2.11. The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely.

7.2.12. The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.

7.2.13. The disconnectors and safety grounding switches shall have mechanical/electrical inter-locks to prevent closing of the grounding switches when isolator switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.

7.2.14. The local control of the Isolator and high-speed grounding switches from the Local Control Cabinet (LCC) should be achieved from the individual control switches with the remote/local transfer switch set to local.

7.2.15. All electrical sequence interlocks will apply in both remote and local control modes.

7.2.16. Each disconnector shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the local control cubicle (LCC) and provisions for taking the signals to the control room. The details of the inscriptions and colouring for the indicator are given as under :

INSCRIPTION	**COLOUR**	
Open Position	OPEN	GREEN
Closed Position	CLOSED	RED

7.2.17. All the disconnecting switches shall have arrangement allowing easy visual inspection of the travel of the switch contacts in both open and close positions, from the outside of the enclosure.

7.2.18. The disconnecting switches shall be provided with rating plates and shall be easily accessible.

7.2.19. The mechanical endurance class shall be M2 as per IEC.

7.2.20. Mechanical position indication shall be provided locally at each disconnector and Electrical indication at each Local Control Cabinet (LCC) / SAS.

7.2.21. All auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10 A DC continuously.

7.2.22. The auxiliary switches shall be capable of breaking at least 10 A in a 220 V DC circuit with a time constant of not less than 20 milliseconds.

7.2.23. The disconnecting switches shall be capable of being padlocked in both the open and closed positions with the operating motor automatically disengaged. The padlocking device shall be suitable for a standard size lock with a 10 mm shank. The padlock must be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.

7.3. The technical parameters of disconnectors are as per **ANNEXURE-2**

8. SAFETY GROUNDING SWITCHES

8.1. Safety grounding switches shall be three-pole group operated or single-pole individual operated (as per single line diagram of the substation). It shall be operated by DC electric motor and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over-current and short circuit.

8.2. Each safety grounding switch shall be electrically interlocked with its associated disconnectors and circuit breaker such that it can only be closed if both the circuit breaker and disconnectors are in open position. Safety grounding switch shall also be mechanically key interlocked with its associated disconnectors.

8.3. Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the Local Control Cabinet (LCC) and provision for taking the signal to Control room.

8.4. The details of the inscription and coloring for the indicator are given as under :

	INSCRIPTION	COLOUR
Open Position	OPEN	GREEN
Closed Position	CLOSED	RED

8.5. Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits.

8.6. Each ground switch shall be fitted with auxiliary switches having 6NO (Normally Open) and 6NC (Normally Closed) contacts for use by others over and above those required for local interlocking and position indication purposes.

8.7. Provision shall be made for padlocking / suitable locking arrangement for the ground switches in either the open or closed position.

8.8. All portions of the grounding switch and operating mechanism required for grounding shall be connected together utilizing flexible copper conductors having a minimum cross-sectional area of 100 sq. mm.

8.9. The main grounding connections on each grounding switch shall be rated to carry the full short circuit current for 1 sec. and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid.

8.10. The safety grounding switches shall conform to the requirements of IEC- 62271- 102 and shall have electrical endurance class: E0 & shall have mechanical endurance class M2 for 400 kV & M1 for 220/66/33 kV voltage level.

8.11. The grounding switch shall be provided with test provision (insulated link) to permit test voltage up to 10 kV and up to 200 A to be applied to the main conductor without removing SF6 gas from the enclosure and without disassembling the enclosure except for ground shunt leads.

8.12. Combined Disconnectors & Safety grounding switch arrangement shall also be acceptable.

8.13. Mechanical position indication shall be provided locally at each switch and Electrical indication at each Local Control Cabinet (LCC) / SAS.

9. HIGH SPEED MAKE PROOF GROUNDING SWITCHES:

9.1. Grounding switches located at the beginning of the line feeder bay modules shall be of the high speed, make proof type and will be used to discharge the respective charging currents, trapped charge in addition to their safety grounding function. These grounding switches shall be capable of interrupting the inductive and capacitive currents and to withstand the associated TRV. These shall confirm to class B and electrical endurance class E1 as per annexure – C of IEC : 62271-102

9.2. High Speed Grounding switches shall be provided with individual/three pole operating mechanism suitable for operation from DC.

9.3. The switches shall be fitted with a stored energy closing system to provide fault making capacity.

9.4. The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating as specified. The switches shall have inductive/ capacitive current switching capacity as per IEC-62271-102.

9.5. Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the Local Control Cabinet (LCC) and provision for taking the signal to Control Room/SAS.

9.6. The details of the inscription and coloring for the indicator shall be as under:-

	INSCRIPTION	COLOUR
Open Position	OPEN	GREEN
Closed Position	CLOSED	RED

9.7. High speed ground switch operation should be possible locally from Local Control Cabinet (LCC)

9.8. These high speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches cannot be closed if disconnectors are closed. Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.

9.9. Each high speed ground switch shall be fitted with auxiliary switches having 6NO (Normally Open) and 6 NC (Normally Closed) contacts for use by others, over and above these required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the Local Control Cabinet. Provision shall be made for padlocking the ground switches in their open or closed position.

9.10. All portion of the grounding switches and operating mechanism required for connection to ground shall be connected together utilizing copper conductor having minimum cross-sectional area of 100 sq. mm.

9.11. The main grounding connection on each grounding switch shall be rated to carry the peak withstand current rating of the switch for 1 sec. and shall be equipped with a silver plated terminal connector suitable for steel strap of adequate design for connection to the grounding grid.

9.12. The high speed make proof grounding switches shall confirm to the requirements of IEC-62271-102.

9.13. The grounding switch shall be provided with test provision (insulated link) to permit test voltage up to 10 kV and up to 200 A to be applied to the main conductor without removing SF6 gas from the enclosure and without disassembling the enclosure except for ground shunt leads.

10. INSTRUMENT TRANSFORMERS

10.1. CURRENT TRANSFORMERS

The current transformers and accessories shall conform to IEC:61869 and other relevant standards except to the extent explicitly modified in the specification.

The particulars of the various cores may change within reasonable limits as per the requirements of protection relay supplier. The manufacturer is required to have these values confirmed from the purchaser before proceeding with design of the cores. The other characteristics of CTs shall be as given in TECHNICAL PARAMETER of Current Transformer.

10.1.1. **Ratios and Characteristics: The** CT core distribution for various voltage levels shall be asper Table 3A, 3B, 3C 3D & 3E. Further the numbers of cores, rating, ratios, accuracy class, etc. for the individual current transformers secondary cores shall be in accordance with above table attached at **Annexure-3.**

Where multi-ratio current transformers are required the various ratios shall be obtained by changing the effective number of turns on the secondary winding.

10.1.2. **Rating and Diagram Plates:** Rating and diagram plates shall be as specified in the IECspecification incorporating the year of manufacture. The rated current & extended current rating in case of current transformers and rated voltage, voltage factor & intermediate voltage in case of voltage transformers shall be clearly indicated on the name plate.

The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals (P1 & P2).

The position of each primary terminal in the current transformer SF6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

10.1.3. **Constructional Details**:

a) The current transformers incorporated into the GIS will be used for protective relaying and metering purposes and shall be of metal- enclosed type.

b) Each current transformer shall be equipped with a secondary terminal box with terminals for the secondary circuits, which are connected to the Local Control Cubicle. The star/ delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.

c) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

d) The rated extended currents for 420 kV class Current transformers shall be as given below:

I. The secondary winding shall be rated for 2A continuously.

II. For 400 kV systems CT, the rated extended primary current of the CT shall be 200% of rated primary on all except 2000/1A tap. At 2000/1A tap the rated extended primary current shall be 120%. At 2000/1A ratio, the CT shall be thermally rated for 200% for 15minutes and 120% continuous.

III. For 400 kV CT rated for 3000A, the rated extended primary current shall be 120% for 3000/1A tap and 180% for 2000/1A tap and 200% for lower tap ratios. The secondary windings shall be rated for 2A continuously.

e) For 245/72.5 /36 kV class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs as specified in the Section – Project.

f) For 420/245/72.5/36 kV current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 5% to 120%(or specified rated extended current whichever is higher) of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.

For 0.2S accuracy shall be maintained between 1% to 120% of rated current.
CT burden shall not be less than 5VA to achieve required 0.2S accuracy class

g) For 420/245/72.5/36 kV CTs, the instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably be inbuilt construction of the CTs. In case these are to be mounted separately these shall be mounted in the LCC panel suitably wired up to the terminal blocks.

h) The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the Secondary terminal box.

i) The current transformers shall be suitable for high speed auto-reclosing.

j) Provisions shall be made for primary injection testing either within CT or outside.

k) All the current transformers shall have effective electromagnetic shields to protect against high frequency transients. Electromagnetic shields to be provided against high frequency

transients typically 1-30 MHz.

l) The bidder will take care for the compatibility of the CT vis-à-vis burden of relay and connecting leads, however for calculation purpose fault current may be taken as 63kA for 400kV, 50kA for 220kV & 31.5 kA for 66kV/33kV and secondary current may be calculated accordingly.

m) The output burden of cores shall be as **Annexure 3A, 3B, 3C, 3D**. However burden of each core shall be finalized during detailed engineering.

10.2. VOLTAGE TRANSFORMERS

The voltage transformers shall conform to IEC- 61869 and other relevant standards except to the extent explicitly modified in the specification.

Voltage transformers shall be of the electromagnetic type with SF6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal box.

10.2.1. **Ratios and Characteristics**: The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be in accordance with **Annexure-4 & Table 4A,4B,4C,4D**

10.2.2. **Rating and diagram plates** :Rating and diagram plate shall be provided complying with the requirements of the IEC specification incorporating the year of manufacture and including turns ratio, voltage ratio, burden, connection diagram etc.

10.2.3. **Secondary Terminals, Earthing and Fuses**

The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of the SF6 switchgear.

All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

10.2.4. The transformer shall be able to sustain full line to line voltage without saturation of transformer. The accuracy class will be at maximum tap.

10.2.5. **Constructional Details of Voltage Transformers:**

a) The voltage transformers shall be located as a separate bay module and will be connected phase to ground and shall be used for protection, metering and synchronization.

b) The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The supplier shall ensure that there is no risk of Ferro resonance due to the capacitance of the GIS.

c) The voltage transformers shall have three secondary windings.

d) Voltage transformers secondary shall be protected by Miniature Circuit breakers (MCBs) with monitoring contacts for all the windings. The secondary terminals of the VT's shall be terminated to preferably stud type non-disconnecting terminal blocks in the secondary boxes via the fuse.

e) The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

f) The accuracy of 0.2 on secondary III should be maintained throughout the entire burden range up to 50 VA on all the three windings without any adjustments during operation.

g) The diagram for the interconnection of the VTs shall be provided inside secondary terminal box.

h) It should be ensured that access to secondary terminals is without any danger of access to high voltage circuit.

10.3. **Tests:**

10.3.1. Current Transformer and Voltage Transformer should have been type tested and shall be subjected to routine tests in accordance with relevant IEC.

10.3.2. The test reports of type tests, as applicable, as per IEC-61869-2 for CT, and IEC-61869-3 for IVT and following additional tests shall be submitted for the Employer's review.

a) Current Transformers (CT): Transmitted over voltage test for 66kV and above voltage rating
b) Inductive Voltage Transformers (IVT): Transmitted over voltage test for 66kV and above voltage rating

11. SURGE ARRESTORS

11.1. The surge arrestors shall confirm in general to latest IEC –60099-4.

11.2. **Insulation co-ordination and selection of surge arrestor**: The contractor shall be fullyresponsible for complete insulation co-ordination of switchyard including GIS. Contractor shall carry out detailed studies and design calculations to evolve the required parameters locations, energy capability etc. of surge arrestors such that adequate protective margin is available between peak impulse, surge and power frequency discharge voltages and BIL of the protected requirement. The locations of surge arrestors shown in single line diagram is indicative only. If the contractor feels that at some more locations the surge arrestors are required to be provided the same should also be deemed included in the offer.

If distance between Surge Arrestor and transformer bushing terminal inclusive of head length is more than 60 m or 170 ft then one surge arrestor shall be with GIS System and another shall be with transformer.

The contractor shall perform all necessary studies and the report shall detail the limits of all equipment parameters which could affect the insulation co-ordination. The report shall also detail the characteristics of the surge arrestor and shall demonstrate that the selected arrestor's protective and withstand levels, discharge and coordinating currents and arrestor ratings and comply with the requirement of this specification.

The contractor shall also consider in the studies the open circuit breaker condition, fast transients generated by slow operation of disconnecting switches. The study report and design calculations shall be submitted for Owner's approval.

11.3. **Duty requirements of GIS Surge Arrestor**

11.3.1. The surge arrestor shall be SF6 gas insulated metal oxide and gapless type. The metal housing of the arrestor shall be connected to the metal enclosure of the GIS with flange, bolted and gasketed joint so that the arrestor housing is grounded through GIS enclosure.

11.3.2. Surge arrestor shall be disconnect-link type and be attached to the gas-insulated system in such a manner that they can be readily disconnected from the system while the system is being dielectrically tested.

11.3.3. The surge arrester shall be of heavy duty station class and gapless (Metal oxide) type without any series or shunt gaps.

11.3.4. The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.

11.3.5. Surge arresters for the 400 kV class arrester shall be capable of discharging energy equivalent to class 4 of IEC for a 400 kV system on two successive operation followed immediately by 50 HZ energisation with a sequential voltage profile as specified below:

705 kVp for 3 peaks

580 kVp for 0.1 Sec.
565 kVp for 1 Sec.
550 kVp for 10 Secs.

11.3.6. 245 kV, 72.5kV & 33kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 245 kV, 72.5 kV & 36kV systems respectively on two successive operations.

11.3.7. The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

11.3.8. The surge arresters are being provided to protect the followings whose insulation levels are indicated in the table given below:-

Equipment	**LigLightning impulse(kVp) for 420 kVsystem**	**Switching surge(kVp) for 420 kV system**	**Lightning impulse(kVp) for 245 kVsystem**	**Lightning impulse(kVp) for 72.5 kVsystem**	**Lightning impulse(kVp) for 36 kVsystem**
Pr.Transformer	+/-1300	+/-1050	+/-950	+/-325	170
InstrInstrument Transformer	+/-1425	+/- 1050	+/- 1050	+/-325	170
Reactor	+/-1300	+/- 1050	+/- 1050		
CB/ Isolator Phase to Ground	+/-1425	+/- 1050	+/- 1050	+/-325	170
Across Open Contract	+/-1425 (+ 240)	+/- 900 (+345)	+/- 1200	+/-375	195

11.3.10. **Constructional Features**

The nonlinear blocks shall be of sintered/inferred metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

The arrestor enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the supplier and each arrestor shall be fitted with a Online continuous resistive leakage current monitoring system along discharge counter. The system shall be provided with an interface to integrate with the substation automation system.

The main grounding connection from the surge arrestor to the earth shall be provided by the contractor. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.

11.4. **TESTS**

11.4.1. In accordance with the requirements stipulated, the surge arrestors shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with IEC document.

11.4.2. Each metal oxide block shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC-60099.

11.4.3. Test on Surge Monitors: The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstands tests to verify efficacy of the same. Additional routine/functional tests with one 100A and 10 kA current impulse, (8/20 micro sec.) shall also be performed on the surge monitor.

11.5. **Technical Parameters**: Technical parameters f surge arrestor is as per **ANNEXURE-5**.

12. OUTDOOR SF6/Air BUSHINGS :

Outdoor bushings, for the connection of conventional external conductors to the SF6 metal enclosed switchgear, shall be provided where specified and shall conform to the requirements given in GTR. The dimensional and clearance requirements for the metal enclosure will be the responsibility of the manufacturer and their dimensions must be coordinated with the switchgear.

Bushings shall generally be in accordance with the requirements of IEC -60137.

12.1 Insulation levels and Creepage distances: All bushings shall have an impulse and power frequency withstand level that is greater than or equal to the levels specified for GIS.

The creepage distance over the external surface of outdoor bushings shall not be less than than 31mm/kV.

12.2 **Bushing types and fitting**: The details of bushing shall be as follows

SF6 to air Bushing shall be of Polymer / composite type and shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout. The electrical and mechanical characteristics of bushings shall be in accordance with IEC: 60137. All details of the bushing shall be submitted for approval and design review.

Polymer / composite insulator shall be seamless sheath of a silicone rubber compound. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the bushing against environmental influences, external pollution and humidity. The hollow silicone composite insulators shall comply with the requirements of the IEC publications IEC 61462 and the relevant parts of IEC 62217. The design of the composite insulators shall be tested and verified according to IEC 61462.

12.3 **Mechanical forces on bushing terminals:** Outdoor bushings must be capable ofwithstanding cantilever forces due to weight of bus duct (GIB) on one side & AIS conductor/Al tube on the other side and short circuit forces.

12.4 Type test reports as per applicable IEC including radio interference voltage (RIV) test shall be submitted in line with the requirement as specified in section GTR for approval. Design calculations in support of the cantilever strength chosen shall be submitted for owners review and approval.

12.5 The technical parameters of Bushing are as per **ANNEXURE-6**.

13. GIS TO CABLE TERMINATION (If applicable)

13.1. This scope covers the supply, erection, commissioning of connection assembly of fluid-filled or extruded cables to gas-insulated metal enclosed switchgear (GIS) as per IEC 62271-209

13.2. The XLPE cables shall be connected to GIS by the interfacing of XLPE cable sealing end to GIS Cable termination enclosure.

13.3. The GIS to XLPE cable termination shall conform to IEC-62271-209.

13.4. The rating of XLPE cables for different voltages is specified in the Section project.

13.5. The limits of supply of gas-insulated metal-enclosed switchgear and the cable termination shall be in accordance with IEC 62271-209.

13.6 Cable termination and cable connection enclosure shall be suitable for the requirements for which it is designed. This interface section shall be designed in a manner which will allow ease of operation and maintenance.

13.7 The SF6 cable end unit and connection support structure should be equipped with provisions for isolating the cable sheath or pipe to permit cathodic protection of cable system.(see IEC62271-209)

13.8 The provision shall be made for a removable link. The gap created when the link is removed should have sufficient electric strength to withstand the switchgear high voltage site tests. The

contractor may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer.

13.9 All supporting structures for the SF6 bus-duct connections between the XLPE cable sealing ends and the GIS shall be the scope of the contract. The supplier may specify alternative connecting & supporting arrangements for approval of the Employer.

13.10 The opening for access shall be provided in each phase terminal enclosures as necessary to permit removal of connectors to isolate the XLPE cables to allow carrying out the insulation tests. The general arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end shall also be submitted.

13.11 Type test reports of radio interference voltage (RIV) level shall be submitted for approval.

14. TRANSFORMER / REACTOR TERMINATION

14.1. TRANSFORMER / REACTOR Direct Connection with GIS (if applicable)

14.1.1. The limits of supply of gas-insulated metal-enclosed switchgear and the direct connection to oil filled transformer shall be in accordance with IEC 62271-211.

14.1.2. The transformer / reactor termination module enables a direct transition from the SF6 gas insulation to the bushing of an oil-insulated transformer / reactor. For this purpose, the transformer/reactor bushing must be oil-tight, gas-tight and pressure resistant. Any temperature related movement and irregular setting of the switchgear's or transformer's/reactor's foundations are absorbed by the expansion fitting.

14.1.3. Terminal connection arrangement to connect GIS duct to bushing and duct mounting arrangement details shall be submitted during detailed engineering for Employer's approval and for co-ordination with transformer and reactor supplier. Any modification suggested by transformer and reactor supplier shall have to be carried out by the GIS supplier to facilitate proper connection with the bushings of the transformer and reactors.

14.2. TRANSFORMER / REACTOR Connection with SF6/Air Bushing

14.2.1. The oil filled transformers and reactors are as shown in the substation SLD. The oil to air bushings of the transformers and reactors shall be supplied by the respective Transformer/Reactor supplier and the same shall be connected to the SF6 ducts thru air to SF6 bushings to be provided under present scope.

14.2.2. In case of single phase Transformers/Reactors are being installed in the substation, HV&IV auxiliary bus for the Transformer/Reactor bank for connecting spare unit shall be formed inside the GIS hall as per the SLD furnished and as specified in Section project.

15. LOCAL CONTROL CUBICLE (LCC)

15.1. Functions

15.1.1. Each circuit-breaker bay shall be provided with a local control cubicle containing local control switches and a mimic diagram for the operation and semaphore/indicating lamp for status indication of the circuit-breaker and all associated isolators and earth switches together with selector switches to prevent local and remote and supervisory controls being in operation simultaneously.

15.1.2. Status indications in the LCC shall be semaphore type or LED type.

15.1.3. Closing of the circuit- breaker from the local control unit shall only be available when the breaker is isolated for maintenance purposes. Circuit-breaker control position selector, operating control switch and electrical emergency trip push button shall be installed in the Local Control Cubicle. Circuit-breaker control from this position will be used under maintenance and emergency conditions only. The emergency trip push buttons shall be properly shrouded.

15.1.4. If Disconnector or earth switch is not in the fully open or closed position a "Control Circuit Faulty" alarm shall be initiated, and electrical operation shall be blocked.

15.1.5. 20% spare terminals shall be provided in each LCC apart from terminals provided for the termination and interconnection of all cabling associated with remote and supervisory control,

alarms, indications, protection and main power supply etc .

15.1.6. Where plugs and sockets connect control cabling between the local control cubicle and the switchgear these shall not be interchanged. In plug in connector type cable arrangement, min 2 cores of the cable with connected condition on both side up to the TB to be left unused as spare.

15.1.7. Hydraulic/pneumatic and SF6 auxiliary equipment necessary for the correct functioning of the circuit breaker, isolators and earth switches shall be located in a separate cubicle compartment.

15.1.8. LCC shall be suitable for remote operation from substation automation system (SAS). Each gas tight compartment shall be monitored individually per phase basis through SAS.

15.2. **Constructional features**

15.2.1. Local Control cubicle shall be either mounted on the GIS with front access or free standing, floor mounting type. It shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation. Alternatively folded sheet panels of adequate thickness and strength is also acceptable.

15.2.2. Access to all compartments shall be provided by doors. All fastenings shall be integral with the panel or door and provision made for locking. Cubicles shall be well ventilated through vermin-proof louvers(if required) having anti insect screen. All doors shall be gasketed all around with suitably profiled Neoprene/EPDM/PU gaskets conforming to the provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors.

15.2.3. For LCC panel of each feeder bay (i.e. line, transformer, and reactor etc.), Bus Coupler bay and Bus Sectionalizer bay, separate AC/DC supply for power circuit of GIS switchgear shall be provided, fed directly from ACDB/DCDB. The control DC supply (for control, interlocking, signaling) shall be tapped from respective relay & protection panel. For LCC panel illumination and heating purpose Loop in Loop out AC Supply can be provided.

15.2.4. Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Fuses/MCBs. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on plug-in type fuse bases. The short time fuse rating of Fuses shall be not less than 9 KA. Fuse carrier base shall have imprints of the fuse 'rating' and 'voltage'.

15.2.5. Each LCC Panel shall be provided with the following

1. **Plug Point**: 240V, Single phase 50Hz, AC socket with switch suitable to accept 5/15Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.
2. **Interior Lighting**: Each panel shall be provided with a door-operated LED lightingfixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch.
3. **Space Heater**: Each panel shall be provided with a thermostatically connected spaceheater rated for 240V, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.

15.2.6 Operating mechanisms, auxiliary switches and associated relays, control switches, control cable terminations, and other ancillary equipment shall be accommodated in sheet steel vermin proof cubicles.

15.2.7 Local control cubicles shall be provided to be free standing and shall be equipped with anti-condensation heaters. A suitable humidity stat and thermostat shall be included in the heater circuit.

15.2.8 The interior of each cubicle shall be finished with a semi gloss white surface. An interior lamp suitable for the local LVAC supply, controlled by a door-operating switch, shall be fitted at the top of each panel.

15.2.9 The arrangement of equipment within cubicles shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance of associated apparatus. All the control switches shall be internal i.e. installed behind a lockable glass door, that allows a complete view of the annunciator and mimic diagram when the LCC door is closed. Necessary protection shall be provided to avoid inadvertent operation of control switches.

15.2.10 An interlocking scheme shall be provided that takes into account the following basic requirements.

I. To safeguard maintenance personnel who may be working on one section of the equipment with other sections live.

II. prevent incorrect switching sequences that could lead to a hazardous situation to plant, equipment and personnel.

15.2.11 Electrical bolt interlocks shall be energized only when the operating handle of the mechanism is brought to the working position. Visible indication shall be provided to show whether the mechanism is locked or free. Means, normally padlocked/handle lock, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.

15..2.12 Where key interlocking is employed tripping of the circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism. Any local emergency-tripping device shall be kept separate and distinct from the key interlocking.

15.2.13 Disconnecting switches shall be so interlocked that they cannot be operated unless the associated circuit-breaker is open except that where double bus bar arrangements are specified, on-load transfer of feeder circuits from one bus bar to another shall be made possible by interlocks which ensure that the associated bus coupler and its isolators are closed.

15.2.14 Bus coupler circuit breaker shall be interlocked so that it shall not be possible to open a bus coupler circuit breaker while on load change over on that side of the breaker is in progress.-

15.2.15 All isolating devices shall be interlocked with associated circuit-breakers and isolators in the same station so that it shall not be possible to make or break current on an isolating device unless a parallel circuit in that station is already closed.

15.3. **Cabling between LCC Panel and GIS equipment**

15.3.1. The unarmored screen cable shall be of 1.1kV grade, multi core, annealed copper conductor, Tinned copper braided screen (approx. 85% coverage).

15.3.2. The core insulation and outer sheath of cable shall be of halogen-free special polymer.

15.3.3. The cable shall be flame-retardant, flexible, abrasion-and wear-resistant.

15.3.4. The size of core shall not be less than 2.5 sq. mm for instrument transformers and 1.5 sq. mm for other control cable.

15.3.5. Prefabricated cables with heavy duty multi-point plug-in connections on GIS end shall be provided.

15.3.6. All instrument transformer connections shall be hard wired to terminal block via ring type connection.

16. GIS BUILDING

16.1. The buildings shall house each voltage class Gas Insulated Switchgear (GIS) and other associated equipment inside each of the GIS buildings. GIS building(s) shall be constructed for the specified number of bays/diameters as per section project.

16.2. For finalizing the dimensions of GIS building the requirement of Turning radius to rotate the largest removable component for assembly/disassembly shall be taken in to consideration.

16.3. Wherever GIS Building of already exists, then the existing GIS Building(s) for respective voltage class shall be suitably extended keeping the width of the building same to accommodate the number of bays/diameters as specified in the Section Project/BPS.

16.4. The contractor shall submit the design & construction proposal of the building along with necessary information, data, and drawings during the detailed engineering according to the complete requirements.

16.5. The area for GIS Building(s) is indicated in the BPS. The area given is for reference only and

may vary according to the requirement of the equipment to be installed inside. The contractor shall finalize the dimensions according to the equipment offered by them providing enough space & access for erection, operation and maintenance.

16.6. The contractor shall place their panels i.e. Bay level units, bay mimic, relay and protection panels, RTCC panels, Communication panels etc. in a separate Relay Panel Room in the GIS building. The size of the room shall be such that all the panels for the bays/ diameters as per clause 16.1 shall be accommodated in the above room. The panel room shall be air-conditioned. Further, the temperature of the room shall be monitored through substation automation system by providing necessary temperature transducers.

17. ELECTRIC OVERHEAD CRANE :

17.1. Two EOT Cranes of suitable capacity shall be provided for erection & maintenance of largest/heaviest GIS component/assembly for each of 400kV, 220kV, 66kV GIS hall/building. The crane shall consist of all special requirements for erection & maintenance of GIS equipment.

17.2. The capacity of the crane shall be sized to lift the heaviest GIS switchgear component.

17.3. The Crane shall be used for the erection and maintenance of the GIS switchgear components installed in the GIS switchgear room. On completion of erection of the switchgear, the Contractor shall completely service the crane before the Taking Over Certificate is issued.

17.4. Crane hook approaches shall be of the minimum possible dimensions to ensure maximum coverage of the GIS building area.

17.5. The crane(s) shall be capable of lifting and accurately positioning all loads ranging from full crane rated capacity to at least 10% rated capacity.

17.6. Crane shall be designed for operation under following variable speeds through VVVF drives at full load :

Hoisting: 0.3 – 3 Meters per Minute
Cross Travel: 1.6 – 16 Meters per Minute
Long Travel: 2.0 – 20 Meters per Minute

17.7. The electric overhead cranes shall be provided with walkways, platforms. shall be provided along the bridge rails and on the crab of EOT crane to facilitate cleaning/maintenance of the crane and to give access to the GIS room high bay lighting and ventilation duct and grilles.

17.8. The platform and walkways shall be designed to support any weight to be imposed upon them during crane overhaul.

17.9. An access platform shall be provided together with a guarded ladder to allow access to the bridge rails.

17.10. The crane shall be provided with pendant control and RF control.

17.11. Contractor shall submit the capacity calculation of crane for GIS hall considering a factor of safety of rope as at least 5.

17.12. The Capacity of Cranes to be provided for GIS Hall shall confirm following.

a) The crane for 400kV GIS hall shall have capacity of minimum 6T safe working load & minimum hook height of crane have shall be 9.0 meters or as per actual requirement whichever is higher.

b) The crane for 220kV GIS/66kV/33kV GIS shall have capacity of minimum 5T/3T safe working load & minimum hook height of crane have shall be 8.0/6.0 meters respectively or as per actual requirement whichever is higher.

17.13. In case the GIS hall is to be extended, the scope of work also involves extension of EOT crane girders and all necessary Electrical & Mechanical accessories to facilitate movement of existing EOT crane in the extended portion of GIS hall. Cost of the same shall be deemed to be covered in the building cost.

17.14. The following tests shall be carried out on EOT Crane.

1. The crane shall be tested at manufacturer work under full load and 25 percent overload of hoisting and cross transverse motions as a routine test.
2. Further the following tests may be done at site after installation of the crane at site

a. Check all the accessories for proper function
b. No load test
c. Load test as per site conditions

18. SEISMIC DESIGN CRITERIA:

The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act non concurrently. Seismic Qualification requirements shall be as per IEC 62271-207 for the design of equipment. The equipments along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. The copies of type test reports for similar rated equipment, if tested earlier, should be furnished. If the equipment has not been type tested earlier Test Report/Analysis Report should be furnished during detailed engineering.

To prevent the movement of GIS sub assemblies i.e. various bay modules during the earthquake, suitable devices shall be provided for fixing the sub assemblies to the foundation. The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub assemblies to the foundation shall be designed to withstand the seismic events. It will also be ensured that the special devices as well as bolts shall not be over stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to the approval.

19. DESIGN REVIEW

19.1. Design reviews shall be conducted by Employer; however the entire responsibility of design shall be with the supplier.

19.2. Employer may also visit to the supplier's works to inspect design, manufacturing and test facilities.

19.3. The design review will commence after placement of award with the successful contractor and shall be finalized before commencement of manufacturing activity. These design reviews shall be carried out in detail to the specific design with reference of the GIS under the scope of this specification. Employer reserve the right to waive off the design review during detailed engineering.

19.4. The design review shall be conducted generally following the, "User Guide for the application of Gas Insulator Switchgear (GIS) rated voltage of 72.5kV and above" – CIGRE report No. 125 prepared by CIGRE Working Group 23.10.

19.5. The manufacturer will be required to demonstrate the use of adequate safety margins for thermal, mechanical, dielectric, insulation coordination and vibration etc. design to take into the account the uncertainties of his design and manufacturing processes.

19.6. The scope of such a design review shall at least include the following:

1. Dielectric Stress of Solid Insulation Like Gas barrier, Support insulator etrc.
2. Dielectric Stress of SF6 Gas Volume.
3. Mechanical strength of enclosure, expansion joints etc.
4. Criteria for providing expansion joint.
5. Sealing system

6. Insulation coordination
7. Thermal stress and resulting increase in gas pressure during short circuit condition.
8. Earthing of enclosure w.r.t circulating current.
9. Seismic design, as per IEC 62271-207
10. Circuit Breaker.
11. Isolator and Earth switch.
12. Voltage transformer.
13. Current Transformer.
14. Arrester.
15. Bushing.
16. Ducting.
17. Corrosion protection.
18. Electrical and physical Interfaces with substation.
19. Testing capabilities.
20. Inspection and test plan
21. Transport and storage.
22. Maintainability.
23. Site Test

19.7. Further, the manufacturer shall furnish the following information during detailed engineering:

a) Details regarding the loosely distributed metallic particles within the GIS encapsulation and calculations of critical field strength for specific particles of defined mass and geometry.
b) Study report of VFTO generated for GIS installation.
c) The methodology and all the equipment for electrical partial discharge (PD) detection, including that mentioned in the specification else-where.
d) The calculations and documents in support of the average intensity of electromagnetic field on the surface of the enclosure above during detailed engineering.
e) The detailed criteria/ design regarding location of pressure relief devices/rupture diaphragms
f) Calculations to show that there is no Ferro resonance due to capacitance of GIS for the voltage transformers
g) Design calculation for simulated parameters for Seismic level as applicable
h) Insulation Coordination studies including studies to recommend for additional surge arrestor
i) Calculations in support of touch & step voltages in all enclosures and earthing of complete GIS installation.
j) Measures to mitigate transient enclosure voltage by high frequency currents.
k) Calculation for providing bus duct supports.

20. TYPE TESTS

The offered GIS equipment shall conform to the type tests as per IEC-62271-203. Contractor shall submit type test reports for the following type tests & additional type tests.

Sl.	Description of the Type Test for GIS
1	Tests to verify the insulation level of the equipment and dielectric test on auxiliary circuits
2	Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit
3.	Tests to prove the ability of the main and earthing circuits to carry the ratedpeak and rated short time withstand current.
4	Tests to verify the making and breaking capacity of the included switching Devices.
5.	Tests to prove the satisfactory operation of the included switching devices.

6	Tests to prove the strength of the enclosures.
7	Gas tightness tests.
8	Tests on partitions.
9	Tests to prove the satisfactory operation at limit temperatures
10	Tests to assess the effects of arcing due to internal fault
11	Verification of the degree of protection of the enclosure
12	Tests to prove performance under thermal cycling and gas tightness tests on Insulators.
13	Additional tests on auxiliary and control circuits
14.	Reactor current switching test For Reactive Current switching capability as per Clause 6.4.1.
15.	Test to demonstrate the Power frequency withstand capability of breaker in open condition at lock out pressure
16	Electromagnetic compatibility tests (if applicable)
17	Radio inference voltage tests

The test reports of the above type tests for GIS (including type test report on Circuit breaker, Disconnect Switch, Grounding switches, Current and Voltage transformers as per relevant IEC and type tests of SF6/Air & Oil bushing as per IEC 60137 shall be submitted for approval as per Section- GTR, Technical Specification.

21. MISCELLEANOUS

21.1. **Painting of enclosure**: All enclosures shall be painted externally as per manufacturer' spainting procedure.

21.2. **Heaters:** Wherever required, heaters shall be provided to prevent moisture condensation inside various Marshaling boxes.

21.3. **Identification & rating plate**

Each bay shall have a nameplate showing

a) Each module will have its own Identification & rating plate. The rating plate marking for each individual equipment like Circuit breaker, Disconnect Switch Grounding switches, Current transformer, Voltage transformers, Surge arrester etc shall be as per their relevant IEC.
b) A schematic diagram indicating their relative locations.
c) DTL Contract no.

22. TRANSPORT OF EQUIPMENT TO SITE

The contractor shall be responsible for the loading, transport, handling and offloading of all equipment and materials from the place of manufacture or supply to site. The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities as well as determining any transport restrictions and regulations imposed by the government and other local authorities. All transport packages containing critical units viz Circuit breakers and Voltage transformers shall be provided with sufficient number of impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. In case of electronic impact recorder, the recording shall commence in the factory and must continue till the units reach site. The data of electronic impact recorders shall be downloaded at site and a soft copy of it shall be handed over to Engineer – in –charge. Further, contractor shall communicate the interpretation of the data within three weeks.

23. PACKING, STORAGE AND UNPACKING

23.1. All the equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and the variations in such conditions that will be encountered enroute from the manufacturer's works to the site.

23.2. The SF6 metal clad equipment shall be shipped in the largest factory assembled units that the transport and loading limitations and handling facilities on site will allow to reduce the erection and installation work on site to a minimum.

23.3. Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Should the units be considered too large for packing in crates, they shall be suitably lagged and protected to prevent damage to any part, particularly small projections, during transport and handling. Special lugs or protective supports shall be provided for lifting to prevent slings and other lifting equipment from causing damage. Each crate, container or shipping unit shall be marked clearly on the outside to show where the weight is bearing and the correct position for the slings.

23.4. Each individual piece to be shipped, whether crate, container or large unit, shall be marked with a notation of the part or parts contained therein.

23.5. Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the metal clad equipment of which each gas section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF6 gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment.

23.6. Blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site which may on later stage necessarily be used during repair and maintenance shall remain the property of DTL. Balance blanking plates, caps, seals, etc shall be returnable to the contractor. If considered necessary, blanking plates or other sealing devices shall be provided with facilities for measuring the gas pressure and recharging at any time during the transport period. Any seals, gaskets, 'O' rings, etc. that may be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Identification numbers shall be stamped into the blanking plates, etc., and on the switchgear equipment to which they are fitted so that they can easily be identified and refitted should it ever be necessary to ship sections of the switchgear back to the manufacturer's works for repair.

23.7. Valves and other gas couplings associated with the switchgear gas systems shall be adequately protected against damage from any bumps or physical blows. They shall also be capped to prevent ingress of dirt or moisture or damage to any coupling, pipes, threads or special fittings. Any explosion vents and other pressure relief devices shall be suitably sealed and protected to prevent accidental exposure of the sealed sections during shipment to site.

23.8. For bus ducts involving male and female joints of the current carrying conductor, the same shall be transported in disassembled condition to avoid any damage during transit. All bright parts liable to rust shall receive a coat of anti rusting composition and shall be suitably protected.

23.9. The contractor shall ensure that during the period between arrival at site and erection, all materials and parts of the contract works are suitably stored in such approved manner as to prevent damage by weather, corrosion, insects, vermin or fungal growth. The scope of providing the necessary protection, storing on raised platform, as required etc. is included in the works to be performed by the contractor. Cost of the raised platform for temporary storage is deemed to be included in overall cost. The raised platform needs to be made ready before arrival of GIS equipment at site. The contractor may use the available storage areas at site with permission of site in charge.

23.10. The equipment shall be unpacked immediately before Installation. They shall not be left lying unnecessarily in open crates or containers. Special precautions shall be taken when gas sections which have been sealed and pressurized for shipping are opened up to reduce the ingress of dirt and atmospheric moisture to a minimum. Whenever possible this shall only be done immediately prior to installation and if any section is to be left outside for any length of time after being opened, it shall be resealed and pressurized with either dry nitrogen or SF6

gas until required.

23.11. For the purpose of release of payment linked to receipt and physical verification in case of GIS equipment it shall mean random opening and physical verification of one number of packing unit of each type of main equipment (i.e. GIS CB/ISO/ES/PT/LA etc.) for each voltage level. Thereafter proper re-packing of the GIS unit shall be ensured as per manufacturer recommendation.

24. INSTALLATION OF GIS

24.1. Civil works of GIS Hall shall be completed in all respects before taking up the installation and it shall be ensured that Ventilation System is operational and all dust and dirt in the hall are removed. The GIS hall needs to be in positive pressure before starting Installation.

24.2. The installation area shall be secured against entry of unauthorized personnel. Only certified manufacturer's engineer and supervisor shall undertake the erection works. Engineers and supervisors of the manufacturer shall submit authorization and competency certificate to DTL.

24.3. Un-packaging of GIS modules shall be done outside the GIS hall and in no case module to be taken inside GIS hall with packing.

24.4. All assembly work shall be done by qualified personnel only who are to be identified and list submitted to DTL site before starting of erection work.

24.5. Assembly drawing for GIS erection for the section under progress shall be available and displayed in GIS hall at the time of erection work.

24.6. Working personnel shall clean their shoes or apply covers on shoes before entering the immediate working area. The working clothes of authorized personnel shall be made of non-fluffy material.

24.7. GIS hall door shall have automatic close facility after entry of personnel to avoid dust and moisture entry. Walls and ceiling shall be in a condition so that neither dirt nor plaster might fall or rub off and formation of condensation water in ceiling shall be prevented under any circumstances.

24.8. Floor in the installation area shall have a firm surface and shall be kept dust free with a vacuum cleaner. Vacuum cleaning to be done on regular basis.

24.9. Only T&P and consumables required for GIS erection shall be kept in GIS during erection.

24.10. In case of outdoor installation of GIS or of GIS components open gas compartments shall be protected from dust and moisture ingress (by tarpaulin covers/protective enclosure/chamber etc)

24.11. Bus duct exits in the GIS hall's wall shall be kept covered by suitable means until permanent cover is provided after installation of bus ducts.

24.12. Maintenance room (as a part of LCR room) shall be constructed for carrying out repair works/ small part assembly. All excess material (not required for immediate installation works) test equipment and tools and tackles to be stored separately from GIS hall in this room for rework.

24.13. Erection agency shall submit method statement and make available formats for checking during each stage of hall preparation, assembly process and final checks to be approved by DTL site before start of erection. Shock recorder down loaded data and analysis shall be submitted preferably before commencement of erection work. In case of violation of shock limits, expert form manufacturer shall visit and do the joint internal inspection and shall submit analysis report before giving clearance for erection. If required the module shall be taken back to factory for further analysis and testing.

24.14. Cleaning is of utmost importance and hence before assembly, all the loose metal parts, subassemblies and all contact & sealing surfaces shall be cleaned before installation. Cleaning shall be carried out with specified cleaning agents of the manufacturer, in no condition water is to be used except for external surfaces. Further, prior to opening of gas compartment, the same shall be thoroughly cleaned externally. The vacuum cleaning of the installation area shall also be done specially the immediate vicinity of the flanges to be connected.

24.15. All Civil Work inside building including internal cable trench shall be completed before GIS installation.

24.16. Installation of flanges shall be done immediately after removal of transport covers. Transport covers, O-rings and other packing material of GIS shall be taken out immediately after

removal.

24.17. O Rings shall be properly stored and taken out only before installation. O Rings are also to be cleaned before use with manufacturer authorized cleaning agent.

24.18. At all points of time during installation authorized personnel shall use suitable gloves to avoid contamination.

24.19. Cable termination work shall commence only after completion of GIS equipment erection, as during GIS installation period laying and termination of cables interferes with the GIS erection work and affects cleanliness.

24.20. Approved Field Quality Plan shall be followed during site work.

24.21. Proper power supply shall be ensured by installing DG Set of proper rating and frequency if required prior to commencement of erection work so that assembly work is not interrupted in the middle which is critical for GIS installation.

25. ON SITE TESTING

After the GIS Switchgear has been fully installed at site and SF6 gas filled at rated filling density, the complete assembly shall be subjected to the site tests as per IEC-62271-203 and with the test voltages specified below:-

25.1. Application of Power Frequency voltage test for duration of 1 minute with the value as per IEC 62271-203.

25.2. Directly after the above test at 25.1, Switching impulse test with three impulses of each polarity and with the value (80 % of the rated switching Impulse withstand level) as per IEC 62271-203.

25.3. In case of a disruptive discharge in the gas as outlined in clause no: C.6.2.2 Procedure b), Annexure-C of IEC 62271-203 during the AC voltage test and a repeat test is performed due to this failure, then the repeat test shall be carried out at Specified voltage.

25.4. In case of a disruptive discharge in the gas as outlined in clause no: C.6.2.2 Procedure b) Annexure-C of IEC 62271-203 during Oscillating Switching Impulse Test and a repeat test is performed due to this failure then the repeat test shall be carried out at a value equal to 90 % of the rated switching Impulse withstand level.

25.5. Method statement/ procedure of ON SITE high voltage testing, PD measurement and Switching Impulse test shall be submitted by contractor in advance. The adequacy of number of UHF sensors and their location shall be verified as per recommendations of CIGRE task force **TF 15/33.03.05** (Task force on **Partial discharge detection system for GIS: Sensitivity verification for the UHF method and the acoustic method**). In case during site testing additional UHF sensors are required, the same shall also be supplied and installed to complete the technical requirement.

25.6. Application of AC voltage equal to 1.2 times the service voltage in order to condition the GIS whilst at the same time permitting measurement of Partial discharge and detection of conductive particles by UHF method.

25.7. In case of a disruptive discharge in the gas as outlined in clause no: C.6.2.2 Procedure b) annexure – C of IEC : 62271-203 , and a repeat test is performed due to failure during the AC voltage test , then the test shall be carried out at 1.2 times the service voltage .

25.8. The analysis of PD measured during High voltage test shall be done very carefully and presence of PD measured by any sensor shall be attended and HV test shall be repeated after the rectification work. Calibration of PD sensors shall be completed before start of HV test to establish reference for detection of PD above 5 pc.

25.9. Method statement/ procedure of onsite high voltage testing and PD measurement shall be submitted by contractor in advance.

26. VENTILATION SYSTEM FOR GIS HALL

26.1. Each GIS Hall shall have an independent ventilation system. Each Ventilation system shall consist of two 100% capacity systems, one operating and one stand-by.

26.2. To ensure that the air being supplied to the GIS hall is free from dust particles, a minimum two stage dust filtration process shall be supplied. This shall consist of at least the following:

i. Pre Filters: To remove dust particles down to 10 micron in size with at least 95% efficiency.

ii. Fine Filters: To remove dust particles down to 5 microns in size with at least 99% efficiency.

All the filters shall be panel type. Easy access should be available to the filters for replacement/cleaning.

26.3. The ventilation of the GIS hall shall be of a positive pressure type with minimum 4 air changes per hour. The pressure inside the GIS hall shall be maintained 5 mm of water above the atmospheric pressure. Fresh outdoor air shall be filtered before being blown into the GIS hall by the air fans to avoid dust accumulation on components present in the GIS hall. GIS hall shall be provided with motorized exhaust dampers with local control.

26.4. In case of extension of GIS hall is covered under the present contract, separate ventilation system shall be provided meeting the functional requirement as specified above and the same shall be integrated with existing ventilation system.

27. MANDATORY SPARE

Design, engineering, manufacture, testing, supply on FOR destination site basis including transportation & insurance, storage at site of Mandatory spares for the GIS(As specified in BPS).

28. TESTING & MAINTENACE EQUIPMENT

Testing & Maintenance equipment shall be offered, as per relevant schedule of BPS.

28.1. SF6 Gas leakage detector.

28.2. The technical specification of SF6 Gas leakage detector shall be as per **Annexure-8**

28.3. Gas filling and evacuating plant : (Gas Processing unit)

I. The plant necessary for filling and evacuating the SF6 gas in the switchgear shall be supplied to enable any maintenance work to be carried out. This shall include all the necessary gas cylinders for temporarily storing the evacuated SF6 gas. The capacity of the temporary storage facilities shall at least be sufficient for storing the maximum quantity of gas that could be removed from at least one phase of one complete bay (switchgear and associated equipment).

II. Where any item of the filling and evacuating plant is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with lifting hooks for lifting and moving with the overhead cranes.

III. The minimum capacity parameters of evacuation plant will be as under :

Oil Free Suction (Recovery) Pump:	30 M^3/Hour
Compressor (Two Stage):	15 M^3/Hour
Oil Free Vacuum Pump:	100 M^3/Hour

IV. The evacuation equipment shall be provided with all the necessary pipes, couplings, flexible tubes and valves for coupling up to the switchgear for filling or evacuating all the gases.

V. Details of the filling and evacuating plant that will be supplied, as well as the description of the filling and evacuating procedures shall be furnished

28.3. SF6 gas analyzer: The technical specification of SF6 gas analyzer shall be as per(As per Annexure-9)

28.4. Portable Partial Discharge(PD) monitoring system (Shall generally applicable for

220kV,66kV& 33 kV)

I. The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs.

II. It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection. The instrument should also be able to detect partial discharges in cable joints and terminations.

III. Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc. Software for display and diagnosis of PD signals and an expert software system for accurate interpretation of cause of PD shall also be supplied and installed by the contractor.

IV. The equipment shall meet the following requirements

1. Measurement shall be possible in noisy environment.
2. Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD.
3. Equipment should have necessary synchronizing circuits to obtain PD correlation with power cycle and power frequency.
4. The equipment shall be battery operated with built-in-battery charger. It shall also be suitable for 230V AC/50 Hz input.
5. Measurement shall be possible in the charged switchyard in the presence of EMI/EMC. Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be supplied along with the offer.
6. Instrument shall be supplied with standard accessories i.e., re-locatable sensors with mounting arrangements, connecting cables (duly screened) to sensors, Lap-top PC, diagnostic and expert interpretation software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50Hz supply connecting cables (duly screened) to view in storage.
7. The function of software shall be covering the following:
   a) Data recording, storage and retrieval in computer
   b) Data base analysis
   c) Template analysis for easy location of fault inside the GIS
   d) Evaluation of PD measurement i.e, Amplitude, Phase Synchronization etc.
   e) Evaluation of bouncing/loose particles with flight time and estimation on size of particle.
   f) Expert software system for accurate interpretation of cause of PD.
   g) Report generation.
8. To prove the suitability in charged switchyard condition, practical demonstration shall be conducted before acceptance.
9. Supplier shall have “Adequate after sales service” facility in India and shall provide the document in support of this.
10. Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS
11. Instrument shall be robust and conform to relevant standard.

IV. **Calibration/Sensitivity verification:** The UHF Couplers have to be first calibrated as per CIGRE Document No.654 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration. The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference.

V. Pulse generator, same type as that of used during factory testing for UHF sensor sensitivity test shall be supplied as a standard accessory.

28.5. Online Partial Discharge Monitoring System (Applicable 400 kV GIS)

a) GIS equipment shall be designed so as to minimize partial discharge or other electrical discharge. A state-of-the art Partial Discharge Monitoring system shall be provided to monitor the entire GIS installation.

b) An on-line continuous Partial Discharge Monitoring (PDM) system shall be designed to provide an automatic facility for the simultaneous collection of PD data at multiple points on the GIS & its associated GIB ducts and Voltage Transformers adopting UHF technique. The data stored shall provide a historical record of the progress of PD sources and shall identify the areas of maximum activity.

c) On-line continuous Partial Discharge Monitoring (PDM) system shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection.

d) The scope shall cover Engineering, supply, installation, testing and commissioning of partial discharge continuous monitoring system, with all necessary auxiliaries and accessories to make a complete system as per technical specification, including site demonstration of successful operation. Any items/accessories necessary to make the system fully functional for the trouble free online PD monitoring of complete GIS installation shall be considered as included in the scope.
The PDM system shall be provided with all its hardware and software, with readily interfacing to the UHF PD couplers installed in the GIS of present bays and future bays as shown in SLD plus 20% additional as extra. Details of this shall be submitted during engineering stage for approval.
The integration of UHF PD coupler in future GIS bays shall be done in respective package. The number of UHF PD coupler for future bays shall be decided based on GIS layout finalized under present scope (considering present GIS equipment with future provision).
The PD Monitoring PC Work Station shall be housed in a lockable cabinet with duplicate keys and shall be located in the control room of the GIS substation. Workstation PCs shall be pre-loaded with all necessary Hardware & Software. The PCs shall have each Combo drive & Retrievable disk drive (1 TB), Ethernet port 100Mbps, printer. The workstation PC shall be powered by suitable dedicated UPS and same is included in the present scope.

e) Design of on-line PDM System

1. The technical proposal for PDM system along with detailed design documentation shall be submitted for EMPLOYER'S approval during engineering stage.
2. To guarantee that sufficient coverage is available for complete GIS installation to monitor PD activity all design details shall be submitted as part of the above for review.
3. The sensitivity of the offered system shall be in accordance with CIGRE Document No. 654 that will be verified as part of site sensitivity tests.

4. UHF attenuation data of GIS shall be submitted for the switching devices, spacers, bends etc.
5. The signal attenuation level of co-axial cable per meter length and justification for the length of cable connection between the couplers and detector units shall be furnished.
6. The overall sensitivity of PD detection system shall take into account the spacing between couplers and the associated cabling, filters, amplifiers, etc.
7. The Sub-station GIS layout as a separate drawing indicating position of spacers, spread over of PD sensors with distance, sensor identification, the detector unit identification etc. shall be submitted during engineering stage for approval.
8. The PD sensors shall be identified / coordinated with the corresponding detector unit etc. with proper identification labeling and indicated in the substation PDM SLD.
9. Internal arrangement/wiring diagram is to be submitted for detector units/control cabinet etc. All internal items are to be identified / labeled to facilitate troubleshooting.
10. Supply requirement (AC & DC) to be specified for the complete monitoring system.
11. Power supply to PDM PC shall have protection against surges, overload and short circuit. A dedicated on-line UPS system shall also be provided as a backup during supply interruption, to ensure trouble-free & reliable running of the PDM System for a minimum of 15 minutes duration. Ratings of UPS shall be proposed for the approval of EMPLOYER'S. The UPS shall have enough capacity to initiate a 'safe' shut down of the PDM PC and the peripherals after this 15-minute period if normal supply fails to resume. The PDM PCs shall restart automatically on resumption of normal supply. The UPS shall not generate spikes during changeover of supply. UPS shall automatically give indication / alarm when it requires battery replacement. Potential Free Contacts shall be generated to signal these events. These contacts shall be wired out to Annunciation / Monitoring systems. Alternately, inverter of suitable capacity is also acceptable. Critical Process and Status alarms of the PDM system shall be displayed.
12. PDM System shall be provided with a user security for accessing the system with a log-on and password entry procedure. The user levels shall be defined as a Master User and other users for the modification of system, update, and entry of parameters or manual operation. System shall be able to generate 3D point on wave pattern whenever any PD activity detected by the system. System shall be able to give online 3D point on wave pattern, online PRPD (phase resolved PD) and online short time trend etc. System shall be able to generate the all the logs related to system fault, system access, PD event, and any changes in system setting etc.
13. Method of electrical isolation/protection provided between PD sensor and detector circuitry in case of flashover/high potential stress inside GIS should be furnished.
14. The selected mode of propagation of PD signal (electromagnetic wave) inside GIS for the design of sensors shall be furnished.
15. The protection available for electronics against transient over voltages caused by switching operations shall be furnished.
16. The capacity of each detector unit to be specified to accommodate as many numbers of PD sensors signal.
17. The applicable standards to meet IEC & IEEE requirements for electromagnetic compatibility shall be specified. The offered system should have been tested for the same for working in a 400kV & above substation environment. The necessary documentation has to be submitted in this regard.
18. Guaranteed technical particulars & data sheet for various components used in the system shall be submitted.

f) **Calibration:** The UHF Couplers have to be first calibrated as per CIGRE procedure TF15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration.

The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference.

g) **Every Day Use & Maintenance** : The system shall be designed suitable for anunmanned s/s and operate automatically. The system shall generate alarms if suspected partial discharge activity is noticed or the system itself is in failure, thereby eliminating the necessity of periodic system access by the user and one such alarm shall be connected to Substation automation system (SAS). The alarms shall be configured coupler wise.

h) **Computers and Peripherals:** The PC operating system shall be the latest version of MS Windows. It should be suitable for continuous process application and should have been tested for the same. The hardware configuration of PC should be the latest available in the market of industrial type subject to EMPLOYER'S / Engineer approval. For storing the historical PD database, sufficient storage facility in the form of hard disc and retrievable hard disk drive of 1TB as specified shall be available in the substation. The PC monitor shall be 21" LCD type of reputed make.

i) **Filtering Facility:** The filtering facility has to be provided in order to distinguish real PDfrom internal/external noise such as switching operations, self-test signal, radio, communication signal etc. The PDM system itself shall be able to discriminate the noise from real PD. The exposed gas barriers of the GIS shall be shielded effectively against noise interference & tested. The gas barrier shields/belts shall be suitable for outdoor use also & able to withstand high ambient temperature. Site measurements have to be performed after installation of the PDM system in order to identify the various sources of external noise to incorporate the same in the filtering facility. This filtering will preferably be through software by band pass, which can be manually activated (as an option) to filter out noise signals in the trend plot display. If hardware filtering is employed then adequate measures have to be taken to avoid masking of other signals, which may lie in the same frequency range. The method adopted for the above shall be specified taking into account the sensitivity requirement of PDM system as per CIGRE document. The noise filters shall be selectable individually coupler-wise.

j) **Self-Test (Diagnostic) Facility**: Built-in self-checking facility shall be incorporated inthe control system which will continuously verify the correct operation of the whole monitoring system with the simulated PD signal viz. checking of the sensitivity of individual detector units, response of PD sensors in addition to the checking of the system functioning. The periodicity of such self-check operation shall be specified. In case of system failure this shall trigger an alarm for communication to SAS. External check facility: Propose the arrangement/device available for externally checking the healthiness of PD sensors by pulse injection in addition to built-in monitoring facility.

k) **Detector Units**: The sensitivity of each detector unit shall be furnished. The sensitivity levelof individual detector units shall be selectable depending on the site background noise level.

l) **Trend Plot**: The trend plot facility shall be available with the update period ofhourly/daily/weekly/monthly/yearly. It shall be possible to view the historical trends for the complete archived data accumulated over several years.

m) **PD Monitoring modes**: There shall be two different modes of system operation viz. a dedicated Continuous PD Monitoring mode for the normal day today operation of the system & a dedicated HV commissioning test mode which is exclusively for PD monitoring during HV commissioning test. The HV commissioning mode shall also operate as an independent feature.

In the HV Commissioning mode the real time display shall be possible for a minimum of two complete bays with associated bus bars and at with one second update period. The HV test software shall automatically record the HV voltage information along with PD so as to check PD inception & extinction voltages precisely. The complete HV & PD data recorded during HV test shall be possible to be reviewed in replay mode after the HV test.

n) **Alarm Facility:** The PDM system shall generate alarm when action is required; viz. a)

PDalarm (abnormal PD activity indicating a risk of failure) & b) PD system fail alarm to be connected to SAS.

o) **Real Time Display:** The PDM system should have the facility of Real Time display, whichwill give an instant indication of PD activity coupler wise, with one-second-update period. The PDM system shall be able to capture the PD data triggered by associated switching operations of CBs & isolators.

p) **Schematics: The** PDM system should have GIS schemes bay-wise incorporating PD sensoridentification and location along with spacer location. The sectional view of typical bay arrangement of GIS showing active parts shall also be included as part of the PDM software.

q) **Print Option/Facility:** PDM system should have the option/facility of printing all trendplots/reports/POW patterns/displays, etc. Laser Colour printer shall be provided for this purpose at substation.

r) **Data Archives:** This is to provide access to historical data and file storage with date andtime stamp. Sufficient storage facility shall be available to review historical data updated for the lifetime of switchgear. The substation & headquarters PCs shall have a backup device in the form of a retrievable disk drive of 1TB capacity for this purpose.

s) **PD Fault Identification & Location/Pattern Recognition/Predictive Maintenance**
Diagnostic Software: In order to interpret various types of PD defects, intelligent diagnostics software (expert system) shall be built- in as part of the PDM software capability. This is mainly to reduce the dependence on PD specialist. The bidder shall also make available typical point-on-wave patters as library pictures to train the user.
Software Updates: It shall be possible to upgrade / update the system software throughout the lifetime of the system with the ongoing development / refinement in PD technology.

t) Fault investigation : In case of any indication of suspected PD activity by the on line system, further investigation has to be carried out by the contractor for the PD defect identification and location during the warranty period

u) Special Tools / equipment, Spare Parts, software packages
   i. Special Tools: Special tools for cutting and crimping of coaxial cable with 'N Connectors' shall be supplied.
   ii. Spare parts: The contractor has to supply critical spares with replacement procedure for the trouble free operation of the system during its expected lifetime as part of the contract. A detailed list shall be included in the tender and also submitted for EMPLOYER'S approval during the detailed engineering stage.
   iii. Software Packages: The complete software package shall be supplied as part of a back-up facility in the form of DVD/CDs viz. Windows operating system with end user license, PDM Software including HV Test, Drivers for modems etc., software for remote access, printer etc. The list shall be submitted for reference.
   iv. Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.

v) Operation & Maintenance Manual :A complete O&M manual covering all aspects of trouble shooting of PDM system in six sets in original shall be provided & also in CD's. For diagram references colour pictures shall be provided. A step-by-step procedure for spare parts replacement shall also be included.

w) **Factory / Site Test Formats**: Thefactory& site tests format to be submitted for approval. Theformat shall cover all possible tests to confirm healthiness of the system and to record the test values.

x) List of References: The bidder shall provide a reference list of PD monitoring system, which is supplied by them and in successful operation worldwide in a power utility.

29.0 Training

The successful bidder shall arrange free of cost training to engineers of the purchaser/purchaser's representative in design, manufacture and testing of GIS being supplied for 120 man days.

• Four weeks on site and on-job training during erection.
• Two weeks training on GIS at principle manufacturer's works as per

curriculum specified below :

Curriculum for GIS Training

The curriculum of GIS training should at least cover the following aspects. Any other specificarea may be brought to notice and included.

1. General Explanation for GIS
2. Layout and Architecture of GIS
3. Gas Sectionalisation of GIS
4. Construction of CB
5. Operating Mechanism of CB
6. Maintenance of CB
7. Overhaul of CB (Interrupting chamber)
8. Overhaul of CB (Operating Unit)
9. Construction of DS/ES
10. Maintenance of DS/ES
11. Overhaul of DS/ ES
12. Construction of Bus/ Cable head/ SF6 – air bushing
13. Maintenance of Bus/ Cable head/ SF6 – air bushing
14. Overhaul of Bus/ Cable head
15. Overhaul of various transformer connections
16. Operation of GIS with SCADA
17. Construction & Maintenance of Lightning Arrester
18. Construction & Maintenance of VT/CT
19. Construction & Maintenance of Local control panel
20. Erection of GIS at site.
21. Installation & Testing of GIS at site
22. Type tests of GIS
23. Routine tests of GIS.
24. Faults simulation of GIS
25. Localization of GIS fault.

30. Service conditions

The equipment and the accessories to be supplied against this technical specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

1. Temperature: The reference ambient temperature be taken as 43.3 º C as per IS 9676.		
a.	Maximum ambient air temperature	50ºC
b.	Maximum daily average ambient temp	40ºC
c.	Maximum indoor ambient temp	35º C
2. Relative Humidity:		
a.	Maximum Relative Humidity	100%
b.	Minimum Relative Humidity	10%

3.	Average annual rainfall	750 mm
4.	Average no. of rainy day	50
5.	Average no. of thunderstorm days per annum	40
6.	Altitude	Not exceeding 300 meters
7.	Rain months	June to Oct.
8.	Wind pressure as per IS 875	195 Kg/Sq. meters up to 30 meters
9	Seismic Level	Zone-IV, as per IS-1893,Year-2002
10	Pollution class/creepage distance	31 mm/kV

The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months. Heavy lightening occurs in the area during rainy months (June to October).

All equipment shall be designed to withstand seismic forces, corresponding to an acceleration of 0.3 g horizontal.

ANNEXURE-1

Technical parameters of Circuit Breaker shall be as follows:

S.No.	Details	Unit	400kV	220kV	66kV	33kV
1.	Rated current	A	3000/2000 A (3000 for bus-coupler breaker& I/C bay)/ As per scheme	1600/2500 (2500 for bus-coupler breaker& I/C bay)/ As per scheme	2000/2500 (2500 for bus-coupler breaker& I/C bay)/As per scheme	1250/2500 (2500 for bus-coupler breaker & I/C bay)/As per scheme
2.	Operating mechanism		Spring/ hydraulic	Spring/ hydraulic	Spring/ hydraulic	Spring
3.	Rated fault current & its duration	kA	63 (1 sec.)	50 (1 sec.)	31.5 (1 sec.)	31.5 (1 sec.)
4.	Rated short circuit making current	kA	158	125	80	80
5.	Rated operating duty cycle:					
5a)	For auto-reclosing type		O-0.3 sec-CO-3 min-CO	O-0.3 sec-CO-3 min-CO	O-0.3 sec-CO-3 min-CO	NA
5b)	For non-auto reclosing type		------	------	------	CO-15sec-CO
6)	Lightning (Full wave)impulse withstand voltage (1.2/50 µ s)					
6a)	Between line terminals and ground	kVp	±1425	±1050	±325	±170
6b)	Between terminals with circuit breaker contacts open:	kVp	±1425 kVp impulse on one terminal & 240 kVp of opposite polarity on the other terminal	±1200	±375	±195
6c	-Lightning impulse voltage applied to one terminal	kVp	1425	---	---	---
6d	-Power frequency voltage applied to opposite terminal	kVp	240	---	----	----
7.	Switching impulse withstand voltage					

S.No.	Details	Unit	400kV	220kV	66kV	33kV
	(250/2500 s) dry & wet					
7a)	Between line terminals and ground	kVp	1050	---	---	---
7b)	Between terminals with circuit breaker contacts open:		900	--	---	---
7c	-Switching impulse voltage applied to one terminal	kVp	900	---	---	---
7d	-Power frequency voltage applied to opposite terminal	kVp	345			
8	One minute power frequency withstand voltage					
8a)	Between line terminals and ground	kV rms	As per IEC			
8b)	Between terminals with circuit breaker contacts open	kV rms	As per IEC			
9)	Minimum corona extinction voltage in open and close position	kV rms	320	156	105	---
10.	Maximum radio interference voltge for frequency between 0.5 to 2MHz in open and close position	Micro-volt	1000 (at 320 kVrms)	1000 (at 156 kVrms)	500 (at 92 kVrms)	---
11.	First pole to clear factor		1.3	1.3	1.3	---
12.	Maximum line charging current (rms)(5)	A	600	125	50	10
13.	Rated cable charging breaking current capacity (rms)	A	400	250	160	50
14.	Break time: -Total break time up to rated breaking current -Rated break time	ms	 45 40	 65 60	 65 60	 105 100
15.	Making time (closing time)	ms	<150	<200	<200	<200
16.	Difference in instants of closing/opening of contacts(6)					
	-within a pole	ms	2.5	2.5	--	--
	-Between poles (for opening)	ms	3.3	3.3	--	--
	-Between poles (for	ms	5	5	---	--

S.No.	Details	Unit	400kV	220kV	66kV	33kV
	closing)					
17.	Maximum noise level (7)	dB	140	140	140	140
18.	Maximum over –voltae on switching of transformer on no load	p.u.	<2.3	---	---	---
19.	Closing time	msec	100	100	100	100
20.	DC control voltage	V	220	220	220	220
21.	Auxiliary contacts continuous current rating	A	10	10	10	10
22.	Auxiliary contacts breaking capacity (for circuit time constant >20 ms)	A	2	2	2	2

Annexure-2

The major technical parameters of Disconnector and Earthing Switches for various voltage levels shall be as follows:

S.No.	Details	Unit	400kV System	220kV System	66kV System	33kV System
1.	Nominal/Rated voltage	kV	400	220	66	33
2.	Highest system voltage	kV	420	245	72.5	36
3.	Rated current	A	3150/2000 A (3000 for bus-coupler breaker& I/C bay)/ As per scheme	1600/2500 (2500 for bus-coupler breaker& I/C bay)/ As per scheme	2000/2500 (2500 for bus-coupler breaker& I/C bay)/As per scheme	1250/2500 (2500 for bus-coupler breaker & I/C bay)/As per scheme
4.	Rated fault current and its duration	kA	63 (1 sec)	50 (1 sec)	31.5 (1 sec)	31.5 (1 sec)
5.	Rated dynamic short circuit current	kAp	158	125	80	62.5
6.	Operating mechanism		AC motor operated & manual	AC motor operated & manual	AC motor operated & manual	Manual
7.	Lightning (Full wave) Impulse withstand voltage (1.2/50µs)					
7a)	Rated insulation Between line terminals and ground(+ve or –ve polarity	kVp	1425	1050	325	170
7b)	Between terminals with disconnector contacts open:	kVp	1425	1200	375	195
	-Lightning impulse voltage applied to one terminal	kVp	1425	--	--	--
	-Power frequency coltage of opposite polarity applied to other terminal	kVp	240	--	--	--
8.	Switching impulse withstand voltage (250/2500µs) dry & wet					
8a)	Between line terminals and ground	kVp	1050	--	--	--
8b)	Between terminals with circuit breaker contacts open:	kVp	900	--	--	--

	-Switching impulse voltage applied to one terminal	kVp	900			
	-Power frequency voltage of opposite polarity applied to other terminal	kVp	345			
9.	One minute power frequency withstand voltage:					
9a)	Between line terminals and ground	kVrms	650	460	275	70
9b)	Between terminals with disconnector contacts open	kVrms	815	530	315	80
10.	Operating time	Sec	<12	<12	<12	<12
12.	Maximum radio interference voltage for frequency between 0.5 to 2 MHz in open and close position	µ-volt	1000 (at 320 kVrms)	1000 (at 156 kV rms)	500 (at 92 kV rms)	--
13.	Total operating time	Sec	<12	<12	<12	<12
15.	DC control voltage	V	220	220	220	220
16.	Auxiliary contacts continuous current rating	A	10	10	10	10
17.	Auxiliary contacts breaking capacity (for circuit time constant >20ms	A	2	2	2	2

ANNEXURE-3

The major technical parameters of Current Transformer

S.No.	Details	Unit	400kV System	220kV System	66kV System	33kV System
1.	Nominal /Rated system voltage	kV	400	220	66	33
2.	Highest system voltage	kV	420	245	72.5	36
3	Rated fault current and duration	kA	63(1 sec)	50(1 sec)	31.5(1 sec)	31.5(1 sec)
4	Rated dynamic short circuit current	kA0	157.5	125	78.75	62.5
5	Lightning (Full wave)impulse withstand voltage (1.2/50µs) -between line terminals and ground	kVp	1425	1050	650	170
6	Switching impulse withstand voltage (250/2500µs) -between line terminals ground (dry& wet)	kVp	1050	--	--	--
7	One minute power frequency withstand voltage -between line terminals and ground	kVrms	630 (dry only)	460	275	75
8	One minute power frequency withstand voltage of secondary winding	kV	5	5	5	5
9	Minimum corona extinction voltage	kVrms	320	156	105	--
10	Maximum radio interference voltage for frequency between 0.5 to 2 MHz	µ-volt	1000 (at 320 kVrms)	1000 (at 156 kVrms)	500 (at 92 kVrms)	--
11	Maximum partial discharge level	pC	10	10	10	10
12	Cantilever	kg.	500	350	350	350

TABLE-3A

REQUIREMENTS FOR 420 kV CURRENT TRANSFORMER

No. of cores	Core No.	Applc ation	Current ratio	Output Burden (VA)	Accurcey Class as Per IEC: 61869	Min. Knee pt Voltage Vk	Max CT Sec. Wdg. Resista nce (ohm)	Max Excitation current at Vk in mA)
5	1	BUS DIFF CHEC K	3000-2000-1000/1	-	-	Vk>K.Is .(Rct +Rb)V	15/10/5	20 on3000/1tap. 30 on2000/1tap. 60 on1000/1tap.
	2	BUS DIFF MAIN	3000-2000-1000/1	-	-	Vk>K.Is .(Rct +Rb)V	15/10/5	20 on3000/1tap. 30 on2000/1tap. 60 on1000/1tap.
	3	MET E-RING	3000-2000-1000/1	20 20 20	0.2s 0.2s 0.2s	-	-	-
	4	TRA NS.B ACK UP/ LINE PRTN .	3000-2000-1000/1			Vk>K.Is .(Rct +Rb)V	15/10/5	20 on3000/1tap. 30 on2000/1tap. 60 on1000/1tap. .
	5	TRA NS. DIFF/ LINE PRTN .	3000-2000-1000/1			Vk>K.Is .(Rct +Rb)V	15/10/5	20 on3000/1tap. 30 on2000/1tap. 60 on1000/1tap. .

Note:

- The Bidder will ensure compatibility of CT and numerical relay in respect of knee-point voltage as well as operating time of relay to avoid mal-functioning or damage to the numerical relay.
- Protection cores shall be of accuracy class PX as per IEC 61869.
- Metering Core shall be of accuracy class 0.2S as per IEC: 61869

TABLE-3B
REQUIREMENTS FOR 245 kV CURRENT TRANSFORMER

No. of cores	Core No.	Application	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min. Knee pt Voltage Vk	Max CT Sec. Wdg.Resistance (ohm)	Max Excitation current at Vk in mA)
5	1	BUS DIFF CHECK	1600-800/1	-	-	1600/800	8/4	25on1600/1tap 50 on800/1 tap.
	2	BUS DIFF MAIN	1600-800/1	-	-	1600-800/1	8/4	25on1600/1ta 50 on800/1 tap.
	3	METE-RING	1600-800/1	20	0.2S	-	-	-
	4	TRANS. BACK UP/ LINE PRTN.	1600-800/1	-	-	1600-800/1	8/4	25on1600/1tap 50 on800/1 tap.
	5	TRANS. DIFF/ LINE PRTN.	1600-800/1	-	-	1600-800/1	8/4	25on1600/1tap 50 on800/1 tap.

NOTE:-

- 220kV C.T ratio of 1600-800/1-1-1-1-1 A for all bays
- The Bidder will ensure compatibility of CT and numerical relay in respect of knee-point voltage as well as operating time of relay to avoid mal-functioning or damage to the numerical relay.
- Protection cores shall be of accuracy class PX as per IEC 61869.
- Metering Core shall be of accuracy class 0.2S as per IEC: 61869

TABLE-3C
REQUIREMENTS FOR 72.5 kV CURRENT TRANSFORMER

No. of Cores	Core no.	Application	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min.Knee pt. Voltage Vk	Instrument security factor
4	1	METERING	*	20	0.2S	-	Less than 5
	2	Differential Protection	*	-	*	Vk>K.I.(Rc +R)V	
	3	Back-up Protection(O/C and E/F)	*	-	*	Vk>K.I.(Rc +R)V	
	4	REF Protection	*	-	*	Vk>K.I.(Rc +R)V	

*** NOTE:-**

i) Protection cores shall be of accuracy class PX as per IEC 61869.
Metering Core shall be of accuracy class 0.2S as per IEC: 61869

ii) 66kV C.T. of ratio 2000/1-1-1-1 A for incoming from 160 MVA Trf and 2000/1-1-1 for bus coupler (with core one for metering and core 2 for back-up protection)

iii) 66kV C.T. ratio 1000 /1-1-1 A for Feeder Protection with core 1 for metering, core 2 for Line protection and core 3 for back-up protection with above accuracy class.

TABLE-3D
REQUIREMENTS FOR 36kV CURRENT TRANSFORMER

No. of cores	Core no.	Application	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min.Knee pt. Voltage Vk	Instrument security factor
3	1	METERING	*	10	0.2S	-	Less than 5
	2	PROTECTION/ O/C & E/F	*	-	*	Vk>K.I.(Rc+R)V	
	3	Back-up Protection	*	-	*	Vk>K.I.(Rc+R)V	

*** NOTE:-**

i)**Protection cores shall be of accuracy class PX as per IEC 61869.**
Metering Core shall be of accuracy class 0.2S as per IEC: 61869

ii) 33kV C.T. of ratio 2000/1-1-1 A for incoming from 100 MVA Trf. and for bus coupler.

iii) 33kV C.T. ratio 800-4001-1-1 A for feeder protection.

Annexure -4

The major technical parameters of voltage Transformer

S.No.	Details	Unit	400kV System	220kV System	66kV System	33kV System
1.	Nominal /Rated voltage	kV	400	220	66	33
2.	Highest system voltage	kV	420	245	72.5	36
3.	Fault current and duration	kA	63 (1 sec)	50 (1 sec)	31.5 (1 sec)	31.5 1 sec
4.	Rated primary voltage	kV	420/ √3	245/ √3	145/ √3	36/ √3
5.	Rated secondary voltage(1)	V	110/√3	110/√3	110/√3	110/√3
6.	Accuracy class					
	-protection		3P	3P	3P	3P
	-metering(2)		0.2	0.2	0.2	0.2
7,	Lightning (Full wave) impulse withstand voltage (1.2/50µs) -between line terminals and ground	kVp	1425	1050	650	170
8.	Switching impulse withstand voltage (250/2500 µs) - between line terminals and ground(dry & wet)	kVp	1050	--	--	--
9.	One minute power frequency withstand voltage -between line terminals and ground	kVrms	630 (dry only)	460	275	75
10.	Minimum corona extinction voltage	kVrms	320	156	105	--
11.	Maximum Radio interference voltage for frequency between 0.5 to 2 MHz	Micro-volt	1000 (at 320 kV rms)	1000 (at 156kV rms)	500 At 92 kVrms)	--
12.	Standard reference range of frequencies for which the accuracies are valid					
	-protection	%	96 to 102	96 to 102	96 to 102	NA
	-measurement	%	99 to 101	99 to 101	99 to 101	NA
13.	High frequency capacitance for	%	80 to 150% of rated	80 to 150% of rated	80 to 150% of rated	NA

S.No.	Details	Unit	400kV System	220kV System	66kV System	33kV System
	entire carrier frequency range		capacitance	capacitance	capacitance	
14.	Equivalent resistance over entire carrier frequency range	Ω	<40	<40	<40	--
15.	Stray capacitance and stray conductance of LV terminal over entire carrier frequency range		As per IEC 60358	As per IEC 60358	As per IEC 60358	--
16.	One minute power frequency withstand voltage (LV side)					
16a)	Between LV (HF) terminal and earth					
	-for exposed terminals	kVrms	10	10	10	10
	-for terminals enclosed in weather proof enclosure	kVrms	4	4	4	4
16b)	For secondary winding	kVrms	3	3	3	3
17.	Rated voltage factor					
	-continuous		1.2	1.2	1.2	1.2
	-for 30 seconds		1.5	1.5	1.5	1.5
18.	Maximum partial discharge level	pC	10	10	10	10
19.	Rated capacitance	pF	4400 (+10,-5%)	4400 (+10,-5%)	4400 (+10,-5%)	--
20.	Cantiliver strength	Kg	500	350	350	350

TABLE-4A

REQUIREMENT OF 400kV VOLTAGE TRANSFORMERS

Sl. No.	**PARTICULARS**	**400kV**		
1	Rated primary voltage	420/√3 kV		
2	Type	Electromagnetic, or Single phase capacitor VT		
3	No. of secondaries	3		
4	Rated voltage factor	1.2 continuous		
		1.5-30 seconds		
5	Phase angle error	±20 minutes		
		Sec.1	Sec II	Sec III
6	Rated voltage (V)	110/√3	110/√3	110/√3
7	Application	Protection	Protection	Metering
8	Accuracy	3P	3P	0.2
9	Output burden (VA) (minimum)	50	50	50

TABLE-4B

REQUIREMENT OF 220kV VOLTAGE TRANSFORMERS

S. N	**PARTICULARS**	**220kV**		
1	Rated primary voltage	245/√3 kV		
2	Type	Electromagnetic		
3	No. of secondaries	3		
4	Rated voltage factor	1.2 continuous		
		1.5-30 seconds		
5	Phase angle error	±20 minutes		
		Sec.1	Sec II	Sec III
6	Rated voltage (V)	110/√3	110/√3	110/√3
7	Application	Protection	Protection	Metering
8	Accuracy	3P	3P	0.2
9	Output burden (VA) (minimum)	50	50	50

TABLE-4C
REQUIREMENT OF 72.5kV VOLTAGE TRANSFORMERS

S. N.	**PARTICULARS**	**66 kV**		
1.	Rated primary voltage	72.5/√3 kV		
2.	Type	Electromagnetic		
3.	No. of secondary	3		
4.	Rated voltage factor	1.2 continuous		
		1.5-30 seconds		
5.	Phase angle error	±20 minutes		
		Sec I	Sec II	Sec III
6.	Rated voltage (V)	110/√3	110/√3	110/√3
7.	Application	Metering	Protection	Protection
8.	Accuracy	0.2	3P	3P
9.	Output burden (VA) (minimum)	50	50	50

TABLE-4D

REQUIREMENT OF 33kVVOLTAGE TRANSFORMERS

Sl. No.	PARTICULARS	33 kV		
1.	Rated primary voltage	36/√3 kV		
2.	Type	Electromagnetic		
3.	No. of secondaries	3		
4.	Rated voltage factor	1.2 continuous		
		1.5-30 seconds		
5.	Phase angle error	±20 minutes		
		Sec I	Sec II	Sec III
6.	Rated voltage (V)	110/√3	110/√3	110/√3
7.	Application	Metering	Protection	Protection
8.	Accuracy	0.2	3P	3P
9.	Output burden (VA) (minimum)	20	20	20

Annexure-5

The major technical parameters of Surge Arresters

S.No.	Details	Unit	400kV System	220kV System	66kV System	33kV System
1.	Rated SYSTEM voltage	kV	400	220	66	33
2.	Highest system voltage	kV	420	245	72.5	36
3.	Rated arrester voltage	kV	336	216	120	30
4.	Continuous operating voltage (COV) at 50˚C	kVrms	267	168	102	25
5.	Discharge current (8/20µs *wave*					
5a)	Nominal discharge current	kAp	20	10	10	10
5b)	Discharge current at which insulation c0ordination will be done	kAP	20	10	10	10
6.	Minimum discharge capability (1)	kJ/kV	12	5	5	5
7,	Maximum residual voltage for					
7a)	Lightning impulse current					
	-20kA	kVp	850	--	--	--
	-10kA	kVp	800	600	330	90
	-5kA	Micro-volt	--	560	310	85
7b)	Switching impulse current					
	-at 2kA	kVp	670	--	--	NA
	-at 1kA	kVp		500	280	NA
	-at 500A		650	--	--	NA
7c)	Steep current impulse at nominal discharge current		925	650	380	110
8.	Long duration discharge class (as per IEC)		Class 4	Class 3	Class 3	Class 3
9.	Perspective symmetrical fault current for pressure relief test (for 0.2 Sec)	kA(rms)	63	50	31.5	25
10.	Low current long duration test value		As per IEC (2400µs)	As per IEC (2400µs)	As per IEC (2400µs)	As per IEC (2400µs)

11.	High current impulse test value (4/10 micro sec.)	kAp	100	100	100	100
12.	Minimum corona extinction voltage	kVrms	320	156	105	NA
13.	Maximum radio interference voltage for frequency between 0.5 to 2 MHz	Micro-Volt	500 At 320 kV rms)	500 (at 156 kVrms)	500 (at 92 kVrms)	---
14.	Full wave impulse withstand voltage (1.2/50µs)-between line terminals and ground	kVp	1425	1050	650	170
15.	Switching impulse withstand voltage (250/250µs)-between line terminals and ground (Dry & wet)	kVp	1050	NA	NA	NA
16.	One minute power frequency withstand voltage between line terminals and	kV(rms)	630	460	275	70
17.	Maximum Partial Discharge for arrester at (1.05 x COV)	pC	50	50	50	50
18.	Cantilever strength	Kg	500	350	350	350

SYSTEM PARAMETERS **(Annexure -6)**

S.No.	Details	Unit	400kV system	220kV System	66kV system	33kV system
1.	Nominal/rated voltage	kVrms	400	220	66	33
2.	Highest system voltage	kVrms	420	245	72.5	36
3.	Phase	nos.	3	3	3	3
4.	Rated frequency	Hz	50	50	50	50
5.	Ambient temperature	^{o}C	50	50	50	50
6.	Specific creepage distance	mm/kV	31	31	31	31
7.	Rated fault current and its duration	kA	63 1 sec.	50 1 sec.	31.5 1 sec.	31.5 1 sec.
8.	Minimum corona extinction voltage	kVrms	320	156	105	NA
9.	Maximum radio interference voltage (RIV) for frequency between 0.5 & 2.0 MHz	-volt	1000 (at 320kV rms)`	1000 (at 156 kV rms)	500 (at 92 kV rms)	NA
10.	Seismic acceleration Zone-IV, as per IS-1893,Year-2002	G	0.3	0.3	0.3	0.3
11.	System neutral earthing		Effectively earthed	Effectively earthed	Effectively earthed	Effectively Earthed
12.	Auxiliary AC supply (3Ph,2wire,50 Hz)	V	415 ±10%			
13.	Auxiliary DC supply (2 wire ungrounded)	V	220 ±10%			

Annexure -7

TECHNICAL PARAMETERS FOR SF6/AIR BUSHING

Sl. No.	Particular	400 kV	220 kV	66kV	33kV
1	Rated Voltage (kV) (rms)	420 kV (rms)	245 kV (rms)	72.5 kV (rms)	36
2	Rated Current (Amp)	As per scheme	As per scheme	As per scheme	As per scheme
3	1.2/50 micro second impulse voltage (Lightning impulse withstand voltage)	1425 kVp	±1050 kVp	±325 kVp	±170 kVp
4	250/2500 micro second switching impulse voltage	1050 kVp	NA	NA	NA
5	One minute power frequency withstand voltage(kV R.M.S)	±650	±460	±140	±70
6	Minimum total Creepage distance in mm	31 mm/kV			
7	Minimum Cantilever strength (kN)	10	8	5	

Annexure-8

Technical Specifications for SF6 Gas Leak Detector Equipment along with Standard Accessories:

1. General Requirements

1.1 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version.

1.2 The instrument should have been proven for repeatability of test result in charged switchyard of EHV substations. Documentary evidence for this should be furnished along with the bid.

1.3 The acceptance of the equipment is subject to the successful demonstration to the satisfaction of DTL at prescribed site of DTL including 400KV switchyard/site during technical evaluation.

1.4 Under very high/low ambient temperatures, high humidity, equipment shall be able to carry out measurement under these conditions.

2. Functional Requirement:

2.1. The meter shall be capable of detecting leakage of SF6 from 400/220kV Circuit Breakers/GISequipments. Instrument shall work in induced condition of charged switchyard up to 400kV level. The equipment shall not be sensitive to moisture or other gases in atmosphere and water vapour.

2.2. It shall be Microprocessor controlled, with advanced digital signal processing, visual LED display Audible signal for progressive leak-size indication having following features:

a. easy and tactile keypad control, battery test function, battery low voltage indication etc;
b. Cordless and portable, Battery operated,
c. Immediate response time for quick leak detection and quick return to zero - position even after detection of large leaks.
d. The sensing probe shall be such that it can reach all the points on the switchgear where leakage is to be sensed.

2.3. The equipment and accessories shall be robust and rugged enough, so that it can be transported safely at different locations. The transportation case and packing of the equipment shall be such that the transportation from one station to other will not affect the performance, repeatability and accuracy of measurement of equipment.

2.4. The test results should have repeatability consistency & immunity to electromagnetic, electrostatic interference in live switch yard up to 400kV.

2.5. Safety, EMC/EMI, Environment, Enclosure, and Interference limit shall be as per national/international standards with latest revision.

2.6. Accessories:

Set of batteries, Battery Charger, Manual, Hard Carrying case, Spare sensor tip etc, Software CD and other mandatory accessory.

SPARES: Filter Tips 5 nos, Infra red cell or any other consumable as required/Mandatory for operations of kit during guarantee period, Optional spares shall be quoted separately.

3. Technical Parameters:-

S.No.	Parameter	Specification
1.	Method of operation and principle	Continuous leak detection and leak measurement operation during leak check without limitation with audible and visual indication.(Infrared technology)
2.	Range of SF6 leak measurement during leak detection	0-1000 and more PPMv by volume with accuracy of ±5% or better
3.	Sensitivity	3.5 gm SF6/year or less. No cross sensitive to other gases
4.	Response Time	Immediately
5.	Alarm	Visual as well as Audio
6.	Power supply	Li-Ion batteries powered / equivalent power supply with charger.
7.	Batteries voltage indication/test function	To be displayed
8.	Spares	Mandatory for operation of equipment during guarantee period
9.	Operating Temperature & Relative Humidity	0 to 50°C& RH 95%

4. Calibration certificate:-

The instrument shall be supplied with proper Calibration certificate from NABL or internationally accredited lab. It is the responsibility of the supplier to provide the Calibration services of the instrument after the calibration interval is over. Date of Calibration Certificate shall not be older than three month from the date of supply of kit.

5. Demonstration:-

The bidder will have to demonstrate the equipment for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site up to the satisfaction of DTL at their own cost and ***this will be the part of technical evaluation***. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

6. Warranty/Guarantee Period:

Min 05 years from the date of successful & complete commissioning at DTL sub-station.

The warranty shall include:

a) Calibration of instrument (annually),

b) As much as visit for repairs to site, along with all the materials, including accessories etc. are to be covered under warranty/guaranty period. If the equipment needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of equipment for repair at test lab / works.

7. Services after sale:

Bidder will have to submit the documentary evidences of having established mechanism for prompt services as and when required by DTL. Bidder need to submit their organization service chart along with bid.

8. Commissioning, Training and Handling Over of the Instrument

Successful bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demo shall be rejected and no repairs are allowed.

Bidder will have to provide training to DTL engineers for safe operation and maintenance of the instrument before handing over the same at DTL site in batches."

9. Guaranteed technical particulars SF6 Gas Leak Detector Test Equipment along with Standard Accessories

Sr.No	**Item**	**Description (To be filled in and signed by the Bidder)**
1.	Mfg.Name/Model No.	
2.	Method of Operation and principle	
3.	Range of Sf6 leak measurement during leak detection	
4.	Sensitivity	
5.	Response Time	
6.	Alarm	
7.	Power Supply	
8.	Spares	
9.	Operating temperature	
10.	Accessories	
11.	Warranty	
12.	Calibration certificate	
13.	Services after Sale	
14.	Safety,EMC/EMI,Environment, Enclosure, and Interference applicable standards	

Annexure-9

Technical specifications of SF6 gas analyzer

1. General Requirements

1.1 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version.

1.2 The instrument should have been proven for repeatability of test result in charged switchyard of EHV substations. Documentary evidence for this should be furnished along with the bid.

1.3 The kit and accessories shall be robust and rugged enough, so that it can be transported safely to different locations. The transportation and packing cases of the kit shall be such that the transportation from one station to other will not affect the performance and accuracy of measurement of kit. Further, the instrument shall be robust enough to sustain the jerks during the transportation in local condition.

1.4 Bidder will have to submit the documentary evidences of having established mechanism for prompt services in India as and when required by DTL. Bidder need to submit their organization service chart along with bid.

2. Functional Requirement

2.1. The instrument should be suitable for online measurement of Moisture (Dew point & ppm), Purity, SO2 content of SF6 Gas in gas insulated EHV equipments and GIS (Gas insulated switchgear), in live switchyard upto 400 kV level.

2.2. The measurement principle shall be based upon zero gas loss i.e. the gas will be returned back to original compartment of the GIS after performing the measurement without being exposed to the atmosphere.

2.3. The instrument shall be able to measure the pressure of the compartment under Test in bar, kPa, MPa.

2.4. The measurement should be possible at standard pressure/system pressure.

2.5. The test results should have repeatability consistency & immunity to electromagnetic, electrostatic interference in live switch yard up to 400kV.

2.6. It should have facility for Data Storing in the kit & down loading to PC. It should have USB / Ethernet Interface.

3. Technical Parameters:-

Item	Specification
Measurement Parameters	1. SF6 purity – Range: 0-100 % , Accuracy: +/- 0.5 % 2. Dew point - Range : -60 to +20 deg C, Accuracy: +/-4 deg C 3. SO2 - Range : 0-100 ppm, Accuracy : +/- 3 ppm 4. HF-Range :-10ppm & Accuracy : +/- 10 %
Input Pressure	0.5 to 9 Bar
Re-circulation/ Pumping Back of SF6 gas	The kit shall have the inbuilt facility of pumping back the measured SF6 gas to the equipment being tested.
Test Leads and accessories	Complete set of Hoses, pipes, coupling, valves etc. for measurement (min 10 m length) with suitable adaptors for connection with Equipment (Areva, CGL,ABB,Hyosung, BHEL, Siemens make GIS/CBs etc).
Design/Engg.	The complete equipment along with complete accessories must be designed/engineered by Original Equipment Manufacturer.
Power Supply	150 – 240 V AC at 50 Hz and Inbuilt battery with charger/adapter etc.
Operating Temperature	-10 to +50 °C
Relative humidity	Max. 90 % non-condensing
IP Class	It should be housed in a robust IP67 case with wheels
Display/Control	LCD/Keypads.
Environment	The test kit shall be compatible for EMI/EMC/safety environment requirement as per IEC.

4. Calibration certificate:-

As per requirement of ISO-9001, calibration certificate for each testing instrument covering entire range shall be supplied with the test kit at the time of supply.

Calibration certificate from NABL accredited lab or internationally reputed lab, shall be submitted. Date of calibration shall not be older than two month from the date of supply of kit.

5. Demonstration:-

The bidder will have to demonstrate the kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site upto the satisfaction of DTL at their own cost and ***this will be the part of technical evaluation***. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

6. Warranty/Guarantee Period:

Min 03 years from the date of successful & complete commissioning at DTL sub-station. All the materials, including accessories etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.

7. Commissioning, Training and Handling Over of the Instrument

Successful bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demo shall be rejected and no repairs are allowed.

Bidder will have to provide training to DTL engineers for safe operation and maintenance of the instrument before handing over the same at DTL site in batches."

8. <u>Guaranteed technical particulars SF6 Gas Quality Analyzer Test Kit along with Standard Accessories</u>

Sr. No.	Particulars	Filled by bidder
1.	Name & Country of Manufacturer	
2.	Type / Model No.	
3.	SF6 Purity Measurement method	
4.	Pumpback of SF6 gas back in to breaker after measurement	
5.	Measurement parameter as per IEC60480 & CIGRE B3.02.01	
6.	SF6 Purity range with accuracy	
7.	Dew Point measurement range with accuracy	
8.	SO2 measurement range with accuracy	
9.	User selectable Inbuilt standards a) IEC60480 b) IEC60376	
10.	Measurement Cycle Selection	
11.	Direct Input Gas pressure	
12.	Vacuum purging for hose pipes	
13.	Quantum of SF6 gas used for measurement	
14.	Data storage	
15.	Display	
16.	Power input	
17.	Battery operation	
18.	Casing Protection class	
19.	Weight	
20.	Accessories	
21.	Service life	

SPECIAL EQUIPMENTS
(Testing Equipment for GIS)

A. Technical Specification of Automatic Transformer Turn Ratio Meter

1.0 Functional requirement

1.1 The equipment offered shall be used for automatic measurement of turns ratio (3phase simultaneously), exciting current, ratio error, and phase angle deviation, tap position for power transformers, instrument transformers and distribution transformers and CT and PT's by directly connecting the instrument to equipment. The instrument should have the provision for measurement for single phase also.

1.2 It should measure actual turn ratio of different, vector groups, phase, tap-position, ratio and deviation, phase angle and deviation, in three phase transformers without conversion and should also give magnetizing current indication.

1.3 Kit should have facility for operator to enter the ratio of the transformer and all of it's taps to the operator to know immediately when a tap is outside the acceptable limits. It should also have facility to enter pass/fail limit so problem taps can be easily flagged.

1.4 It should easily portable.

1.5 Automatic range selection and self-calibration for each test.

2.0 Display

Digital LCD display with backlight viewable in bright sunlight.

3.0 Ratio measuring range and accuracy

1-10000:1 minimum with accuracy of 0.1% to 0.5% maximum at different ranges

4.0 Test Voltage

8 to 80V rms minimum, automatically or manually selected

5.0 Magnetising Current

1mA to 2000mA @ 0.1mA and Accuracy = ± 5mA

6.0 Phase angle Range

±90º @ resolution 0.1 º and accuracy ± 0.5 º

7.0 Data Entry

Through instrument mounted key board/front panel/external key board.

8.0 Power Supply

It shall work on single-phase 230±10% V, 50±5% Hz, supply with variations in voltage and frequency respectively.

9.0 Protection of Kit

Kit should have all necessary protections against transient surges, over voltages, induction, short circuits etc.

10.0 Storage

Internal, nonvolatile memory for storing up to minimum 100 sets of three-phase measured and calculated ratio, exciting current, phase, ratio error, and name plate details of transformer.

11.0 Repeatability

It should offer repeatability of test results in 220 kV/400 kV charged area.

12.0 Software

The kit should have facility to connect with windows based computer for exporting the test data. The software should be suitable for data storage, report printout, and download of data etc. The original software in CD shall be handed over to DTL during the commissioning.

13.0 Interfacing PC

The kit shall be provided with necessary ports (RS232/USB/ equivalent) to interface the other peripherical devises such as printers, portable drive, etc.

14.0 Accessories

Complete set of test leads (min. 20 meter) with clamps and connectors, PC cables, Licensed OS software, Licensed software of the testing kit, combination plugs, power-supply cables, original hard carrying case for main kit and cables (which should be robust/ rugged enough for proper safety of the kit during transportation), manual (both in soft copy & hard copies) etc, required for carrying out all types of testing.

15.0 Cooling arrangement

Necessary in built cooling arrangement should be provided to dissipate the heat generated during testing. No external coolant/accessory shall have to be required.

16.0 Printer

Thermal/Normal printer, inbuilt or external.

17.0 Calibration certificate

Kit should have automatic self calibration feature. However party will have to submit the calibration certificate from/traceable to, NABL accredited lab or internationally reputed lab, shall be submitted. Date of calibration shall not be older than two months from the date of supply of Kit.

18.0 Environment

a. The test kit shall be compatible for EMI/EMC/safety environment requirement as per IEC 61000.
b. Temp 0 to 50Deg.C,
c. Humidity not condensing-upto90%,

19.0 Warranty

Kit shall have Warranty for minimum 5 years for smooth and reliable operation of the kit. The warranty includes:

i. Calibration of instrument (annually till completion of 5 years)
ii. As much as visits for repairs to site.
iii. If the kit needs to be shifted to suppliers works for repairs, supplier will have to bear the cost of spares, softwares, transportation, transit insurance (To & Fro), etc of kit for repair at test lab/works. Kit after repairs need to be returned within thirty days from the date of despatch.
iv. All the expenses for maintaining the supplied instrument "Healthy and in working condition" is to be borne by Successful bidder as per LOA.

20.0 Transit Case

The kit and accessories shall be robust and rugged enough, so that it can be transported safely at different locations. The transportation and packing cases of the kit shall be such that the transportation from one station to other will not affect the performance and accuracy of measurement of kit.

21.0 Services after Sales

Bidder will have to submit the documentary evidences of having established mechanism for prompt services as and when required by DTL. Bidder need to submit their organisation service chart along with bid.

22.0 Demonstration and Handing over of Instruments

The contractor shall have to demonstrate the instrument to the satisfaction of DTL. The Supplier shall have to ensure the kit is made user friendly apart from the detailed demonstrations at each site. The instrument failed during the demonstration shall be rejected and no repairs are allowed.

B. CIRCUIT BREAKER OPERATIONAL ANALYSER WITH DCRM

1.0 General:

1.1 This instrument shall be used for testing functioning of EHV circuit breakers in live/charged switchyards.

1.2 The operation analyzer should be able to measure, record and print graphically the operation timings, mechanism travel and velocity, trip and close coil current rise and fall, dynamic contact resistance (DCRM) and functioning of auxiliary contacts of CB.

1.3 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version.

1.4 The kit and accessories shall be robust, rugged enough and easily portable so that it can be transported safely to different locations. The transportation and packing cases of the kit shall be such that the transportation from one station to other will not affect the performance and accuracy of measurement of kit. Further, the instrument shall be robust enough to sustain the jerks during the transportation in local condition.

1.5 The bidder will have to demonstrate the kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site upto the satisfaction of DTL at their own cost and this will be the part of technical evaluation. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

1.6 The kit should be capable of operating and storing data at temperature from 0 degree C to 50 degree C and humidity up to 90%.

2.0 Functional Requirement:

2.1 The Computer Aided CB Analyzer system comprising of CB operation unit, programme unit, travel analyzer unit & analysis software should be capable to perform close, open ,close-open, open-close, open-close, open operation on CB under test, with a facility to introduce time delays between composite operation.

2.2 The instrument should be suitable for measuring the Operation timing of main and auxiliary contacts (wet &dry) as well as coil currents.

2.3 The CB Analyzer should be able to measure and record current rise and fall of tripping coils as well as of closing coils for at least two breaks of Circuit Breaker poles simultaneously.

2.4 It should measure the Dynamic Contact Resistance of main & arcing contacts as well as travel measurement (with external travel transducer) of operating mechanism.

2.5 The instrument should be suitable for testing the CBs up to 400 kV as per applicable standards and testing procedure of DTL.

2.6 The test results should have repeatability, consistency & Immunity to electromagnetic interference in live switchyard upto 400 kV levels.

2.7 The CB Analyzer should be capable to measure pole discrepancy timing.

2.8 The CB Analyzer should be capable to calculate and print all contact closing & opening tuning in tabular form also.

3.0 Technical Parameters:

S. No	Description			
1.	Functional Requirement		The operation analyzer must have availability of minimum no. of following channels:	
			400kV	220kV
	The operation analyzer must have availability of minimum no. of following channels:	1.	Main Contact Channels:6 (2 per pole on 3 pole simultaneously)	Main Contact Channels:3 (1 per pole on 3 pole simultaneously)
		2	DCRM/Test Current Channels:6	DCRM/Test Current Channels:3
		3	Travel Channel:03	Travel Channel:03
		4	Coil Current Channel:06	Coil Current Channel:06
		5	Aux. Contact Channel:06	Aux. Contact Channel:06
2.	Sampling Speed	≥20 kHz		
3.	Accuracy	1.	Timing : ± 1 % of reading	
		2.	Coil Current: ± 1 % of reading	
		3.	R : ± 2 % of reading	

		4.	Travel: ± 1 % of reading
4.	Measurement Range:	1.	Timing: 0-4 s
		2.	R: 0-8 m Ω.
		3.	Coil Current:0-25 A
5.	Resolution	Timing: 0.1 ms	
6.	DCRM Test Current	100 Amp (Minimum)	
7.	PC Interface	It shall include supply of one laptop PC of Dell/Lenovo/HP make with latest specifications such as Core i5 Intel Processor,4GB RAM, 320GB or better HDD, 15'' TFT screen, Combo 24xCD R/W Drive ie having CD read / write facility complete with required cables and connectors with preloaded operating MS Window 7 professional or better with latest version application software require for storage analysis and record management.	
8.	Power Supply	It shall work on single phase 230 Volts ±10 %, 50 Hz ±5 % supply with standard socket.	
9.	Operating Temperature	0 to +50 deg C	
10.	Relative humidity	Max. 90% non-condensing.	
11.	Environment	The test kit shall be compatible for EMI/EMC/Safey environment.	

4.0 System Operation hardware/software, peripherals and analysis software for CB Analyzer

4.1 The test report for recording motion should provide test results both in form of curve and tables. The tables should consist of calculated CB parameters such as closing/opening speed etc.

4.2 The entry of various data/parameters (pertaining to CB) be possible built in display of menu.

4.3 The battery backup and real time clock should be provided for automatic date and time functions.

4.4 The analyzer should be capable to record transient phenomenon for duration at least 500 ms.

4.5 The binary channel accuracy and analogue channel accuracy should be suitable meet all desired functions (stated above).

4.6 The CB analyzer should be provided with facility of down loading data to PC.

4.7 The printer provided with CB analyzer should be preferably a plain paper printer.

4.8 The computer aided CB analysis software should be supported with suitable report generation.

4.9 It should be possible to change scale factor of time axis to enable enlarged view of part of diagram.

4.10 It should be possible to change amplitude scale to make best use of available space.

4.11 It should be possible to study on speed curve, the damping and speed variations at CB opening and closing time.

4.12 The CB analyzer should be supplied with portable memory bank to store test result taken by test kit to enable further down loading to centrally located PC.

4.13 Window based PC down loading software should be provided with CB analyzer to facilities downloading test result from memory bank to PC where it can be analyzed and stored in proper directory/file.

4.14 It should be possible to compare present results with previous one. The feature of Zooming the graph and moving the cursors on graph, thereby indicating instantaneous values of test parameters should also be provided.

4.15 The latest version of CB analyzer system (hardwares and softwares) to be supplied and time to time updating of software should be offered.

4.16 As and when required, technical support for analysis of critical test result to be offered, on regular basis.

4.17 The software should be suitable for automatic testing & report generation, signature as well as trend analysis. The kit should have facility to store and communicate with windows based computer for exporting the test data.

5.0 Other Essential Requirements.

5.1 Protection/ Control

Against short circuit, over voltage, improper ground connection, over load & transient surges, the kit should have alarm/cut-off features to protect the instrument. Also the kit should have facility of stopping automatically on power failure.

5.2 Cooling Arrangement

Necessary in built cooling arrangement should be provided to dissipate the heat generated during testing. No external coolant/ accessory shall have to be required.

5.3 Test Leads and accessories

One complete set of cables of sufficient length (min 20metre) with suitable clamps & connectors, compatible with the instruments should be provided for successfully carrying out the test in DTL S/Stn. Additionally all the required accessories should be provided for the smooth functioning of kit. Further hard carrying case (which should be robust/ rugged enough) for ensuring proper safety of the kit during transportation shall have to be provided.

5.4 Travel Transducers

One set of travel transducers along with clamp/fixtures to suit 400/220 kV CBs of ABB/AREVA/ALSTOM/BHEL/CGL/ SIEMENS etc (wherever applicable) make for AIS and for GIS Stations, CB details shall be provided by DTL and the supplier shall

have to develop & supply the transducers within delivery schedule. The voltage class and make shall be intimated along with the order.

5.5 Calibration Certificate

Unit shall be duly calibrated before supply and the date of calibration shall not be older than two month from the date of supply of Kit.

5.6 Training

Supplier shall have to ensure that the kit is made user friendly. Apart from the detailed demonstration at site, the supplier shall also have to arrange necessary training to DTL engineers, where kit is being supplied.

5.7 Weight

It should be portable and trolley mounted for smooth movement in live switchyard.

GUARANTEED TECHNICAL PARTICULARS FOR CIRCUIT BREAKER OPERATION ANALYSER WITH DCRM

(To be filled in and signed by the Bidder)

1.	Name of manufacturer	
2.	Type and Model	
3.	Applicable standards	
4.	Logic	
5.	Maximum Configuration	
6.	Time measurement	
	(i)Range	
	(ii)Resolution	
	(iii)Accuracy	
7.	No. of current channels	
8.	No. of travel channels	
9.	Binary channels .	
10.	Sampling speed	
11.	Plot length	
12.	Printer	

13.	Paper type		
14.	Display of test results		
15.	Test leads		
	(i)	Type of leads	
	(ii)	No. of leads	
	(iii)	Length	
16.	Power supply		
17.	Weight		
18.	Details o f type tests		
19.	No. of cases		
20.	Case type & size		
21.	Transducer (i) Voltage (ii) Speed.		
22.	Particulars of Dynamic contact resistance		
	(i)	Working current	
	(ii)	Range Full scale	
	(iii)	Operation • Battery • Mains	
	(iv)	Resolution • Minimum • Maximum	
	(iv) Accuracy		
23.	Environmental/service conditions :		

C. Technical Specification of Fully Automatic Capacitance and Tan Delta Kit

1. General Requirements

1.7 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version.

1.8 Kit should be able to measure capacitance and tan delta/ power factor automatic without balancing any decade and also interference suppression shall be automatic.

1.9 The instrument should have been proven for repeatability of test result in charged switchyard of EHV substations. Documentary evidence for this should be furnished along with the bid.

1.10 The kit and accessories shall be robust, rugged enough and easily portable so that it can be transported safely to different locations. The transportation and packing cases of the kit shall be such that the transportation from one station to other will not affect the performance and accuracy of measurement of kit. Further, the instrument shall be robust enough to sustain the jerks during the transportation in local condition

1.11 The acceptance of the kit is subject to the successful demonstration to the satisfaction of DTL at prescribed site of DTL including 400KV switchyard/site during technical evaluation.

1.12 Bidder will have to submit the documentary evidences of having established mechanism for prompt services in India as and when required by DTL. Bidder need to submit their organization service chart along with bid.

1.13 The kit should be capable of operating and storing data at temperature from 0 degree C to 50 degree C and humidity up to 90%.

2. Functional Requirements

2.1 The instrument shall be suitable for automatic offline measurement of Capacitance and Tan delta of EHV class transformers (1/2/3 winding), Bushings, CTs, Bus & Line CVTs and Grading Capacitors of CB's as well as excitation current of transformer/reactor at site in charged switchyard up to 400 kV AC.

2.2 The test results should have repeatability consistency & immunity to electromagnetic, electrostatic interference in live switch yard up to 400kV.

2.3 The kit shall be capable of measuring capacitance and tan-delta of each winding up to 500 MVA transformers in suitable switching mode so that capacitance of other winding does not affect the reading etc.

2.4 The test voltage should be independent of input voltage & frequency so that no variation in frequency is there during testing.

2.5 The test kit should be capable of performing tests on all ungrounded and grounded specimens in various modes such as UST, GST-g, GST without changing the leads always.

2.6 The kit shall be capable of measuring excitation current of transformer winding at 10 kV. The kit shall be able to measure the ambient temperature and relative humidity with inbuilt/external arrangement.

2.7 The optional arrangements, if available, for measurement of inductance, transformer turns-ratio, transformer leakage reactance and loss etc, may be included in the offer. However, the tech/financial evaluation will be made for the basic kit, which have the facility of measurement of tan-delta and capacitance with induction suppression feature as detailed above.

2.8 Display should be LCD/LED (readable in sunlight), Front Panel/ Key Pad mounted on Control unit (with built-in microprocessor/computer) and providing external industrial grade Laptop PC preloaded with application software of reputed brand with latest specifications such as Intel core i5, 4GB RAM, 500 GB or higher HDD, Integrated Graphics & Audio, DVD-RW Drive, 13 inch Display, Touch pad,Wifi-802.11 a/b/g, 1gbps NIC, Bluetooth, 1xVGA, windows-7 professional or higher version latest with antivirus, Original CDs etc.

2.9 It should have facility for Data Storing in the kit & down loading to PC. It should have USB / Ethernet Interface.

2.10 It should have indications like HV Supply ON, Ground Open, Power Supply ON etc.

2.11 Protection against short circuit, over voltage, improper ground connection over load & transit surges, the kit should have alarm/cut-off features to protect the instrument. Also the kit should have facility of stopping automatically on power failure as well as interlock for HV.

2.12 Necessary inbuilt cooling arrangement should be provided to dissipate the heat generated during testing. No external coolant/accessory shall have to be required.

2.13 **Cables & Accessories:**

The equipment shall be complete with measuring bridge, HV power supply unit of 12kV, standard Capacitor, Laptop (of latest specifications, built-in display screen and all standard accessories including cables, hard carrying case(box) and fitted with trolley (if applicable) etc. Brief description of cables is as below:

- HV/LV screened Cable set – 20 Meters (Min.) with Clamps and connector
- Power Supply Cable
- Grounding Cable with Clamps
- One set of Interconnecting Cables
- Other cables and accessories required for carrying out measurement including temperature sensing probe.
- One set of Fuses and Indicating Lamps and other consumables shall be supplied with the kit.

2.14 It should have Data Analysis Software with the features of:

- Storing and downloading of files in data base for further analysis in PC
- Facility of drawing Graphs of tan δ (with and without temperature correction of tan δ values), frequencies etc. between voltages.
- Comparing of different value of same parameter at different period/time (trending).
- The data format shall be XML/CSV open with excel for easy transfer to data base applications.

- Facility to make reports in word/excel/pdf formats

3. Technical Parameters

Output voltage	0-12 kV (AC)(Continuously variable)
Output current	100 mA (Min) continuous & 200 mA (Min) intermittent
Output frequency	45Hz to 70Hz
Tan delta (DF)	Range: 0 to 200% Min. Accuracy : 1% of reading ± 0.0005 Resolution : 0.01% or better
Power Factor	Range: 0 to 100% Min. Accuracy : 1% of reading ± 0.0005 Resolution : 0.01% or better
Capacitance	Range: 10pF to 1µF Accuracy: 0.5% of reading ± 1 pF Resolution : ±1pF
Power Supply (input)	240 V ±10% AC, 50 Hz ±5%
Operating & Environment Conditions	Temp.- 0 to 50^{o}C Humidity- 90% not condensing The kit shall be compatible for EMI/EMC requirements as per relevant IEC.

4. Calibration certificate:-

As per requirement of ISO-9001, calibration certificate for each testing instrument covering entire range shall be supplied with the test kit at the time of supply.
Calibration certificate from NABL accredited lab or internationally reputed lab shall be submitted. Date of calibration shall not be older than three (03) month from the date of supply of kit.

5. The bidder will have to demonstrate the kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site upto the satisfaction of DTL at their own cost and **this will be the part of technical evaluation**. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

6. Warranty/Guarantee Period:

Min 03 years from the date of successful & complete commissioning at DTL sub-station. All the materials, including accessories, cables, laptops etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.

7. Commissioning, Training and Handling Over of the Instrument

Successful bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demonstration at site shall be rejected and no repairs are allowed.
Bidder will have to provide training to DTL engineers for safe operation and maintenance of the instrument before handing over the same at DTL site in batches.

GUARANTEED TECHNICAL PARTICULARS FOR TAN DELTA KIT

(To be filled in and signed by the Bidder)

1	Name of manufacturer	
2	Type and Model	
3	Output voltage	
4	Output current	
5	Output frequency	
6	Tan delta (DF) i. Range ii. Accuracy iii. Resolution	
7	Power Factor i. Range ii. Accuracy iii. Resolution	
8	Capacitance i. Range ii. Accuracy iii. Resolution	
9	Power Supply (input)	
10	Operating & Environment Conditions	
i	Temp	
ii	Humidity	
11	Weight	
12	Cable & Accessories	

D. TECHNICAL SPECIFICATION OF TRANSFORMER WINDING RESISTANCE METER

1.0 Functional requirement

1. The instrument should be suitable for offline measurement of winding resistance of transformer, including OLTC and reactors etc. up to 400KV in live switchyards up to 400KV level, as per applicable standards/testing procedure.

2. The instrument shall be able to provide the current vs time plot of OLTC from one tap to another.

3. It should have min .02 No. measuring channels.

4. The test results should have repeatability, consistency & immunity to interference in live switchyard up to 400KV levels.

2.0 Test Current

Minimum 25A DC continuous.

3.0 Resistance Measurement

Resolution: 0.1 μΩ up to 500 μΩ range and 0.02% of FS above 500 μΩ range. Accuracy value 0.5 % ± 2 digits.

4.0 Measurement Range

0-2000Ω Auto Ranging.

5.0 OLTC Testing

The kit should be capable of checking the current v/s time characteristics during the tap change. It should be able to display the magnitude of current variation during tap change operation in %. The kit should present the transition time from one tap to the next tap in the test results.

6.0 Open Circuit Voltage

50 V DC or more.

7.0 Temperature Correction

The kit should have the facility to have correction of resistance value to a reference temp. i.e. provide temp. compensated reading of resistance (for Copper & Aluminum).

8.0 Test Lead/Accessories

One complete set of cable of sufficient length (Min 20 Mtr) with suitable clamps & connectors, compatible with the instruments should be provided for successfully carrying out the test in DTL substation. Additionally all the required accessories should be provided for the smooth functioning of kit. Further hard carrying case (which should be robust/rugged enough) for proper safety of the kit during transportation shall have to be provided. All the standard accessories for desired monitoring, operation & control of instrument shall have to be provided.

9.0 Design/ Engineering

The complete equipment along with complete accessories must be designed /engineered by Original Equipment Manufacturer.

10.0 Power Supply

It shall work on input supply variations, Voltage: 230±10%, Frequency: 50Hz ±5% on standard sockets.

11.0 Operating Temperature

Temp 0 to 50Deg.C

12.0 Relative Humidity

Maximum 90%, non condensing

13.0 Protection/Control

Against short circuit, over load, transient surges etc. The instrument should have facility of discharging the specimen when test is completed or when current cable is accidentally disconnected or when instrument power supply is lost. The kit should have built in rapid discharge circuit for automatically discharging the stored energy in the transformer at the end of each test.

14.0 Cooling arrangement

Necessary in built cooling, if required, arrangement should be provided to dissipate the heat generated during use. No external coolant/accessory shall have to be required.

15.0 Weight

It should be easily portable.

16.0 Software

The software should be suitable for automatic testing & report generation including temperature compensation. The kit should have facility to connect with windows based computer for exporting the test data.

17.0 Display/Control

Onboard laptop or external laptop of approved make/configuration, control (to be supplied with instrument).

18.0 Printer

Inbuilt printer.

19.0 Memory

Non-volatile memory to store minimum 1000 measurement.

20.0 Environment

The test kit shall be compatible for EMI/EMC/safety environment requirement as per IEC.

21.0 Calibration certificate

Unit shall be duly calibrated before supply and date of calibration shall not be older than 2 months from the date of supply of kit.

22.0 Training

Supplier shall have to ensure that the instrument is made user friendly. Apart from the detailed demonstration at site the supplier shall also have to arrange necessary training to DTL engineers.

23.0 Commissioning, Handing over of Instruments

Successful bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demonstration shall be rejected and no repairs are allowed.

24.0 Services after Sales

Bidder will have to submit the documentary evidences of having established mechanism in

India for prompt services.

E. Technical Specification of 10kV Digital Insulation Tester:-

Functional Requirement	1. The instrument should be suitable for measuring insulation resistance and PI, in live switchyard up to 400 kV level, as per applicable standard testing procedure of DTL. 2. The test results should have repeatability, consistency & immunity to electromagnetic interference in live switchyard up to 400 kV level. 3. The instrument should automatically discharge the energy transferred to test specimen at the end of test. 4. The instrument should have Guard Terminal to eliminate the effect of surface leakages etc. (with accuracy of ±2%)
Output	Voltage: 0-10kV in several steps (Digital) with range of 1 kV

	(or lower) to 10 kV (or higher).in 25V steps.
Short Circuit Current	Not less than 5mA
Accuracy	1. IR : ±05 % of reading 2. Voltage: ±05 % of reading
Measurement Range:	Insulation Resistance : 0-5T Ω(or higher) (Auto Ranging & Digital) Capacitance : up to 50µF
Test Modules	Auto IR, PI, DAR
Voltage measurement	0 to 600V AC or DC, ±3% accuracy
Leakage current measurement	0.01 nA to 5 mA
Test Leads and accessories	Two complete set of screened cables, each of 3m and 15m with suitable clamps & connectors, compatible with the instruments should be provided for successfully carrying out the test in DTL S/S. Additionally all the required accessories should be provided for the smooth functioning of kit. Further hard carrying case (which should be robust / rugged enough) for ensuring proper safety of the kit during transportation shall have to be provided.
Design/Engg.	The complete equipment along with complete accessories must be designed / engineered by Original Equipment Manufacturer.
Power Supply	It shall work on single phase 230 Volts ±10%, 50 Hz ±5% supply with standard socket along with Internal Chargeable Battery.
Operating Temperature	0 to ±50 deg C
Relative humidity	Max. 90% non-condensing
Protection/	Against short circuit, over voltage, improper ground connection
Control	Over load & transient surges, the kit should have alarm/ cut-off features to protect the instrument.
Weight	It should be easily portable
Display/control	Digital LCD/Keypad
Data storage	Data stored: selected voltage, test time elapsed, voltage applied, leakage current, and insulation resistance. The PI, DAR, capacitance, time constant and Dielectric Discharge (DD) values are also stored if available at the end of the test. Suitable Software may be used to transfer this data to a PC.
Environment & safety	The test kit shall be compatible for EMI/EMC/Safety environment requirement as per relevant IEC.
Applicable standards	As per relevant IS/IEC
Guarantee	Warranty/Guarantee period: Min 01 year from the date of successful & complete commissioning at DTL sub-station. All the materials, including accessories, cables etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's words for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.
Demonstration	The bidder will have to demonstrate the kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site upto the satisfaction

	of DTL at their own cost and this will be the part of technical evaluation. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.
Calibration Certificate	Calibration certificate from NABL accredited lab or internationally reputed lab, shall be submitted. Date of calibration shall not be older than one month from the date of supply of kit.
Commissioning, handing over the Instrument	Successful bidder will have to commission the instrument to the satisfaction of DTL. The supplied instrument, failed during the demonstration at site shall be rejected and no repairs are allowed.

Guaranteed Technical Particulars for 10kV Digital Insulation Tester:-

Sr. No.	Description	To be submitted by Bidder
1.	Name of manufacturer	
2.	*Type & Model*	
3.	Input Supply (A.C.)	
4	*Output*	
5	*Short Circuit Current*	
6	*Accuracy*	
7	*Measurement Range:*	
8	*Test Modules*	
9	*Voltage measurement*	
10	*Leakage current measurement*	
11	*Test Leads and accessories*	
12	*Operating Temperature/ Relative humidity*	
14	*Protection/ Control*	
16	*Display/ Weight*	
17	*Data storage*	
18	*Environment & safety*	
19	*Applicable standards*	
20	*Guarantee*	
21	*Calibration Certificate*	

F. **Technical Specifications for Automatic Transformer Oil Breakdown Voltage (BDV) Tests along with Standard Accessories:-**

1) General Requirements

1.1 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version

1.2 Kit should be able to measure Transformer Oil Breakdown Voltage (BDV) Tests along with Standard Accessories automatic without balancing any decade and also interference suppression shall be automatic.

1.3 The instrument should have been proven for repeatability of test result in charged switchyard of EHV substations.

1.4 The kit and accessories shall be robust and rugged enough, so that it can be transported safely to different locations. The transportation and packing cases of the kit shall be such that the transportation from one station to other will not affect the performance and accuracy of measurement of kit. Further, the instrument shall be robust enough to sustain the jerks during the transportation in local condition.

1.5 Bidder will have to submit the documentary evidences of having established mechanism for prompt services in India as and when required by DTL. Bidder need to submit their organization service chart along with bid.

1.6 The kit should be capable of operating and storing data at temperature from 0 degree C to 50 degree C and humidity up to 95%.

2. Functional Requirement

2.1 The equipment offered shall be suitable for determination of electrical strength (Break Down Voltage) of insulating oil conforming to IS-335 and IS-1866 upto 100KV, when measured in accordance with IS:6792.

2.2 The test cell shall be as per IS: 6792 and IEC 156-1995 suitable for BDV upto 100kV without external flash over.

2.3 The unit shall be automatic type having control unit and high voltage transformer in a common cabinet with necessary partition.

2.4 HV chamber interlocking and zero start interlocking shall be provided.

2.5 The unit shall have motorized drive to increase voltage linearly as per the rate specified in IS: 6792. Provision shall also be available for manual increase of voltage

2.6 The unit shall be complete with test cell stirrer, calibrator and necessary gauges for adjusting the gap.

2.7 The equipment shall be suitable for operation at 240 volts +/- 10% 50Hz +/- 5% single phase AC supply.

2.8 The instruments should be capable of storing the test results. The results should be easily down loadable to a PC through RS232 and USB interface

2.9 The instrument should have a built–in printer for getting a hard copy of test results with and without the need for downloading to a PC but provision of RS-232/USB interface must be present.

2.10 The test set should be either magnetic stirring or propeller stirring facility.

3.0) Technical Parameters:-

S.No.	Parameters	Technical Specifications
1	Applicable Indian / International standards for the equipment	ASTM D 877B-02, IS 6792
2	Environment	The test kit shall be compatible for EMI/EMC/Safety environment as per LATEST IS/IEC
3	Power Supply voltage in volts.	240V $\pm$ 10%, 50Hz $\pm$ 5% on a standard socket
4	Measurement standard	IEC 60156–95, IEC-156-1995 & ASTM method
5	Protection provided to equipments.	1. HV Chamber interlocking. 2. Zero starts interlocking.
6	Display.	LCD/LED with alphanumeric keypad to facilitate entry of test ID notes etc
7	Test output voltage.	Suitable for BDV up to 100KV without external flashover. 0.1kV $\pm$1% $\pm$2 digits. (Rate of rise :2 kV/sec)
8	Standard Accessories	1. Test cell 400ml with lockable gap setting, test cell stirrer, calibrator. 2. Flat electrode gap gauge – 1mm & 2.5mm. 3. Electrodes should be supplied as per IEC60156 4. Printer should be in-built. 5. Hard carrying case
9	Additional features of equipments.	1. The Unit shall be fully automatic type having control unit & high voltage transformer in common cabinet with necessary partition. 2. Automatic oil temp. measurements with a resolution of 1°C 3. Large, easy clean test chamber with oil drain. High visibility of test chamber.
10	Operating temp. range of equipment in degree C.	0 to 50^0C
11	A)Breakdown detection should perform in terms of both “Voltage” and “Current” Trip time should be less then 10mSec B) The short-circuit current of the transformer and associated trip time Required as per IEC156 shall be 4mA for 5ms and 1ms in case of Silicon oils. Normal breakdown detection speed shall be within 10msec. C) The HV switch off time shall be <10µs automatically if an established arc of 4mA occurs for 5ms as per IEC156.	
13	Non condensing operating humidity range for equipment in %.	5 to 95%
14	The equipments shall be work in presence of high interference / high voltage.	
15	Service life of the equipments in years.	Should be specified by supplier.

16	Whether the kit has USB port facility.	Yes, for printing data and requirement of software for downloading data & inter prediction of test result. Software should be window base.

4) **Calibration certificate:-**

As per requirement of ISO-9001, calibration certificate for each testing instrument covering entire range shall be supplied with the test kit at the time of supply.

Calibration certificate from NABL accredited lab or internationally reputed lab, shall be submitted. Date of calibration shall not be older than one month from the date of supply of kit.

5) Supplier shall have to ensure that the kit is made user friendly. Apart from the detailed demonstration at site, the supplier shall also have to arrange necessary training to DTL engineers.

The bidder will have to demonstrate the kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site upto the satisfaction of DTL at their own cost and this will be the part of technical evaluation. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

6) **Warranty/Guarantee Period:**

Min 05 years from the date of successful & complete commissioning at DTL sub-station.All the materials, including accessories, cables, laptops etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.

7) Commissioning, Training and Handling Over of the Instrument

Successful bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demo shall be rejected and no repairs are allowed.

Bidder will have to provide training to DTL engineers for safe operation and maintenance of the instrument before handing over the same at DTL site in batches."

Guarantee Technical particular Automatic Transformer Oil Breakdown Voltage (BDV) Test Kit along with Standard Accessories:-

S.No	Parameters	Technical Specifications
1	Applicable Indian / International standards for the equipment	
2	Environment	
3	Power Supply voltage in volts.	
4	Measurement standard	
5	Protection provided to equipments.	
6	Display.	
7	Test output voltage.	
8	Standard Accessories	
9	Additional features of equipments.	
10	Operating temp. range of equipment in degree C.	
11	Non condensing operating humidity range for equipment in %.	
12	Service life of the equipments in years.	
13	Whether the kit has USB port facility.	

G. Technical Specification of "Automatic Water Content Measurement (PPM) instrument in Insulating Oil Using Coulometric Karl Fisher Titration Method"

1.0 **General :**

1.1 The testing instrument covered in this specification is generally meant for carrying out testing and maintenance at site/Laboratory and shall be complete with all material and accessories. These shall be robust in design, so that they give accurate results even in adverse site conditions.

1.2 Design, Manufacture, Testing at factory; Supply, Installation and commissioning of Water Content Measurement Kit of given specifications.

1.3 The intended use of Automatic Water Content Measurement Kit in insulating oil is to measure moisture content in insulating oil as per (IS-13567-2003, IEC-60814). As such the range and accuracy of the kit shall be sufficient to meet these testing requirements.

1.4 The equipment should be microprocessor controlled for determination of water in insulating oil by 'Coulometric Karl Fischer Titration' Method.

1.5 The equipment shall be robust, have automatic test sequences, automatic control with digital display and option to interface with computer to download test results.

1.6 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version.

1.7 The instrument should be complete in all respects & ready to use with all accessories as supplied with the instruments.

2.0 Functional Requirements:

2.1 The kit should have fully automatic EHV electrostatic and electromagnetic interference suppression. The kit shall be compatible for EMI/EMC environment as per IEC 61000.

2.2 Under very high/low ambient temperatures, high humidity, equipment shall be able to carry out measurement under these conditions.

2.3 Instrument should be designed on Coulometirc Karl Fischer Titration method for measuring moisture contents in PPM or micrograms or Percentage.

2.4 Instrument should have facility to automatic compensate Error generated due to change in electrolysis cell resistance so that calibration of reagent is not required.

2.5 All accessories and reagents should be supplied with equipments.

2.6 Latest windows based application software CD (Original) should be provided with the equipment for evaluation of test results.

2.7 Should be free from effect of humidity, parasitic reaction and inherent drift of circuitry.

2.8 Should have back up indication for mains on, instrument error, stirrer moving and titration over

2.9 Titrators offer a broad range of options for handling test results data. Choose whether to export as CSV, PDF or XML files. Devices such as printers or memory sticks can be connected via the USB port and are automatically recognized

2.10 **Solvent extraction unit:**

The kit should have the provision of extraction & addition of titration solvent to titration vessel by motorized automatic mechanism.

2.11 **SAFETY:**

Shock proof, Vibration proof, EMC compliant & Safety requirements as per relevant International Standards.

2.12 Technical Requirements:

Sr.No	Description	Details
i)	Method of Measurement	Microprocessor Controlled Determination of Water in Insulating Oil by Columetric Karl Fischer Titration Method.
ii)	Water Concentration	Above 2mg/Kg and Viscosity less than 100 mm^2/s at 40^0.C.
iii)	Iodine Production	Pulse of variation length and current density
iv)	Titration Speed	2.0 mg H_2O/min.
v)	Measuring Range	10µg to 10mg H_2O
vi)	Moisture Range	1 ppm to 100% of water
vii)	Resolution	0.1 µg H_2O
viii)	Precision/ Accuracy	Upto 3 µg for water of 100 µg or better; For more water 0.5% or better
ix)	Drift Compensation	Automatic
x)	Keypad/ User controls	Should be capable of carrying out all operational functions
xi)	Stirrer Control	The speed of the stirrer shall be microprocessor controlled. The speed of stirrer should preferably be controllable.
xii)	Modes	Standard/ Preset as well as User programmable
xiii)	Report Output	In Display as well as Printer, Result in ppm, %, µg, mg/kg formats
xiv)	Diagnostics	Should have error messages/ indications for any defects in vessel, solution, electrodes etc. as well as instrument error, mains on, stirrer moving etc.
xv)	Interface	Interface for balance and printer/ PC
xvi)	Power Supply	AC Voltage 230 V ±10 % Frequency 50 Hz ±5 %
xvii)	Printer	Built in printer or facility to connect external printer via USB/Serial Port/Ethernet/Bluetooth. Suitable Printer for printing the results
xviii)	05 ml Glass Syringe	02 Nos. 05 ml Hamilton Glass syringes
xix)	Display/ Key Board	Alpha numeric LCD/LED Display and key board

3.0 Auxiliary Spares: Apart from the standard supplied kit one set of Complete Titration Vessel assembly is also to be supplied by the supplier.

Should have 3 nos of syringes required for measurement and 6 nos of reagent bottle.

4.0 Supply of spares:

The Vendor shall ensure supply of spares/services for at least 7 years.

5.0 MANUAL: The supplier has to supply Instrument's Operation & Maintenance manual with circuit diagrams and troubleshooting guidelines...Operating / User's Manual in English.

6.0 Calibration certificate:-

Calibration certificate for each testing instrument covering entire range shall be supplied with the test kit at the time of supply.

The instrument shall be supplies with proper Calibration certificate from NABL accredited lab or internationally reputed lab .Calibration certificate traceable to national/international standards from an international accredited laboratory with uncertainty calculations shall be provided. It is the responsibility of the supplier to provide the Calibration services to the instrument after the calibration interval is over. Date of Calibration Certificate shall not be older than three month from the date of supply of kit.

7.0 The bidder will have to demonstrate the kit for accuracy and repeatability shall be established at prescribed site of DTL/any other site/Lab including 400/220kV switchyard/site up to the satisfaction of DTL at bidder cost and this will be the part of technical evaluation. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

8.0 Warranty/Guarantee Period:

Min 03 years from the date of successful & complete commissioning at DTL sub-station. All the materials, including accessories, cables, laptops etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.

9.0 After sales-service: The supplier should have adequate "After Sales Service" in India so that repair / calibration of the testing kit can be done in the short period of time.

10.0 Commissioning, Training and Handling Over of the Instrument

Successful bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demo shall be rejected and no repairs are allowed.

Supplier shall arrange exhaustive classroom training with the theory and practical session on the usage of the instrument by the technical expert of the Principal Company in our premises without any extra cost to DTL

Guarantee Technical particular "Automatic Water Content Measurement instrument in Insulating Oil Using Coulometric Karl Fisher Titration Method" (To be submitted by bidder)

S.No.	Parameters	(To be submitted by bidder)
1	Titration Method	
2	Electrolysis Control	

3	End Point Detection	
4	End Point Indication	
5	Measuring Range	
6	Moisture Range	
7	Resolution	
8	Drift Compensation	
9	Precision	
10	Method storage	
11	Display Format	
12	Print Format	
13	Start Delay	
14	Min. Titration time	
15	Stirrer Speed	
16	Stirring method	
17	Keypad/user Control	
18	Printer	
19	Carry case	
20	Power Supply	
21	Dimensions	
22	Weight	
23	Screen	
24	Instrument manuals	
25	Accessories/ Auxiliary Spares	

H. Technical Specification of Thermo Vision Scanning Camera

Item	Specification
Functional Requirement	1. The instrument shall be thermal imaging system based on principle of infra-red radiation detection. It should be suitable for following measurement in live substations and transmission lines up to 400 kV level. I. The Absolute value of Hot spot temperature. II. Color thermal as well as visual image of focused object III. Isotherm 2. The test results should have repeatability, consistency & immunity to electromagnetic interference in live switchyard upto 400 kV levels. 3. The measurement of ambient temperature.
Measurement Range	Temperature:0-500 º C
Detector Type / Infrared Pixels	320 x 240 pixels (Uncooled) Infrared Pixels to be captured by the camera and not enhanced after image capturing
Accuracy	T: ±2 º C or 2 % of Reading
IFOV or Spatial Resolution	Standard Lens: 1.4 mrad or better Telephoto Lens: 0.7mrad or better
Min. focus distance	50 cm
Focus	Auto / manual

Text annotation	Predefined by user and should be stored with image
Digital Video	1.3 MP (min.) color
Spectral Range	8µm to 13 µm (min)
Sensitivity	Min 0.1 ºC at 30 ºC or better
Emissivity Correction	Automatic temp. correction for emissivity (Variable from 0.1 to 1.0)
Accessories	One complete set of lens i.e. normal as well as telephoto lens, removable memory card (Min. 1 GB), PC communication cable, windows based software, battery set with adapter (02 set) etc, compatible with the instruments should be provided for successfully carrying out the test in DTL S/S and transmission line. Additionally all the required accessories, drawing & documents including Operating/Maintenance instruction manual, tools etc. should be provided for the smooth functioning of kit. Further hard carrying case (which should be robust/ rugged enough) for ensuring proper safety of the kit during transportation shall have to be provided.
Design/Engg.	The complete equipment along with complete accessories must be designed/engineered by Original Equipment Manufacturer.
Power Supply	It shall work on single phase 230 Volts ±10 %, 50 Hz ±5 % supply with standard socket and Rechargeable Battery.
Rechargeable battery (1 battery capacity)	4 hours continuous operation
Operating Temperature	0 to +50 deg C
Degree of Protection	IP 54 (Min)
Relative humidity	Max. 90 % non-condensing
Protection/ Control	Against short circuit, over voltage, improper ground connection over load & transient surges, the instrument should have alarm/cut-off features to protect the instrument.
Mounting Arrangement	The necessary tripod mounting arrangement should be provided for long distance measurement.
Weight	The weight should be preferably less than 2.5Kg for easy portability.
Software	The software should be provided free of cost & suitable for report generation and temperature analysis on windows based platform. The instrument should have facility to store, in standard formats, and communicate with windows based computer for exporting the test data. USB port or any other arrangement shall be provided for downloading the images, etc via USB port.
Display/Control	3.5 ” LCD Display (Min)
Environment	The test kit shall be compatible for EMI/EMC/safety environment requirement as per IEC.
Guarantee	Warranty/Guarantee Period: Min 01 year from the date of successful demonstration of supplied equipment at DTL sub-station. All the materials, including accessories, cables etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier’s works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software,

	transportation of kit for repair at test lab/ works.
Calibration Certificate	Unit shall be duly calibrated before supply and the date of calibration shall not be older than two month from the date of supply of Kit.
Training	Supplier shall have to ensure that the kit is made user friendly. Apart from the detailed demonstration at site, the supplier shall also have to arrange necessary training to DTL engineers.
Commissioning, handing over the Instrument	Successful bidder will have to supply and demonstrate the instrument to the satisfaction of DTL. The instrument failed during the demonstration shall be rejected and no repairs are allowed.
After sales service	Bidder will have to submit the documentary evidence of having established mechanism in India for prompt after sale services.

Note: For substation purpose, only thermo scanning camera without telephoto lens is required whereas for lines purpose thermo scanning camera with telephoto lens is required.

SECTION-III

GENERAL TECHNICAL REQUIREMENTS

SEC-GTR
(GENERAL TECHNICAL REQUIREMENTS)

1.0 FOREWORD

1.1 The provisions under this section are intended to supplement general requirements for the materials, equipments and services covered under other sections of tender documents and is not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

2.0 GENERAL REQUIREMENT

2.1 The bidders shall submit the technical requirements, data and information as per the technical data sheets provided in the Volume III of bid documents.

2.2 The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification.

2.3 It is recognized that the Contractor may have standardized on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Purchaser's. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the specific requisite schedule, will not be considered as valid deviation.

2.4 Except for lighting fixtures, wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition. For lighting fixtures, makes shall be as defined in Section- Lighting System

2.5 Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard/substation unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment provided, shall be inter-changeable with one another.

3.0 **STANDARDS**

3.1 The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.

3.2 The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the date of bid opening) of standard specified under Annexure -C of this section, unless specifically mentioned in the specification.

3.3 The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.

3.4 The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.

3.5 When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

3.6 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under Annexure C / individual sections for various equipments shall also, be accepted, however the salient points of difference shall be clearly brought out in additional information schedule of Vol III along with English language version of such standard. The equipment conforming to standards other than specified under Annexure C / individual sections for various equipments shall be subject to Purchaser's approval.

3.7 The bidder shall clearly indicate in his bid the specific standards in accordance with which the works will be carried out.

4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

4.1 The 400kV system is being designed to limit the switching surge over voltage to 2.5pu and the power frequency over voltage to 1.5 pu. In case of the 400kV system, the initial value of the temporary over voltages could be 2.0 pu for 1 - 2 cycles. The equipment 400kV system is being designed to limit the switching surge over voltage to 2.5pu and the power frequency over voltage to 1.5 pu. In case of the 400kV system, the initial value of the temporary over voltages could be 2.0 pu for 1 - 2 cycles. The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc under such over voltage conditions.

4.2 All equipments shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.

4.3 All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment.

4.4 The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.

4.5 The equipment shall also comply to the following:

a) All outdoor EHV equipments except marshalling kiosks shall be suitable for hot line washing.

b) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".

c) All piping, if any between equipment control cabinet/ operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.

4.6 Operating times of circuit breakers, protective relays and PLCC equipment have been specified in respective sections. However, the bidder is allowed to have minor variations on the individual equipment timings subject to the condition that overall fault clearing time remains within 100 milli seconds at 400 kV and 160 milli seconds at 220 kV level under comparable conditions.

4.7 EHV equipments and system shall be designed to meet the following major technical parameters as brought out hereunder.

4.7.1 System Parameter

S.NO	**Description Of parameters**	**400 kV System**	**220 kV System**	**66 kV System**	**33 kV System**
1.	System operating voltage	400kV	220kV	66kV	33kV
2.	Rated frequency	50Hz	50Hz	50Hz	50Hz
3.	No. of phase	3	3	3	3
4. Rated Insulation levels					
i) Full wave impulse withstand voltage (1.2/50 micro sec.)		1550 kVp	1050 kVp	325 kVp	170 kVp
ii) Switching impulse withstand voltage (250/2500 micro sec.) dry and wet		1050 kVp	-	-	-
iii) One minute power		630kV	460kV	140kV	80kV

frequency dry and wet withstand voltage (rms)				
5. Corona extinction voltage	320kV	156kV	-	-
6. Max. radio Interference voltage for frequency between 0.5 MHz and 2 MHz at 320kV rms for 400kV system and 156kV rms for 220kV system & 92 kV rms for 132kV system	1000 microvolt	1000 Microvolt	-	-
7. Minimum creepage distance	25 mm/kV 10500 mm)	25 mm/kV (6125 mm)	25 mm/kV (1812.5 mm)	25 mm/kV (900 mm)
8. Min. clearances				
i) Phase to phase	4200 mm (for Rod -conductor configuration) 4000 mm (for conductor - conductor configuration)	2100mm	630mm	320mm
ii) Phase to earth	3500mm	2100mm	630mm	320mm
iii) Sectional clearances	6500mm	5000 mm	3000mm	3000mm
10. Rated short circuit current for 1 sec. duration	40 kA	40 kA	31.5 kA	31.5 kA
11. System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed

Note : The insulation and RIV levels of the equipments shall be as per values given in the respective chapter of the equipments.
Bidder is required to maintain the clearances as per relevant IEC/IS and shall adhere to safety guidelines

4.7.2 Major Technical Parameters

The major technical parameters of the equipments are given below. For other parameters and features respective technical sections should be referred.

(A) For 400/220/33 kV Auto Transformer

Voltage ratio (kV)	400/220/33		
Rated frequency (Hz)	50		
Max. Design Ambient Temp. (°C)	50		
Windings	HV	IV	LV
(i) System Fault level (kA)	40	40	25
(ii) 1.2/50 micro sec. impulse withstand voltage kVp	1300	950	250
(iii) 20/200/500 micro second switching surge withstand voltage kVp	1050	-	-
(iv) One minute power frequency voltage kV (rms)	-	-	95
(v) Winding connection	Star	Star	delta
(vi) Neutral	- Solidly grounded -		
(vii) Insulation	- Solidly grounded -		
(viii) Vector Group	- YN a0 d11		

(B) For 420 kV Circuit Breaker and Isolator

Rated voltage (kV, rms)	420
Rated frequency (Hz)	50
No. of poles	3
Design ambient temperature (°C)	50

Rated Insulation levels:

1) Full wave impulse withstand voltage (1.2/50 microsec.)

- between line terminals and ground	±1425 kV peak
- between terminals	± 1425 kVp impulse on

with circuit breaker/ Isolator open	one terminal and240 kVp power frequency Voltage of opposite polarity on other terminal
2) Switching impulse withstand voltage (250/2500 micro-second) dry and wet	
- between line terminals and ground	± 1050 kV peak
- between terminals with circuit breaker/ Isolator open	900 kVp impulse on one terminal and 345 kVp power frequency voltage of opposite polarity on other terminal
3) One minute power frequency dry and wet withstand voltage	
- between line terminals and ground	520 kV rms
- between terminals with circuit breaker/ Isolator open	610 kV rms
Corona extinction voltage (kV rms) with Circuit Breaker/Isolator in all positions	320 (min)
Max. radio interference voltage (micro volts) for frequency between 0.5 MHz and 2 MHz at 266 kV rms. in all positions	1000

Minimum Creepage distance :-

i) Phase to ground (mm)	10500
ii) Between CB Terminals (mm)	10500
Phase to phase spacing	6000 mm (min.)
Seismic acceleration	0.3g horizontal

Thermal Rating of Auxiliary Contacts	10 A at 220 V DC
Breaking Capacity of auxiliary contacts	2 A DC with circuit time constant not less than 20 ms.
System neutral earthing	Effectively Earthed

Auxiliary switch shall also comply with other clauses of this chapter.

(FOR 420 kV CT/CVT/SA)

Rated voltage (kV, rms)	420
Rated frequency (Hz)	50
No. of poles	1
Design ambient temperature (°C)	50

Rated Insulation levels :

1) Full Insulation levels :

- between line terminals and ground for CT and CVT	± 1425 kV peak
- For arrester housing	± 1425 kV peak

2) Switching impulse withstand voltage (250/2500 micro second) dry and wet

- between line terminals and ground for CT and CVT	± 1050 kVp peak
- For arrester housing	± 1050 kV peak

3) One minute power frequency dry and wet withstand voltage

- between line terminals and ground for CT and CVT	630 kV rms.
- For arrester housing 630 kV rms	320 (min)
Corona extinction voltage (kV rms) for CT/CVT.	
Max. radio interference	1000 for CT/CVT
voltage for frequency between 0.5 MHz and 2 MHz at 266 kV rms (Micro volts)	500 for SA

Min. Creepage distance :-

Phase to ground (mm)	10500
Seismic acceleration	0.3g horizontal
Partial discharge :-	
- for arrester at 1.05 COV	Not exceeding 50 pc.
- for CT/CVT	Not exceeding 10 pC.
System neutral earthing	Effectively earthed

(C) For 220/66/11 kV Power Transformer

Voltage ratio (kV)		**220/66/11**		
Rated frequency (Hz)		50		
Max. Design Ambient Temp. (°C)		50		
Windings		HV	IV	LV
(i)	System Fault level (kA)	40	31.5	18.35
(ii)	1.2/50 micro sec. impulse withstand voltage kVp	±1050	±325	±170
(iii)	One minute power frequency voltage kV(rms)	±460	±140	±70
(iv)	Winding connection	Star	Star	delta
(v)	Neutral	- Solidly grounded -		
(vi)	Insulation	- Solidly grounded -		
(vii)	Vector Group	- YN yn0 d11 -		

(D) For 245 kV & 72.5 kV Circuit Breaker and Isolator

Rated voltage kV (rms)	245	72.5
Rated frequency (Hz)	50	50
No. of Poles	3	3
Design ambient temperature (°C)	50	50

Rated insulation levels :

1) Full wave impulse withstand voltage (1.2/50 micro sec.)

-	between line terminals and ground	± 1050 kVp	±325 kVp
-	between terminals with circuit breaker open	± 1200 kVp	±375 kVp

- between terminals with isolator open	± 1200 kVp	±375 kVp

2) One minute power frequency dry and wet withstand voltage

- between line terminals and ground	460 kV (rms)	±140kV (rms)
- between terminals with circuit breaker open	460 kV (rms)	As per IEC
- between terminals with Isolator open	530 kV (rms)	As per IEC
Max. radio interference voltage (microvolts) for frequency between 0.5 MHz and 2 MHz in all positions of the equipments.	1000 (at 156 kV rms)	-

Minimum creepage distance :-

Phase to ground (mm)	6125	1812.5
Between CB Terminals (mm)	6125	1812.5
System neutral earthing	Effectively earthed	Effectively earthed
Seismic acceleration	- 0.3g horizontal -	
Rating of Auxiliary Contacts	- 10 A at 220 V DC -	
Breaking capacity of Auxiliary Contacts	2 A DC with circuit time constant of not less than 20 ms.	
Phase to phase spacing (mm)	4000 (min.)	2000

Auxiliary Switch shall also comply with other clauses of this chapter.

FOR 245 kV & 72.5 kV CT/CVT/SA

Rated voltage kV (rms)	245	72.5
Rated frequency (Hz)	50	50
No. of poles	1	1
Design ambient temperature (°C)	50	50

Rated insulation levels :

1) Full wave impulse withstand voltage (1.2/50 micro sec.)		
- between line terminals and ground for CT and CVT	± 1050 kVp	±325 kVp
- for arrester housing	± 1050 kV peak	±325 kVp
2) One minute power frequency dry and wet withstand voltage		
- between line terminals and ground for CT and CVT	460 kV rms	140 kV rms
- for arrester housing	460 kV rms	140kV rms
Max. radio interference	1000 for CT/CVT 500	
voltage (microvolts) for frequency between 0.5 MHz and 2 MHz in all positions of the equipment.	500 for SA (at 156 kV rms)	
Minimum creepage distance :-		
Phase to ground (mm)	6125	1812.5
System neutral earthing	- Effectively earthed -	
Seismic acceleration	- 0.3g horizontal -	
Partial discharge for :-		
- Surge arrester at 1.05 COV	- Not exceeding 50 pc. -	
- for CT/CVT	- Not exceeding 10 pc. -	

(E) Technical Parameters of Bushings/Hollow Column insulators/support insulators :

	For 400 kV System	For 220 kV System	For 66 kV System	For 33 kV System
(a) Rated Voltage (kV)	420	245	72.5	36
(b) Impulse withstand voltage (Dry & Wet) (kVp)	±1425	±1050	±325	±170
(c) Switching surge withstand voltage (dry and wet) (kVp)	±1050	-	-	-
(d) Power frequency withstand voltage (dry and wet) (kV rms)	630	460	140	70

(e) Total creepage distance (mm)	10500	6125	1813	900

(f) Pollution Class-III Heavy (as per IEC 71) and as specified Section-2 for all class of equipment

(g) Insulator shall also meet requirement of and IEC-815 for 400 kV, 220 kV system, as applicable having alternate long & short sheds.

5.0 ENGINEERING DATA AND DRAWINGS

5.1 The engineering data shall be furnished by the Contractor in accordance with the Schedule for each set of equipment as specified in the Technical Specifications.

5.2 The list of drawings/documents which are to be submitted to the Purchaser shall be discussed and finalised by the Purchaser at the time of award. The Contractor shall necessarily submit all the drawings/ documents unless anything is waived. The Contractor shall submit 4 (four) sets of drawings/ design documents /data/ test reports as may be required for the approval of
the Purchaser.

5.3 Drawings

5.3.1 All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Each drawing submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

5.3.3 Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.

5.4 The review of these data by the Purchaser will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. This review by the Purchaser may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the purchaser shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities

for mistakes and deviations from the requirements, specified under these specifications and documents.

5.5 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

5.6 All engineering data submitted by the Contractor after final process including review and approval by the Purchaser shall form part of the Contract Document and the entire works performed under these specifications shall be performed I strict conformity, unless otherwise expressly requested by the Purchaser in Writing.

5.7 Approval Procedure

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Purchaser would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

i)	Approval/comments/ by Purchaser on initial submission	As per agreed schedule
ii)	Resubmission (whenever required)	Within3 (three) weeks from date of Comments including both ways postal time).
iii)	Approval or comments	Within 3 weeks of receipt of resubmission.
iv)	Furnishing of distribution copies in bound volume (5 copies per substation and one copy for Corporate Centre)	2 weeks from the date of final approval
v)	Furnishing of distribution copies of test reports	
(a)	Type test reports (one copy per substation plus one copy for corporate centre)	2 weeks from the date of final approval

(b)	Routine Test Reports (one copy for each substation)	–do
vi)	Furnishing of instruction/ operation manuals (4 copies per substation and two copies for corporate centre)	As per agreed schedule
vii)	RTFs of drawings (one set substation and one set for corporate centre)	-do
(viii)	Video Cassette (VHS-PAL) - highlighting installation and maintenance techniques/ requirements of circuit breaker & isolators (one per substation plus one for corporate centre)	do
(ix)	As built drawings & RTFs (Two sets per substation plus one set for corporate centre)	On completion of entire works
(x)	ROM optical disks for all As built drawings (one per substation plus one for corporate	–do

NOTE:

(1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Purchaser or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

(2) The drawings which are required to be referred frequently during execution should be submitted on cloth lined paper. The list of such drawings shall be finalised with the Contractor at the time of Award.

(3) All major drawings should be submitted in Auto Cad Version 12 or better.

(4) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.

(5) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Purchaser.

(6) The Contractor shall furnish to the Purchaser catalogues of spare parts.

5.8 The list of major drawings and General Technical Parameters shall be as per Annexure – D.

6.0 MATERIAL/ WORKMANSHIP

6.1 General Requirement

6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

6.1.2 Incase where the equipment, materials or components are indicated in the specification as "similar" to any special standard, the Purchaser shall decide upon the question of similarity. When required by the specification or when required by the Purchaser the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads.

The use of other thread forms will only be permitted when prior approval has been obtained from the Purchaser.

6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the

erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to reestablish the manufacturer's limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

6.1.6 The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.

6.1.7 All oil, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. In such is the case he shall declare in the proposal, where such oil or grease is available. He shall help Purchaser in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.

6.1.8 A cast iron or welded steel base plate shall be provided for all rotating equipment which are to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base plate shall support the unit and its drive assembly, shall be of design with pads for anchoring the units, shall have a raised up all around and shall have threaded in air connections, if so required.

6.1.9 Corona and radio interference voltage test and seismic withstand test procedures for equipments shall be in line with the procedure given at Annexure-A and B respectively.

6.2 Provisions For Exposure to Hot and Humid climate

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipments located in non-air-conditioned areas shall also be of same type.

6.2.1 Space Heaters

6.2.1.1 The heaters shall be suitable for continuous operation at 240 V as supply voltage. On-off switch and fuse shall be provided.

6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

6.2.2 FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

6.2.3 Ventilation opening

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

6.2.4 Degree of Protection

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

a) Installed out door: IP- 55
b) Installed indoor in air conditioned area: IP-31
c) Installed in covered area: IP-52
d) Installed indoor in non air conditioned area where possibility of entry of water is limited: IP-41.
e) For LT Switchgear (AC & DC distribution Boards) : IP-52
The degree of protection shall be in accordance with IS:13947 (Part-I) / IEC-947 (Part-I) / IS 12063 / IEC 529. Type test report for degree of protection test, on each type of the box shall be submitted for approval.

6.3 RATING PLATES, NAME PLATES AND LABELS

6.3.1 Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as

may be required by the Purchaser. The rating plate of each equipment shall be according to IEC requirement.

6.3.2 All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

6.4 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into successful Operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS / COORDINATION

7.1 The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Purchaser or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Purchaser & contractor agree upon any such changes, the specification shall be modified accordingly.

7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

7.3 The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, subassemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

7.4 The Contractor has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Purchaser. The names of agencies shall be intimated to the successful bidders.

7.5 The Contractor will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Purchaser (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at New Delhi or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 QUALITY ASSURANCE PROGRAMME

8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's Works or at his Sub-contractor's premises or at the Purchaser's site or at any other place of Work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be broadly outlined by the contractor and finalised after discussions before the award of contract. The detailed programme shall be submitted by the contractor after the award of contract and finally accepted by DTL after discussion. However, in case detailed valid programme approved by DTL for the equipment already exist, same would be followed till its validity. A quality assurance programme of the contractor shall generally cover the following:

(a) His organisation structure for the management and implementation of the proposed quality assurance program:
(b) Documentation control system;
(c) Qualification data for bidder's key personnel;
(d) The procedure for purchases of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
(e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
(f) Control of non-conforming items and system for corrective actions;
(g) Inspection and test procedure both for manufacture and field activities.
(h) Control of calibration and testing of measuring instruments and field activities;
(i) System for indication and appraisal of inspection status;
(j) System for quality audits;
(k) System for authorising release of manufactured product to the Purcahser.
(l) System for maintenance of records;
(m) System for handling storage and delivery; and
(n) A quality plan detailing out the specific quality control measures an procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Purchaser or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

8.2 Quality Assurance Documents

The contractor would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of purchaser's inspection of equipment/material

9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

9.1 All equipment being supplied shall conform to type tests including additional type tests as per technical specification and shall be subject to routine tests in

accordance with requirements stipulated under respective sections. Purchaser reserves the right to witness any or all the type tests. The Contractor shall intimate the Purchaser the detailed program about the tests atleast three (3) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

9.2 The reports for all type tests and additional type tests as per technical specification shall be furnished by the Contractor alongwith equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accredition body of the country where laboratory is located) or witnessed by the representative(s) of DTL or Utility. The test reports submitted shall be of the tests conducted within last 10 (Ten) years prior to the date of bid opening. In case the test reports are of the test conducted earlier than 10 (Ten) years prior to the date of bid opening, the contractor shall repeat these test(s) at no extra cost to the purchaser.

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design / manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all additional type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

9.3 Bidder shall conduct type tests on equipments other than GIS if required in their respective section.

9.4 The Purchaser, his duly authorised representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractor's/sub-vendors premises or Works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, despatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

9.5 The Contractor shall give the Purchaser /Inspector thirty (30) days written notice of any material being ready for joint testing including contractor and DTL. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Purchaser / inspector, unless witnessing of the tests is virtually waived, will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to have been made in the Inspector's presence

and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

9.6 The Purchaser or Inspector shall, within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Purchaser /Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

9.7 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Purchaser/inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Purchaser /Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/Inspector. Failure of the Purchaser /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of CIP by the Purchaser.

9.8 In all cases where the Contract provides for tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Purchaser /Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Purchaser /Inspector or to his authorised representative to accomplish testing.

9.9 The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

9.10 The Purchaser will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

9.11 The Purchaser reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Purchaser.

10. TESTS

10.1 Pre-commissioning Tests

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Purchaser and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in respective chapters and shall be included in the Contractor's quality assurance programme.

10.2 Commissioning Tests

10.2.1 The testing equipments required for testing and commissioning shall be arranged by the Contractor.

10.2.2 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

10.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed by DTL on production of requisite documents.

11.0 PACKAGING & PROTECTION

11.1 All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Purchaser, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Purchaser takes no responsibility of the availability of the wagons.

11.2 All coated surfaces shall be protected against abrasion, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12.0 FINISHING OF METAL SURFACES

12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4. All steel conductors including those used for

earthing/grounding (above ground level) shall also be galvanized according to IS: 2629.

12.2 HOT DIP GALVANISING

12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq. m and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq. m minimum.

12.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

12.2.3 After galvanizing. no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

12.2.4 The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.

12.2.5 Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

12.2.6 Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005 “Code of practice for phosphating iron and sheet”. All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be

shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

12.3.2 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

12.3.3 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

12.3.4 The exterior colour of the paint shall be as per shade no: 697 (for outdoor) & 692 (for indoor) of IS-5 and inside shall be glossy white for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.

12.3.5 In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted alongwith the Bids for Purchaser's review & approval.

12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air Conditioning systems

S.No	**. PIPE LINE**	**Base colour**	**Band colour**
Fire Protection System			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line – water	FIRE RED	Sea Green
3	Emulsifier system detection line –Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
Air Conditioning System			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
6	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red

7	Refrigerant liquid pipeline	Dark Admiralty Green	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

The direction of flow shall be marked by → (arrow) in black colour.

Base Colour Direction of flow Band Colour

13.0 HANDLING, STORING AND INSTALLATION

13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

13.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

13.3 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

13.4 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

13.5 Contractor shall be responsible for examining all the shipment and notify the Purchaser immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. The Contractor shall submit to the Purchaser every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit,

handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

13.6 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Purchaser in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Purchaser, as well as protection of the same against theft, element of nature, corrosion, damages etc.

13.7 Where material / equipment is unloaded by Purchaser before the Contractor arrives at site or even when he is at site, Purchaser by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.

13.8 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

13.9 The words 'erection' and 'installation' used in the specification are synonymous.

13.10 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

13.11 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances as given in clause 4.7.1 the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

13.12 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have
threaded drain connections.

14.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

15.0 AUXILIARY SUPPLY

15.1 The sub-station auxiliary supply is normally met through a system indicated under section "Electrical & Mechanical Auxiliaries" having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform the parameters as indicated in the following.

Normal Voltage connection	Variation in Voltage	Frequency in HZ	Phase /Wire	Neutral
415V	+/- 10%	50 +/- 5%	3/ 4 Wire	Solidly Earthed.
240V	+/- 10%	50 +/- 5%	1/ 2 Wire	Solidly Earthed.
220V	190V to240V	DC	-	Isolated 2 wire System
50V	_	DC	_	2 wire system (+) earthed

Combined variation of voltage and frequency shall be limited to +/-10%.

16.0 SUPPORT STRUCTURE

The Contractor is required to supply standard structures of various equipments. Bidder may also refer relevant Clauses of Section (Civil) in this regard.

17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

17.1 All power clamps and connectors shall conform to IS:5561 & NEM CC1 and shall be made of materials listed below :

a) For connecting ACSR conductors	Aluminum alloy casting, conforming to designation A6 of IS:617 and all test shall conform to IS:617
b) For connecting equipment ter-minals made of copper with ACSR conductors	Bimetallic connectors made from aluminum alloy casting, conforming to designation A6 of IS 617 with 2mm thick bimetallic liner and all test shall conform to IS:617
c) For connecting G.I	Galvanised mild steel shield

wire

i) Bolts, nuts & Plain, washers	i) Electrogalvanised for sizes below M12, for others hot dip galvanised.
ii) Spring washers for items 'a' to 'c'	ii) Electro-galvanised mild steel suitable for atleast service condition-3 as per IS:1573

17.2 Each equipment shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The conductor terminations of equipment shall be either expansion, sliding or rigid type suitable for 4" IPS (OD : 114.2 mm, ID: 97.18 mm) aluminum tube or suitable for Quad/Twin ACSR / AAAC Conductor (450 mm sub-conductor spacing and 250 mm Sub- Conductor spacing for 400 kV & 220 kV respectively). The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings and the equipment shall be factory tested with the connectors in position. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.

17.3 Where copper to aluminum connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress. The design details of the joint shall be furnished to the Purchaser by the Contractor.

17.4 Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of Work.

17.5 No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminum body for Bi-metallic clamps.

17.6 All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

17.7 Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of 4" IPS AL. tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

17.8 Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified

ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.

17.10 Clamps and connectors shall be designed to be corona controlled. Corona extinction voltage for 400kV & 220 kV class clamps shall not be less than 320kV (rms) & 156 kV respectively and R.I.V. level shall not be more than 1000 micro volts at the test voltage specified in respective sections.

17.11 Tests

17.11.1 Clamps and connectors should be type tested as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports on three samples of similar type shall be submitted for approval as per clause 9.2 above except for sl. no.(ii) & (iii) for which type test once conducted shall be applicable (i.e. the requirement of test conducted within last five years shall not be applicable).

i) Temperature rise test (maximum temperature rise allowed is 35° C over 50°C ambient)
ii) Short time current test
iii) Corona (dry) and RIV (dry) test (for 220 KV and above voltage level clamps)
iv) Resistance test and tensile test

18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039/IS-8623, IEC-439, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

18.3 Cabinet/boxes shall be free standing floor mounting type, wall mounting type or pedestal mounting type as per requirements. A canopy and sealing arrangements

for operating rods shall be provided in marshalling boxes / Control cabinets to prevent ingress of rain water.

18.4 Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.

18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged/cracked during the ten years of operation of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimize distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connnections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate projecting at least 150 mm above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. The gland shall project at least 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.

18.7 A 240V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.

18.8 For illumination of a 20 Watts flourscent tube or 15 watts CFL shall be provided. The switching of the fittings shall be controlled by the door switch.

18.9 All control switches shall be of rotary switch type and Toggle/piano switches shall not be accepted.

18.10 Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.

18.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.

18.12 a) The following routine tests alongwith the routine tests as per IS:5039 shall also be conducted:
i) Check for wiring
ii) Visual and dimension check
b) The enclosure of bay marshalling kiosk, junction box, terminal box shall conform to IP-55 as per IS:13947 including application of, 2.5 KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.

19.0 Auxiliary Switches (Applicable for isolators and circuit breakers)

The following type test reports on auxiliary switches shall be submitted for approval:

(a) Electrical endurance test - A minimum of 2000 operation for 2A D. C. with a time constant greater than or equal to 20 millisecond with a subsequent examination of mV drop/visual defects/temperature rise test.

(b) Mechanical endurance test. A minimum of 1,00,000 operations with a subsequent checking of contact pressure test/visual examination.
(c) Heat run test on contacts.
(d) IR/HV test etc.

20.0 TERMINAL BLOCKS AND WIRING

20.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All interphase and external connections to equipment or to control cubicles will be made through terminal blocks.

20.2 Terminal blocks shall be 650 V grade and have continuous rating to carry the maximum expected current on the terminals. These shall be of moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non disconnecting stud type equivalent to Elmex type CATM4, Phoenix cage clamp type of Wago or equivalent.

20.3 Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

20.4 The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

20.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.

20.6 The terminal blocks shall be of extensible design.

20.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

20.8 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

a) All circuits except Minimum of two of 2.5 sq CT circuits copper flexible.
b) All CT circuits Minimum of 4 nos. of 2.5 sq mm copper flexible.

20.10 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

20.11 Atleast 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

20.13 The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. For equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge overvoltges either transferred through the equipment or due to transients induced from the EHV circuits.

20.14 All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment

21.0 LAMPS AND SOCKETS

21.1 Lamps

All incandescent lamps shall use a socket base as per IS-1258, except in the case of signal lamps.

21.2 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

21.3 Hand Lamp:

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

21.4 Switches and Fuses:

21.4.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with switchfuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

21.4.2 All fuses shall be of HRC cartridge type conforming to IS: 9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

22.0 Bushings, Hollow Column Insulators, Support Insulators:

22.1 Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5621. The support insulators shall be manufactured and tested as per IS 2544/IEC 168 and IEC 273. The insulators shall also conform to IEC 815 as applicable. The bidder may also offer composite silicon insulator, conforming to IEC-1109.

22.2 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

22.4 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

22.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by

chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

22.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

22.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

22.8 Tests

In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099 & IS: 2544 & IS : 5621. The type test reports shall be submitted for approval.

23.0 MOTORS

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

23.1 Enclosures

a) Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP 55 as per IS: 4691. For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP 44 as per IS: 4691.

b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.

c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.

d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs other means to facilitate lifting.

23.2 Operational Features

a) Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise
in service.

b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Section.

23.3 Starting Requirements:

a) All induction motors shall be suitable for full voltage direct-online starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The locked rotor current shall not exceed six (6) times the rate full load current for all motors, subject to tolerance as given in IS: 325.

d) Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding atleast two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

23.4 Running Requirements:

a) The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS: 325 (for 3 - phase induction motors) after adjustment due to increased ambient temperature specified.

b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

23.5 TESTING AND COMMISSIONING

An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the

equipment Contractor or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

(a) Insulation resistance.
(b) Phase sequence and proper direction of rotation.
(c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

24.0 TECHNICAL REQUIREMENT OF EQUIPMENTS

24.1 Circuit Breakers

a. The manufacturer(s) whose SF6 Circuit Breaker are offered should have designed, manufactured tested as per IEC/IS or equivalent standard supplied the same for the specified system voltage and which are in satisfactory operation for at least 2 (two) years as on the date of bid opening.

Or

b. The manufacturer(s) whose SF6 Circuit Breaker are offered who have recently established production line in India for the specified system voltage or above class, based on technological support of a parent company or collaborator for the respective equipment(s) can also be considered provided the parent company (Principal) or collaborator meets qualifying requirements stipulated under clause no 24.1.a given above.

And

Furnishes (jointly with parent company or collaborator) a legally enforceable undertaking to guarantee quality, timely supply, performance and warranty obligations as specified for the equipment(s)

And

Furnishes a confirmation letter from the parent company or collaborator alongwith the bid stating that parent company or collaborator shall furnish performance guarantee for an amount of 10% of the cost of such equipment(s). This performance guarantee shall be in addition to contract performance guarantee to be submitted by the Bidder

24.2 Isolators

The manufacturer whose isolators are offered, should have designed, manufactured, tested as per IEC/IS or equivalent standard and supplied the isolator for the specified system voltage and fault level and should be in satisfactory operation for at least 2 (two) years as on the date of bid opening.

24.3 Instrument Transformers

The manufacturer whose instrument transformers are offered, should have designed, manufactured & tested as per IS/IEC or equivalent standard and supplied

the same for the specified system voltage for CT & CVT and fault level in case of CT. These equipment should be in satisfactory operation for at least 2 (two) years as on the date of bid opening.

24.4 Surge Arresters

The manufacturer whose Surge Arresters are offered should have designed, manufactured and tested as per IEC/IS or equivalent standard and supplied the Surge Arrester for the specified energy capability with rated system voltage and which are in satisfactory operation for at least 2 (two) years as on the date of bid opening.

24.5 1.1 kV Grade Power & Control Cables

24.5.1 Applicable for PVC Control Cable

The manufacturers, whose PVC control cables are offered, should have designed, manufactured, tested and supplied in a single contract at least 100 Kms of 1.1 kV grade PVC insulated control cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 27C x 2.5 Sq.mm or higher size as on the date of bid opening.

24.5.2 Applicable for PVC Power Cable

The manufacturer, whose PVC Power Cables are offered, should have designed, manufactured, tested and supplied in a single contract atleast 100 Kms of 1.1 kV or higher grade PVC insulated power cables as on the date of bid opening . Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 1C x 150 Sq. mm or higher size as on the date of bid opening.

24.5.3 Applicable for XLPE Power Cables

The Manufacturer, whose XLPE Power cables are offered, should have designed, manufactured, tested and supplied in a single contract atleast 25 Kms of 1.1 kV or higher grade XLPE insulated power cables as on the date of bid opening . Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 1C x 630 Sq. mm or higher size as on the date of bid opening.

24.6 LT Switchgear

24.6.1 The Manufacturer whose LT Switchgear are offered, should be a manufacturer of LT Switchboards of the type and rating being offered. He should have designed, manufactured, tested and supplied at least 50 nos. draw out circuit breaker panels, out of which at least 5 nos. should have been with relay and protection schemes with current transformer. He should have also manufactured at least 50 nos. motor control center panels of the type and rating being offered which should be in successful operation as on date of bid opening.

24.6.2 The Switchgear items (such as circuit breakers, fuse switch units, contactors etc.), may be of his own make or shall be procured from reputed manufacturers and of

proven design. At least one hundred circuit breakers of the make and type being offered shall be operating satisfactory as on date of bid opening.

24.7 Battery and Battery Charger

24.7.1 Requirements for Battery Manufacturers

The manufacturer whose Batteries are offered should have designed, manufactured and supplied DC Batteries of the type specified and being offered, having a capacity of at least 600 AH and these shall be operating satisfactorily for two years in power sector and/or industrial installations as on date of bid opening.

24.7.2 Requirements for Battery Charger Manufacturers

The manufacturer, whose Battery Chargers are offered, should have designed, manufactured and supplied Battery Chargers generally of the type offered, with static automatic voltage regulators and having a continuous output of atleast ten (10) KW and these should be in successful as on the date of bid opening.

24.8 LT Transformers

The manufacturer, whose transformers are offered should have designed, manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformers of at least 33 kV class of 800 kVA or higher. The transformer should have been in successful operation for at least 2 years as on the date of bid opening.

24.9 Fire Fighting System

Nitrogen Injection Fire Prevention and Extinguishing System shall be used for fire protection of Transformer. In addition fire protection wall shall be erected between the two transformers which have adjacent base. Portable Fire Extinguishers shall also be provided.

The manufacturer whose NIFPES are offered, should have a minimum experience of five years in the design, manufacturing, erection, testing and commissioning of nitrogen injection fire protection, system on power transformers of similar or higher rating. At least 6 sets of the system shall be in successful operation on power transformers on similar & higher ratings with at least three different organizations for a minimum period of 2 years.

24.10 Control and Relay Panels

24.10.1 The manufacturer whose C&R panels and protective relay are offered should have designed, manufactured, tested, installed and commissioned C&R panels including protection relays which must be in satisfactory operation on 400 kV system for atleast 2 (two) years on the date of bid opening.

24.10.2 The C&R Panel from a manufacturer whose have designed, manufactured, tested, installed and commissioned C&R panels which are in satisfactory operation on 220 kV system for atleast 2 (two) years on the date of bid opening can also be offered, provided the protective relay schemes should be offered from a Contractor who fully meets the requirements stipulated under clause 24.10.1 above. Further, in such an event the manufacturer shall furnish an undertaking jointly executed by him and his protective relay schemes Supplier, as per the format enclosed in the bid documents for
successful performance of the protection system offered.

24.11 PLCC

24.11.1 The manufacturer whose PLCC panels are offered should have designed, manufactured, tested, supplied and commissioned PLCC panels for the specified voltage level and the same should be in successful operation for atleast 2 (two) years as on the date of bid opening.

24.11.2 The manufacturer whose line traps are offered should have designed, manufactured tested, supplied and commissioned similar line traps for the specified voltage and fault level and should be successful operation for atleast 2 (two) years as on the date of bid opening.

24.11.3 PLCC Panels/line traps manufactured by the the manufacturer meeting the requirements at Clause No. 24.11.1 & 24.11.2 except that the PLCC Panels/line traps manufactured, tested and supplied by them is not in operation for the stipulated period can also be offered provided the manufacturer furnishes an undertaking jointly executed by him and his collaborator, who in turn fully meets the requirement specified at 24.11.1/24.11.2 above as per the format enclosed in the bid document for successful performance of the equipment offered.

ANNEXURE-A

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

Unless otherwise stipulated, all equipment (except Auto Transformer) together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV).

2. Test Levels:

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3. Test Methods for RIV:

3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 400 kV, 220 kV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

4. Test Methods for Visible Corona

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130 %, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, 115% and 130%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall been such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

4.1 The test shall be recorded on each photograph. Additonal photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.

4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.

4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

4.4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

5. Test Records:

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

a) Background noise before and after test.
b) Detailed procedure of application of test voltage.
c) Measurements of RIV levels expressed in micro volts at each level.
d) Results and observations with regard to location and type interference sources detected at each step.
e) Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.
f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

ANNEXURE – B

SEISMIC WITHSTAND TEST PROCEDURE

The seismic withstanding test on the complete equipment (except Auto Transformer) shall be carried out alongwith supporting structure. The Bidder shall arrange to transport the structure from his Contractor's premises/DTL sites for the purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and any other point as agreed by the Purchaser. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the Purchaser.

ANNEXURE - C

LIST OF SPECIFICATIONS

GENERAL STANDARDS AND CODES

India Electricity Rules
Indian Electricity Act
Indian Electricity (Supply) Act
Indian Factories Act

IS-5,	-	Colors for Ready Mixed Paints and Enamels.
IS-335,	-	New Insulating Oils.
IS-617,	-	Aluminium and Aluminium Alloy Ingots and
	-	Castings for General Engineering Purposes
IS-1448 (P1 to P 145)	-	Methods of Test for Petroleum and its Products.
IS-2071 (P1 to P3)	-	Methods of High Voltage Testing.
IS-12063	-	Classification of degrees of protection provided by enclosures of electrical equipment.
IS-2165 P1:1997 P2:1983	-	Insulation Coordination.
IS-3043	-	Code of Practice for Earthing
IS-6103	-	Method of Test for Specific Resistance(Resistivity) of Electrical Insulating Liquids
IS-6104	-	Method of Test for Interfacial Tension of Oil against Water by the Ring Method
IS-6262	-	Method of test for Power factor & Dielectric Constant of Electrical Insulating Liquids.
IS-6792	-	Method for determination of electric strength of insulating oils.
IS-5578	-	Guide for marking of insulated conductors.
IS-11353	-	Guide for uniform system of marking & identification of conductors & apparatus terminals.
IS-8263	-	Methods for Radio Interference Test on High voltage Insulators.
IS-9224 (Part 1,2&4)	-	Low Voltage Fuses
IEC-60060 (Part 1 to P4)	-	High Voltage Test Techniques
IEC 60068	-	Environmental Test
IEC-60117	-	Graphical Symbols
IEC-60156,	-	Method for the Determination of the Electrical Strength of Insulation Oils.
IEC-60270,	-	Partial Discharge Measurements.

IEC-60376	-	Specification and Acceptance of New Sulphur Hexafloride
IEC-60437	-	Radio Interference Test on High Voltage Insulators.
IEC-60507	-	Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems.
IEC-60694	-	Common Specification for High Voltage Switchgear & Controlgear Standards.
IEC-60815	-	Guide for the Selection of Insulators in respect of Polluted Conditions.
IEC-60865 (P1 & P2)	-	Short Circuit Current - Calculation of effects.
ANSI-C.1/NFPA.70	-	National Electrical Code
ANSI-C37.90A	-	Guide for Surge Withstand Capability (SWC) Tests
ANSI-C63.21,	-	Specification for Electromagnetic Noise and
C63.3	-	Field Strength Instrumentation 10 KHz to 1 GHZ
C36.4ANSI-C68.1	-	Techniquest for Dielectric Tests
ANSI-C76.1/EEE21	-	Standard General Requirements and Test Procedure for Outdoor Apparatus Bushings.
ANSI-SI-4	-	Specification for Sound Level Metres
ANSI-Y32-2/C337.2	-	Drawing Symbols
ANSI-Z55.11	-	Gray Finishes for Industrial Apparatus and Equipment No. 61 Light Gray
NEMA-107T	-	Methods of Measurements of RIV of High Voltage Apparatus
NEMA-ICS-II	-	General Standards for Industrial Control and Systems Part ICSI-109
CISPR-1	-	Specification for CISPR Radio Interference Measuring Apparatus for the frequency range 0.15 MHz to 30 MHz
CSA-Z299.1-1978h	-	Quality Assurance Program Requirements
CSA-Z299.2-1979h	-	Quality Control Program Requirements
CSA-Z299.3-1979h	-	Quality Verification Program Requirements
CSA-Z299.4-1979h	-	Inspection Program Requirements

TRANSFORMERS AND REACTORS

IS:10028 (Part 2 & 3)	-	Code of practice for selection, installation & maintenance of Transformers (P1:1993) (P2:1991), (P3:1991)
IS-2026 (P1 to P4)	-	Power Transformers
IS-3347 (part 1 to Part 8)	-	Dimensions for Porcelain transformer Bushings for use in lightly polluted atmospheres.
IS-3639	-	Fittings and Accessories for Power Transformers
IS-6600	-	Guide for Loading of OIl immersedTransformers.
IEC-60076 (Part 1 to Part 5)	-	Power Transformers
IEC-60214	-	On-Load Tap-Changers.

IEC-60289	-	Reactors.
IEC- 60354	-	Loading Guide for Oil - Immersed power transformers
IEC-60076-10	-	Determination of Transformer and Reactor Sound Levels
ANSI-C571280	-	General requirements for Distribution, Power and Regulating Transformers
ANSI-C571290	-	Test Code for Distribution, Power and Regulation Transformers
ANSI-C5716	-	Terminology & Test Code for Current Limiting Reactors
ANSI-C5721	-	Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 KVA
ANSI-C5792	-	Guide for Loading Oil-Immersed Power Transformers upto and including 100 MVA with 55 deg C or 65 deg C Winding Rise
ANSI-CG,1EEE-4	-	Standard Techniques for High Voltage Testing

CIRCUIT BREAKERS

IEC-62271-100	-	High Voltage Alternating Current Breakers
IEC-60427	-	Synthetic Testing of High Voltage alternating current circuit Breakers.
IEC-61264	-	Pressurised Hollow Column Insulators

CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITOR VOLTAGE TRANSFORMERS

IS-2705	-	(P1 to P4) - Current Transformers.
IS:3156	-	(P1 to P4) - Voltage Transformers.
IS-4379	-	Identification of the Contents of Industrial Gas Cylinders
IEC-60044-1	-	Current transformers.
IEC-60044-2	-	Voltage Transformers.
IEC-60358	-	Coupling capacitors and capacitor dividers.
IEC-60044-4	-	Instrument Transformes : Measurement of Partial Discharges
IEC-60481	-	Coupling Devices for power Line Carrier Systems.
ANSI-C5713	-	Requirements for Instrument transformers
ANSIC92.2	-	Power Line Coupling voltage Transformers
ANSI-C93.1	-	Requirements for Power Line Carrier Coupling Capacitors

BUSHING

IS-2099	-	Bushings for Alternating Voltages above1000V
IEC-60137	-	Insulated Bushings for Alternating Voltages above1000V

SURGE ARRESTERS

IS-3070 (PART2)	-	Lightning arresters for alternating current systems : Metal oxide lightning arrestors without gaps.
IEC-60099-4	-	Metal oxide surge arrestors without gaps
IEC-60099-5	-	Selection and application recommendation

ANSI-C62.1	-	IEE Standards for S A for AC Power Circuits
NEMA-LA 1	-	Surge Arresters

CUBICLES AND PANELS & OTHER RELATED EQUIPMENTS

IS-722, IS-1248, IS-3231, 3231 (P-3)		- Electrical relays for power system protection
IS:5039	-	Distributed pillars for Voltages not Exceeding 1000 Volts.
IEC-60068.2.2	-	Basic environmental testing procedures Part 2: Test B: Dry heat
IEC-60529	-	Degree of Protection provided by enclosures.
IEC-60947-4-1	-	Low voltage switchgear and control gear.
IEC-61095	-	Electromechanical Contactors for household and similar purposes.
IEC-60439 (P1 & 2)	-	Low Voltage Swtichgear and control gear assemblies
ANSI-C37.20	-	Switchgear Assemblies, including metal enclosed bus.
ANSI-C37.50	-	Test Procedures for Low Voltage Alternating Current Power Circuit Breakers
ANSI-C39	-	Electric Measuring instrument
ANSI-C83	-	Components for Electric Equipment
IS: 8623: (Part I to 3)	-	Specification for Switchgear & Control Assemblies.
NEMA-AB	-	Moulded Case Circuit and Systems
NEMA-CS	-	Industrial Controls and Systems
NEMA-PB-1	-	Panel Boards
NEMA-SG-5	-	Low voltage Power Circuit breakers
NEMA-SG-3	-	Power Switchgear Assemblies
NEMA-SG-6	-	Power switching Equipment
NEMA-5E-3	-	Motor Control Centers
1248 (P1 to P9)	-	Direct acting indicating analogue electrical measuring instruments & their accessories.

Disconnecting switches

IEC-60129	-	Alternating Current Disconnectors (Isolators) and Earthing switches
IEC-1129	-	Alternating Current Earthing Switches Induced Current switching
IEC-60265 (Part 1 & Part 2)	-	High Voltage switches
ANSI-C37.32	-	Schedule of preferred Ratings, Manufacturing Specifications and Application Guide for high voltage Air Switches, Bus supports and switch accessories
ANSI-C37.34	-	Test Code for high voltage air switches
NEMA-SG6	-	Power switching equipment

PLCC and line traps

IS-8792	-	Line traps for AC power system.
IS-8793	-	Methods of tests for line traps.
IS-8997	-	Coupling devices for PLC systems.
IS-8998	-	Methods of test for coupling devices for PLC systems.
IEC-60353	-	Line traps for A.C. power systems.
IEC-60481	-	Coupling Devices for power line carrier systems.
IEC-60495	-	Single sideboard power line carrier terminals
IEC-60683	-	Planning of (single Side-Band) power line carrier systems.
CIGRE	-	Teleprotection report by Committee 34 & 35.
CIGRE	-	Guide on power line carrier 1979.
CCIR	-	International Radio Consultative Committee
CCITT	-	International Telegraph & Telephone Consultative Committee
EIA	-	Electric Industries Association

Protection and control equipment

IEC-60051 : (P1 to P9)	-	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories.
IEC-60255 (Part 1 to part 23)	-	Electrical relays.
IEC-60297 (P1 to P4)	-	Dimensions of mechanical structures of the 482.6mm (19 inches) series.
IEC-60359	-	Expression of the performance of electrical & electronic measuring equipment.
IEC-60387	-	Symbols for Alternating-Current Electricity meters.
IEC-60447	-	Man machine interface (MMI) - Actuating principles.
IEC-60521	-	Class 0.5, 1 and 2 alternating current watt hour metres
IEC-60547	-	Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)
ANSI-81	-	Bolts and Nuts
ANSI-C37.1	-	Relays, Station Controls etc.
ANSI-C37.2	-	Manual and automatic station control, supervisory and associated Telemetering equipment
ANSI-C37.2	-	Relays and relay systems associated with electric power apparatus
ANSI-C39.1	-	Requirements for electrical analog indicating instruments

MOTORS

IS-325	-	Three phase induction motors.
IS-4691	-	Degree of protection provided by enclosure for rotating electrical machinery.
IEC-60034 (P1 to P19:)	-	Rotating electrical machines
IEC-Document 2	-	Three phase induction motors (Central Office)
NEMA-MGI		Motors and Generators

Electronic equipment and components

MIL-21B, MIL-833 & MIL-2750
IEC-60068 (P1 to P5) Environmental testing
IEC-60326 (P1 to P2) : Printed boards
Material and workmanship standards

IS-1363 (P1 to P3) product grade C.	-	Hexagon headbolts, screws and nuts of
IS-1364 (P1 to P5)	-	Hexagon head bolts, screws and nuts of products grades A and B.
IS-3138	-	Hexagonal Bolts and Nuts (M42 to M150)
ISO-898	-	Fasteners: Bolts, screws and studs
ASTM	-	Specification and tests for materials

Clamps & connectors

IS-5561	-	Electric power connectors.
NEMA-CC1	-	Electric Power connectors for sub station
NEMA-CC 3	-	Connectors for Use between aluminium or aluminum- Copper Overhead Conductors

Bus hardware and insulators

IS: 2121	-	Fittings for Aluminum and steel cored Al conductors for overhead power lines.
IS-731	-	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V.
IS-2486 (P1 to P4)	-	Insulator fittings for overhead power lines with a nominal voltage greater than 1000 V.
IEC-60120	-	Dimensions of Ball and Socket Couplings of string insulator units.
IEC-60137	-	Insulated bushings for alternating voltages above 1000 V.
IEC-60168	-	Tests on indoor and outdoor post insulators of ceramic material or glass for Systems with Nominal Voltages Greater than 1000 V.
IEC-60233	-	Tests on Hollow Insulators for use in electrical equipment.
IEC-60273	-	Characteristices of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
IEC-60305	-	Insulators for overhead lines with nominal

		voltage above 1000V-ceramic or glass insulator units for a.c. systems Characteristics of String Insulator Units of the cap and pintype.
IEC-60372 (1984)	-	Locking devices for ball and socket couplings of string insulator units : dimensions and tests.
IEC-60383 (P1 and P2)	-	Insulators for overhead lines with a nominal voltage above 1000 V.
IEC-60433	-	Characteristics of string insulator units of the long rod type.
IEC-60471	-	Dimensions of Clevis and tongue couplings of string insulator units.
ANSI-C29	-	Wet process proelain insulators
ANSI-C29.1	-	Test methods for electrical power insulators
ANSI-C92.2	-	For insulators, wet-process porcelain and toughened glass suspension type
ANSI-C29.8	-	For wet-process porcelain insulators apparatus, post-type
ANSI-G.8	-	Iron and steel hardware
CISPR-7B	-	Recommendations of the CISPR, tolerances of form and of Position, Part 1
ASTM A-153	-	Zinc Coating (Hot-Dip) on iron and steel hardware

Strain and rigid bus-conductor

IS-2678	-	Dimensions & tolerances for Wrought Aluminum and Aluminum Alloys drawn round tube.
IS-5082	-	Wrought Aluminum and Aluminum Alloy Bars. Rods, Tubes and Sections for Electrical purposes.
ASTM-B 230-82	-	Aluminum 1350 H19 Wire for electrical purposes
ASTM-B 231-81	-	Concentric - lay - stranded, aluminum 1350 conductors
ASTM-B 221	-	Aluminum - Alloy extruded bar, road, wire, shape
ASTM-B 236-83	-	Aluminum bars for electrical purpose (Busbars)
ASTM-B 317-83	-	Aluminum-Alloy extruded bar, rod, pipe and structural shapes for electrical purposes(Bus Conductors)

Batteries and batteries charger Battery

IS:1651	-	Stationary Cells and Batteries, Lead-Acid Type (with Tubular Positive Plates)
IS:1652	-	Stationary Cells and Batteries, Lead-Acid Type (with Plante Positive Plates)
IS:1146	-	Rubber and Plastic Containers for Lead-Acid

		Storage Batteries
IS:6071	-	Synthetic Separators for Lead-Acid Batteries
IS:266	-	Specification for Sulphuric Acid
IS:1069	-	Specification for Water for Storage Batteries
IS:3116	-	Specification for Sealing Compound for Lead-Acid Batteries
IS:1248	-	Indicating Instruments

Battery Charger

IS:3895	-	Mono-crystalline Semiconductor Rectifier Cells and Stacks
IS:4540	-	Mono-crystalline Semiconductor Rectifier Assemblies and Equipment.
IS:6619	-	Safety Code for Semiconductor Rectifier Equipment
IS:2026	-	Power Transformers
IS:2959	-	AC Contactors for Voltages not Exceeding 1000 Volts
IS:1248	-	Indicating Instruments
IS:2208	-	HRC Fuses
IS:13947 (Part-3)	-	Air break switches, air break disconnectors & fuse combination units for voltage not exceeding 1000V AC or 1200V DC
IS:2147	-	Degree of protection provided by enclosures for low voltage switchgear and controlgear.
IS:6005	-	Code of practice for phosphating of Iron and Steel
IS:3231	-	Electrical relays for power system protection
IS:3842	-	Electrical relay for AC Systems
IS:5	-	Colours for ready mix paint
IEEE-484	-	Recommended Design for installation design and installation of large lead storage batteries for generating stations and substations.
IEEE-485	-	Sizing large lead storage batteries for generating stations and substations

Wires and cables

ASTMD-2863	-	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)
IS-694	-	PVC insulated cables for working voltages upto and including 1100 Volts.
IS-1255	-	Code of practice for installation and maintenance of power cables, upto and including 33 kV rating
IS-1554 (P1 and P2)	-	PVC insulated (heavy duty) electric cables (part 1) for working voltage upto and including 1100 V.

	-	Part (2) for working voltage from 3.3 kV upto and including 11kV.
IS:1753	-	Aluminium conductor for insulated cables
IS:2982	-	Copper Conductor in insulated cables.
IS-3961 (P1 to P5)	-	Recommended current ratings for cables.
IS-3975	-	Mild steel wires, formed wires and tapes for armouring of cables.
IS-5831	-	PVC insulating and sheath of electric cables.
IS-6380	-	Elastometric insulating and sheath of electric cables.
IS-7098	-	Cross linked polyethylene insulated PVC sheathed cables for working voltage upto and including 1100 volts.
IS-7098	-	Cross-linked polyethyle insulated PVC sheathed cables for working voltage from 3.3kV upto and including 33 kV.
IS-8130	-	Conductors for insulated electrical cables and flexible cords.
IS-1753	-	Aluminum Conductors for insulated cables.
IS-10418	-	Specification for drums for electric cables.
IEC-60096 (part 0 to p4)	-	Radio Frequency cables.
IEC-60183	-	Guide to the Selection of High Voltage Cables.
IEC-60189 (P1 to P7)	-	Low frequency cables and wires with PVC insulation and PVC sheath.
IEC-60227 (P1 to P7)	-	Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V.
IEC-60228	-	Conductors of insulated cables
IEC-60230	-	Impulse tests on cables and their accessories.
IEC-60287 (P1 to P3)	-	alculation of the continuous current rating of
cables (100% load factor).		
IEC-60304	-	Standard colours for insulation for lowfrequency cables and wires.
IEC-60331	-	Fire resisting characteristics of Electric cables.
IEC-60332 (P1 to P3)	-	Tests on electric cables under fire conditions.
IEC-60502	-	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto to 30 kV
IEC-754 (P1 and P2)	-	Tests on gases evolved during combustion of electric cables.

AIR conditioning and ventilation

IS-659	-	Safety code for air conditioning
IS-660	-	Safety code for Mechanical Refrigeration
ARI:520	-	Standard for Positive Displacement RefrigerationCompressor and Condensing Units
IS:4503	-	Shell and tube type heat exchanger
ASHRAE-24	-	Method of testing for rating of liquid coolers

ANSI-B-31.5	-	Refrigeration Piping
IS:2062	-	Steel for general structural purposes
IS:655	-	Specification for Metal Air Dust
IS:277	-	Specification for Galvanised Steel Sheets
IS-737	-	Specification for Wrought Aluminium and Aluminium Sheet & Strip
IS-1079	-	Hot rolled cast steel sheet & strip
IS-3588	-	Specification for Electrical Axial Flow Fans
IS-2312	-	Propeller Type AC VentilationFans
BS-848	-	Methods of Performance Test for Fans
BS-6540 Part-I	-	Air Filters used in Air Conditioning and General Ventilation
BS-3928	-	Sodium Flame Test for Air Filters (Other than for Air Supply to I.C. Engines and Compressors)
US-PED-2098	-	Method of cold DOP & hot DOP test
MIL-STD-282	-	DOP smoke penetration method
ASHRAE-52	-	Air cleaning device used in general ventilation for removing particle matter
IS:3069	-	Glossary of Terms, Symbols and Units Relating to Thermal Insulation Materials.
IS:4671	-	Expanded Polystyrene for Thermal Insulation Purposes
IS:8183	-	Bonded Mineral Wool
IS:3346	-	Evaluation of Thermal Conductivity properties by means of guarded hot plate method
ASTM-C-591-69	-	Standard specification for rigid preformed cellular urethane thermal insulation
IS:4894	-	Centrifugal Fans
BS:848	-	Method of Performance Test for Centrifugal Fans
IS:325	-	Induction motors, three-phase
IS:4722	-	Rotating electrical machines
IS:1231	-	Three phase foot mounted Induction motors, dimensions of
IS:2233	-	Designations of types of construction and mounting arrangements of rotating electrical machines
IS:2254	-	Vertical shaft motors for pumps, dimensions of
IS:7816	-	Guide for testing insulation resistance of rotating machines
IS:4029	-	Guide for testing three phase induction motors
IS:4729	-	Rotating electrical machines, vibration of, Measurement and evaluation of
IS:469	-	Degree of protection provided by enclosures for rotating electrical machinery
IS:7572	-	Guide for testing single-phase a.c. motors
IS:2148	-	Flame proof enclosure for electrical apparatus
BS:4999	-	Noise levels

(Part-51)

Galvanizing

IS-209	-	Zinc Ingot
IS-2629	-	Recommended Practice for Hot-Dip galvanizing on iron and steel.
IS-2633	-	Methods for testing uniformity of coating of zinc coated articles.
ASTM-A123	-	Specification for zinc (Hot Galavanizing) Coatings, on products Fabricated from rolled, pressed and forged steel shapes, plates, bars and strips.
ASTM-A-121-77	-	Zinc-coated (Galvanized) steel barbed wire

Painting

IS-6005	-	Code of practice for phosphating of iron and steel.
ANSI-Z551	-	Gray finishes for industrial apparatus and equipment
SSPEC	-	Steel structure painting council

Fire protection system

Fire protection manul issued by tariff advisory committee (TAC) of India

HORIZONTAL CENTRIFUGAL PUMPS

IS:1520	-	Horizontal centrifugal pumps for clear, cold and fresh water
IS:9137	-	Code for acceptance test for centrifugal & axial pumps
IS:5120	-	Technical requirement - Rotodynamic special purpose pumps
API-610	-	Centrifugal pumps for general services - Hydraulic Institutes Standards
BS:599	-	Methods of testing pumps
PTC-8.2	-	Power Test Codes - Centrifugal pumps

DIESEL ENGINES

IS:10000	-	Methods of tests for internal combustion engines
IS:10002	-	Specification for performance requirements for constant speed compression ignition engines for general purposes (above 20 kW)
BS:5514	-	The performance of reciprocating compression ignition (Diesel) engines, utilising liquid fuel only, for general purposes
ISO:3046	-	Reciprocating internal combustion engines performance
IS:554	-	Dimensions for pipe threads where pressure tight joints are required on threads
ASME Power Test Code	-	Internal combustion engine PTC-17

- Codes of Diesel Engine Manufacturer's Association, USA

PIPING VALVES & SPECIALITIES

IS:636	-	Non percolating flexible fire fighting delivery hose
IS:638	-	Sheet rubber jointing and rubber inserting jointing
IS:778	-	Gun metal gate, globe and check valves for general purpose
IS:78	-	Sluice valves for water works purposes (50 to300 mm)
IS:901	-	Couplings, double male and double female instantaneous pattern for fire fighting
IS:902	-	Suction hose couplings for fire fighting purposes
IS:903	-	Fire hose delivery couplings branch pipe nozzles and nozzle spanner
IS:1538	-	Cast iron fittings for pressure pipes for water, gas and sewage
IS:1903	-	Ball valve (horizontal plunger type) including floats for water supply purposes
IS:2062	-	SP for weldable structural steel
IS:2379	-	Colour Code for the identification of pipelines
IS:2643	-	Dimensions of pipe threads for fastening purposes
IS:2685	-	Code of Practice for selection, installation and maintenance of sluice valves
IS:2906	-	Sluice valves for water-works purposes (350to 1200 mm size)
IS:3582	-	Basket strainers for fire fighting purposes (cylindrical type)
IS:3589	-	Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
IS:4038	-	Foot valves for water works purposes
IS:4927	-	Unlined flax canvas hose for fire fighting
IS:5290	-	Landing valves (internal hydrant)
IS:5312	-	Swing check type reflex (non-return) valves(Part-I)
IS:5306	-	Code of practice for fire extinguishing installations and equipment on premises
Part-I	-	Hydrant systems, hose reels and foam inlets
Part-II	-	Sprinkler systems
BS:5150	-	Specification for cast iron gate valves

MOTORS & ANNUNCIATION PANELS

IS:325	-	Three phase induction motors
IS:900	-	Code of practice for installation and maintenance of induction motors
IS:996	-	Single phase small AC and universal electric motors
IS:1231	-	Dimensions of three phase foot mounted induction motors
IS:2148	-	Flame proof enclosure of electrical apparatus

IS:2223	-	Dimensions of flange mounted AC induction motors
IS:2253	-	Designations for types of construction and mounting arrangements of rotating electrical machines
IS:2254	-	Dimensions of vertical shaft motors for pumps
IS:3202	-	Code of practice for climate proofing of electrical equipment
IS:4029	-	Guide for testing three phase induction motors
IS:4691	-	Degree of protection provided by enclosure for rotating electrical machinery
IS:472	-	Rotating electrical machines
IS:4729	-	Measurement and evaluation of vibration of rotating electrical machines
IS:5572	-	Classification of hazardous areas for electrical (Part-I) installations (Areas having gases and vapours)
IS:6362	-	Designation of methods of cooling for rotating electrical machines
IS:6381	-	Construction and testing of electrical apparatus with type of protection 'e'
IS:7816	-	Guide for testing insulation for rotating machine
IS:4064	-	Air break switches
IEC DOCUMENT 2 (Control Office) 432	-	Three Phase Induction Motor
VDE 0530 Part I/66	-	Three Phase Induction Motor
IS:9224 (Part-II)	-	HRC Fuses
IS:6875	-	Push Button and Control Switches
IS:694	-	PVC Insulated cables
IS:1248	-	Indicating instruments
IS:375	-	Auxiliary wiring & busbar markings
IS:2147	-	Degree of protection
IS:5	-	Colour Relay and timers
IS:2959	-	Contactors

PG Test Procedures

NFPA -13	-	Standard for the installation of sprinkler system.
NFPA-15	-	Standard for water spray fixed system for the fire protection
NFPA-12A	-	Standard for Halong 1301 Fire Extinguishing System.
NFPA-72E	-	Standard on Antomatic Fire Detectors
		Fire Protection Manual by TAC (Latest Edition)
NFPA-12	-	Standard on Carbon dioxide extinguisher systems.
IS:3034	-	Fire of industrial building: Electrical generating and distributing stations code of practice
IS:2878	-	CO2 (Carbon dioxide) Type Extinguisher
IS:2171	-	DC (Dry Chemical Powder) type

IS:940 - Pressurised Water Type

D.G. SET

IS:10002 - Specification for performance requirements for constant speed compression ignition (diesel engine) for general purposes

IS:10000 - Method of tests for internal combustion engines

IS:4722 - Rotating electrical machines-specification

IS:12063 - Degree of protection provided by enclosures

IS:12065 - Permissible limit of noise levels for rotating electrical machines.

- Indian Explosive Act 1932

Steel structures

IS-228 (1992) - Method of Chemical Analysis of pig iron, cast iron and plain carbon and low alloy steels.

IS-802 (P1 to 3:) - Code of practice for use of structural steel in overhead transmission line towers.

IS-806 - Code of practice for use of steel tubes in general building construction

IS-808 - Dimensions for hot rolled steel beam, column channel and angle sections.

IS-814 - Covered electrodes for manual arc welding of carbon of carbon manganese steel.

IS-816 - Code of Practice for use of metal arc welding for general construction in Mild steel

IS-817 - Code of practice for training and testing of metal arc welders. Part 1 : Manual Metal arc welding.

IS-875
(P1 to P4) - Code of practice for design loads (other than earthquake) for buildings and structures.

IS-1161 - Steel tubes for structural purposes.

IS-1182 - Recommended practice for radiographic examination of fusion welded butt joints in steel plates.

IS-1363
(P1 to P3) - Hexagonal head bolts, screws & nuts of products grade C.

IS-1364 - Hexagon headbolts, screws and nuts of product grades A and B.

IS-1367
(P1 to P18) - Technical supply condition for threaded steel fasteners.

IS-1599 - Methods for bend test.

IS-1608 - Method for tensile testing of steel products.

IS-1893 - Criteria for earthquake resistant design of structures.

IS-1978 - Line Pipe.

IS-2062 - Steel for general structural purposes.

IS-2595 - Code of practice for Radiographic testing.

IS-3063 - Single coil rectagular section spring washers for bolts, nuts and screws.

IS-3664 - Code of practice for ultrasonic pulse echo testing by contact and immersion methods.

IS-7205 - Safety code for erection of structural steel work.
IS-9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.
ANSI-B18.2.1 - Inch series square and Hexagonal bolts and screws
ANSI-B18.2.2 - Square and hexagonal nuts
ANSI-G8.14 - Round head bolts
ASTM-A6 - Specification for General Requirements for rolled steel plates, shapes, sheet piling and bars of structural use
ASTM-A36 - Specifications of structural steel
ASTM-A47 - Specification for malleable iron castings
ASTM-A143 - Practice for safeguarding against embilement of Hot Galvanized structural steel products and procedure for detaching embrilement
ASTM-A242 - Specification for high strength low alloy structural steel
ASTM-A283 - Specification for low and intermediate tensile strength carbon steel plates of structural quality
ASTM-A394 - Specification for Galvanized steel transmission tower bolts and nuts.
ASTM-441 - Specification for High strength low alloy structural manganese vanadium steel.
ASTM-A572 - Specification for High strength low alloy colombium- Vanadium steel of structural quality
AWS D1-0 - Code for welding in building construction welding inspection
AWS D1-1 - Structural welding code
AISC - American institute of steel construction
NEMA-CG1 - Manufactured graphite electrodes

Piping and pressure vessels

IS-1239 (Part 1 and 2) - Mild steel tubes, tubulars and other wrought steel fittings
IS-3589 - Seamless Electrically welded steel pipes for water, gas and sewage.
IS-6392 - Steel pipe flanges
ASME - Boiler and pressure vessel code
ASTM-A120 - Specification for pipe steel, black and hot dipped, zinc-coated (Galvanized) welded and seamless steel pipe for ordinary use
ASTM-A53 - Specification for pipe, steel, black, and hotdipped, zinc coated welded and seamless
ASTM-A106 - Seamless carbon steel pipe for high temperature service
ASTM-A284 - Low and intermediate tensile strength carbonsilicon steel plates for machine parts and general construction.
ASTM-A234 - Pipe fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures
ASTM-S181 - Specification for forgings, carbon steel for general purpose piping
ASTM-A105 - Forgings, carbon steel for piping components
ASTM-A307 - Carbon steel externally threated standard fasteners
ASTM-A193 - Alloy steel and stainless steel bolting materials for high temperature service
ASTM-A345 - Flat rolled electrical steel for magnetic applications

ASTM-A197	-	Cupola malleable iron
ANSI-B2.1	-	Pipe threads (Except dry seal)
ANSI-B16.1	-	Cast iron pipe flangesand glanged fitting. Class 25, 125, 250 and 800
ANSI-B16.1	-	Malleable iron threaded fittings, class 150 and 300
ANSI-B16.5	-	Pipe flanges and flanged fittings, steel nickel alloy and other special alloys
ANSI-B16.9	-	Factory-made wrought steel butt welding fittings
ANSI-B16.11	-	Forged steel fittings, socket-welding and threaded
ANSI-B16.14	-	Ferrous pipe plug, bushings and locknuts with piple threads
ANSI-B16.25	-	Butt welding ends
ANSI-B18.1.1	-	Fire hose couplings screw thread.
ANSI-B18.2.1	-	Inch series square and hexagonal bolts and screws
ANSI-B18.2.2	-	Square and hexagonal nuts
NSI-B18.21.1	-	Lock washers
ANSI-B18.21.2	-	Plain washers
ANSI-B31.1	-	Power piping
ANSI-B36.10	-	Welded and seamless wrought steel pipe
ANSI-B36.9	-	Stainless steel pipe

Other civil works standards

IS-269	-	33 grade ordinary portland cement.
IS2721	-	Galvanized steel chain link fence fabric
IS-278	-	Galvanized steel barbed wire for fencing.
IS-383	-	Coarse and fine aggregates from natural sources for concrete.
IS-432 (P1 and P2)	-	Mild steel and medium tensile steel bars and hard-dawn steel wire for concrete reinforcement.
IS-456	-	Code of practice for plain and reinforced concrete.
IS-516	-	Method of test for strength of concrete.
IS-800	-	Code of practice for general construction in steel.
IS-806	-	Steel tubes for structural purposes.
IS-1172	-	Basic requirements for water supply, drainage and sanitation.
IS-1199	-	Methods of sampling and analysis of concrete.
IS-1566	-	Hard-dawn steel wire fabric for concrete reinforcement.
IS-1742	-	Code of Practice for Building drainage.
IS-1785	-	Plain hard-drawn steel wire for prestressed concrete.
IS-1786	-	High strength deformed Steel Bars and wires for concrete reinforcement.
IS-1811	-	Methods of sampling Foundry sands.
IS-1893	-	Criteria for earthquake resistant design of structures.
IS-2062	-	Steel for general structural purposes.
IS-2064	-	Selection, installation and maintenance of sanitary appliances-code of practices.
IS-2065	-	Code of practice for water supply in buildings.
IS-2090	-	High tension steel bars used in prestressed concrete.

IS-2140 - Standard Galvanized steel wire for fencing.
IS-2470 (P1 & P2) - Code of practice for installation of septic tanks.
IS-2514 - Concrete vibrating tables.
IS-2645 - Integral cement waterproofing compounds.
IS-3025 (Part 1 to Part 48) - Methods of sampling and test (Physical and chemical) for water and waste water.
IS-4091 - Code of practice for design and construction of foundations for transmission line towers and poles.
IS-4111 (Part 1 to P5) - Code of practice for ancillary structures in sewerage system.
IS-4990 - Plywood for concrete shuttering work.
IS-5600 - Sewage and drainage pumps.

National buiding code of India 1970

USBR E12 - Earth Manual by United States Department of the interior Bureau of Reclamation
ASTM-A392-81 - Zinc/Coated steel chain link fence fabric
ASTM-D1557-80 - test for moisture-density relation of soils using 10-lb (4.5 kg) rame land 18-in. (457 mm) Drop.
ASTM-D1586 - Penetration Test and Split-Barrel (1967) - Sampling of Soils
ASTM-D2049-69 - Test Method for Relative Density of Cohesionless Soils
ASTM-D2435 - Test method for Unconsolidated, (1982)
- Undrained Strengths of Cohesive Soils in Triaxial Compression.
BS-5075 - Specification for accelerating Part I Admixtures, Retarding Admixtures and Water Reducing Admixtures.
CPWD - Latest CPWD specifications

ACSR MOOSE CONDUCTOR

IS:6745	Methods for Determination of BS:443-1969 Mass of zinc coating on zinc coated Iron and Steel Articles
IS:8263	Methods for Radio Interference IEC:437-1973Test on High Voltage Insulators NEMA:107-1964 CISPR
IS:209	Zinc Ingot BS:3436-1961
IS:398	Aluminum Conductors for IEC:209-1966
Part – V	Overhead Transmission Purposes
BS:215(Part-II)	Aluminium Conductors galvanized IEC:209- forced extra high
BS:215(Part-II)	voltage (400 kV and above)
IS:1778	Reels and Drums forBS:1559-1949 Bare Conductors
IS:1521	Method for Tensile Testing ISO/R89-1959 of steel wire

IS:2629	Recommended practice for Hot dip Galvanising on Iro and Steel.
IS:2633	Method for Testing Uniformity of coating of zinc Coated Articles.
IS:4826	Hot dip galvanised coatings on round steel wires ASTMA-472-729

GALVANISED STEEL EARTHWIRE

IS:1521	Method for Tensile Testing of Steel Wire ISO/R:89-1959
IS:1778	Reels and Drums for Bare Conductors
IS:2629	Recommended practice forHot Dip Galvanising on Ironand Steel.
IS:2633	Methods for testing Uniformityof Coating of Zinc Coated Articles.
IS:4826	Hot dip Galvanised Coatings ASTM:A 475-72 a on Round Steel Wires BS:443-1969
IS:6745	Method for Determination BS:443-1969of mass of Zinc Coating on Zinc coated Iron and Steel Articles.
IS:209	Zinc ingot BS:3463-1961
IS:398(Pt. I to P5:1992)	Aluminum Conductors for overhead transmission purposes. BS:215 (Part-II)

Lighting Fixtures and Accessories

(i)	IS:1913	General and safety requirements for electric lighting fittings.
(ii)	IS:3528	Water proof electric lighting fittings.
(iii)	IS:4012	Dust proof electric lighting fittings.
(iv)	IS:4013	Dust tight proof electric lighting fittings.
(v)	IS:10322	Industrial lighting fittings with metal reflectors.
(vi)	IS:10322	Industrial lighting fittings with plastic reflectors.
(vii)	IS:2206	Well glass lighting fittings for use under ground in mines (non-flameproof type).
(viii)	IS:10322	Specification for flood light.
(ix)	IS:10322	Specification for decorative lighting outfits.
(x)	IS:10322	Lumanaries for street lighting
(xi)	IS:2418	Tubular flourescent lamps

(xii)	IS:9900	High pressure mercury vapour lamps.
(xiii)	IS:1258	Specification for Bayonet lamp flourescent lamp.
(xiv)	IS:3323	Bi-pin lamp holder tubular flourescent lamps.
(xv)	IS:1534 (Part-I)	Ballasts for use in flourescent lighting fittings.
(xvi)	IS:1569	Capacitors for use in flourescent lighting fittings.
(xvii)	IS:2215	Starters for flourescent lamps.
(xviii)	IS:3324	Holders for starters for tubular flourescent lamps
(xix)	IS:418	GLS lamps
(xx)	IS:3553	Water tight electric fittings
(xxi)	IS:2713	Tubular steel poles
(xxii)	IS:280	MS wire for general engg. purposes

Conduits, Accessories and Junction Boxes

(1)	IS:9537	Rigid steel conduits for electrical wiring
(2)	IS:3480	Flexible steel conduits for electrical wiring
(3)	IS:2667	Fittings for rigid steel conduits for electrical wiring
(4)	IS:3837	Accessories for rigid steel conduits for electrical wiring
(5)	IS:4649	Adaptors for flexible steel conduits.
(6)	IS:5133	Steel and Cast Iron Boxes
(7)	IS:2629	Hot dip galvanising of Iron & Steel.

Lighting Panels

(1)	IS:13947	LV Switchgear and Control gear(Part 1 to 5)
(2)	IS:8828	Circuit breakers for over current protection for house hold and similar installations.
(3)	IS:5	Ready mix paints
(4)	IS:2551	Danger notice plates
(5)	IS:2705	Current transformers
(6)	IS:9224	HRC Cartridge fuse links for voltage above 650V(Part-2)
(7)	IS:5082	Wrought aluminium and Al. alloys, bars, rods, tubes and sections for electrical purposes.
(8)	IS:8623	Factory built Assemblies of Switchgear and Control Gear for voltages upto and including 1000V AC and 1200V DC.
(9)	IS:1248	Direct Acting electrical indicating instrument

Electrical Installation

(1) IS:1293	3 pin plug
(2) IS:371	Two to three ceiling roses
(3) IS:3854	Switches for domestic and similar purposes
(4) IS:5216	Guide for safety procedures and practices in electrical work.
(5) IS:732	Code of practice for electrical wiring installation (system voltage not exceeding 650 Volts.)
(6) IS:3043	Code of practice for earthing.
(7) IS:3646	Code of practice of interior illumination part II & III.
(8) IS:1944	Code of practice for lighting of public through fares.
(9) IS:5571	Guide for selection of electrical equipment for hazardous areas.
(10) IS:800	Code of practice for use of structural steel in general building construction.
(11) IS:2633	Methods of Testing uniformity of coating on zinc coated articles.
(12) IS:6005	Code of practice for phosphating iron and steel.
(13)	INDIAN ELECTRICITY ACT
(14)	INDIAN ELECTRICITY RULES

LT SWITCHGEAR

IS:8623 (Part-I)	Specification for low voltage switchgear and control gear assemblies
IS:13947 (Part-I)	Specification for low voltage switchgear and control gear, Part 1 General Rules
IS:13947 (part-2)	Specification for low voltage switchgear and control gear, Part 2 circuit breakers.
IS:13947 (part-3)	Specification for low voltage switchgear and control gear. Part 3 Switches, Disconnectors, Switch-disconnectors and fuse combination units
IS:13947 (part-4)	Specification for low voltage switchgear and control gear. Part 4 Contactors and motors starters.
IS:13947 (part-5)	Specification for low voltage switchgear and control gear. Part 5 Control-circuit devices and switching elements
IS:13947 (part-6)	Specification for low voltage switchgear and control gear. Part 6 Multiple function switching devices.
IS:13947 (part-7)	Specification for low voltage switchgear and control gear. Part 7 Ancillary equipments
IS:12063	Degree of protection provided by enclosures
IS:2705	Current Transformers
IS:3156	Voltage Transformers

IS:3231	Electrical relays for power system protection
IS:1248	Electrical indicating instruments
IS:722 AC	Electricity meters
IS:5578	Guide for Marking of insulated conductors of apparatus terminals
IS:13703 (part 1)	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC Part 1 General Requirements
IS:13703 (part 2)	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC Part 2 Fuses for use of authorized persons
IS:6005	Code of practice of phosphating iron and steel
IS:5082	Wrought Aluminum and Aluminum alloys for electrical purposes
IS:2633	Hot dip galvanising

ANNEXURE – D

LIST OF DRAWINGS/DOCUMENTS

1. Single Line Diagram
2. Electrical Layout – Plan and Sections
3. Switchyard structural Layout and Section
4. DSLP Calculation and drawing
5. Earthmat Design
6. Short circuit Force and Critical Span Calculations
7. Busbar Design calculations
8. Cantilever Strength calculations
9. Design calculation for Sag – Tension stringing chart
10. GTP and drawings for Bus-Post Insulator
11. Tension/suspension string insulator and Hardware Assembly GTP and drawing
12. Structure Layout (Plan & Section) drawing
13. Soil Investigation Report

14. **Circuit Breakers (400kV, 220kV, 33kV)**
    - GA drawing
    - GTP
    - Type test Reports
15. **CTs (400kV, 220kV, 33kV)**
    - GA drawing
    - GTP
    - Type test Reports
16. **Surge Arrestors (390kV, 216kV, 33kV)**
    - GA drawing
    - GTP
    - Type test Reports
17. **Isolators (400kV, 220kV, 33kV)**
    - GA drawing
    - GTP
    - Type test Reports
18. T**ransformers (400/220kV, 220/33kV) (Applicble for transformer package)**
    - Outline GA drawings
    - Foundation Plan
    - Data Sheet
    - OLTC GA drawing/schematic
    - RTCC GA drawing/schematic
    - OGA and Data sheets for Bushing
    - GA and schematic of Marshalling Kiosk
    - Rating and Diagram Plate
    - Type test Reports
19. **Reactor (Applicable for Reactor Package)**

- Outline GA drawings
- Foundation Plan
- Data Sheet
- OGA and Data sheets for Bushings
- GA and schematic of Marshalling Kiosk
- Rating and Diagram Plate
- Type Test Report

20. **Control and Relay Panels**
- GTP and technical literature
- Type test report of Relays/Relays/Equipments

21. **PLCC**
- GTP and technical literature, type test reports of panels

22. **Civil Works**
- **Control Room Building**

  Structure Design, Foundation Design & Drg., Plinth Beam Design & Drg. and column Design & Drg. upto G.F. Level
- Auto transformer foundation design/drawings
- Reactor foundation design/drawings
- 400 and 220kV Tower foundation design/drawings.

ANNEXURE-A

COMPLIANCE CERTIFICATE OF TECHNICAL SPECIFICATION

The bidder shall confirm compliance to the following by signing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same.

2. There are no deviation(s) with respect to specification other than those furnished in the 'schedule of technical deviations'.

3. Only those technical submittals which are specifically asked for in NIT to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of offer.

4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.

5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

Date: Bidder's Stamp & Signature

ANNEXURE – B

SCHEDULE OF TECHNICAL DEVIATIONS

Bidder shall list below all technical deviation clause wise w.r.t. tender specifications:

S.No.	Technical Section & Page No	Clause No.	Deviation	Reason / Justification

Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date: Tenderer's Stamp & Signature

SECTION 1: CHECKLIST FOR TECHNICAL EVALUATION

Along with the technical offer/ bids, the bidder should submit this checklist confirming the inclusion of the enclosures as listed below,

Sl. No.	Documents to be enclosed	Bidder to confirm (Please tick "Confirmed")
1.	Supporting documents for compliance of Technical Qualifying Requirement.	Confirmed
2.	Unpriced BOQ duly mentioning "Quoted" for all the items, signed and sealed.	Confirmed
3.	Annexure- A duly signed and sealed & Annexure- B duly filled, signed and sealed.	Confirmed

Note: Any bidder not meeting the above requirement shall be liable for non-evaluation.

The above checklist is reviewed and verified for,

NIT Reference No.:

Name of Bidder:

Name of Project:

Date: Bidder's Stamp & Signature