BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT
NOIDA

DOCUMENT NO.	TB-PBTU-DTL-GIS-Part2	Rev 00	Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION	NAME	AK	DKS	VK
TITLE 220kV & 66kV Gas Insulated Switchgear with its accessories		SIGN			
		DATE	05.04.2022	05.04.2022	05.04.2022
		GROUP	TBEM		
		WO No.			

CUSTOMER	Delhi Transco Ltd. (DTL)
PROJECT	Pre Bid Tie up for, Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Sub-Station at Budella, New Delhi (India) on turnkey basis

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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.

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16. EXCLUSION FROM BIDDER'S SCOPE

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.

This section covers bidder's scope for GIS with LCC & its Accessories. The offered GIS with LCC & its Accessories shall comply with the Section-1, 2 & 3 of technical specification.

The complete technical specification comprises of following sections:

Section-1	:	Scope, Project Specific Technical Requirements & Bill of Quantities including scope matrix
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

Please refer Section-1(PART-B) of technical specification.

3. NOTE FOR BILL OF QUANTITIES

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.
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 ±30% 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 regards.
8. Supply scope of Testing & Maintenance Equipment – Scope of supply of following Equipments shall be applicable only if covered in BOQ / BPS.
    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.

Remark: BPS: Bid Price Schedule

4. NOTES ON MODE OF MEASUREMENT

1. The price of Bus-duct inside the GIS hall (upto **outer** wall face of GIS Hall) shall be integral part of the respective bay module and it will not be paid separately. However, the payment of bus-duct for outside the GIS hall along with support structure shall be paid as per running meters in line with provision of Technical Specification & Bid Price schedule.
2. In the case of outdoor type GIS, 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.).
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.

5. SUPPORT STRUCTURE & HARDWARES (INCLUDING STRUCTURE STEEL)

Structural Steel, Support Structure & Hardwares (required for installation 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. 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.
3. Structural steel for complete GIS system with LCC & its Accessories is deemed inclusive in bidder's scope of supply.

6. EARTHING MATERIALS OF GIS

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

1. Supply of 40 mm MS ROD, 75X12 mm GI Flat, 50X06 mm GI Flat is **not in bidder's scope** of supply.
2. All other earthing materials including complete Hardwares, nut, bolts washers, lug etc. required, as per earthing design shall be in bidder's scope of supply.
3. Installation / Erection of earthing will be done by BHEL team under the supervision of bidder/manufacturer, as per manufacturer's design.

7. SCOPE FOR CABLES

1. Power, control & instrumentation cables for **Cabling** (1.) within GIS, (2.) GIS to LCC, (3.) LCC to LCC shall be deemed inclusive in bidder's scope of supply.
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.

8. OTHER GENERAL REQUIREMENTS

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. 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.
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. 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.

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- Equipment Layout with Earthing philosophy
6	GIS- Type Test Reports (Including all GIS equipment)
7	GIS- Quality Assurance Plan & Inspection Test Schedule
LOT-2	
8	GIS- Earthing Design, philosophy, Layout
9	GIS- Secondary Engineering Base Design
10	GIS- Control Schematics for GIS and Local Control Cabinet
11	GIS- Maintenance Equipment Catalogue with Guaranteed Technical Particulars, test reports
12	GIS- Quantification for main Items, Spares, Consumables
13	GIS- Civil Design Specification with Foundation Loading Diagram (Including interfacing details)
14	Other documents as per Technical Specification / BPS / BOQ shall be finalized during detailed engineering stage.
OTHER	
15	GIS- 3D OGA Drawing (3D-Model with complete editable data base) compatible with Autocad & Primtech for complete GIS & its accessories.
16	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

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 free support at site for HV Test Kit i.e. it's unloading, assembling of HV test kit, dismantling & loading back on carrier.
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
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)

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	Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66KV GIS Sub-Station with complete civil works & automation at Budella New Delhi (India) on Turnkey Basis.
Locations	220/66kV Budella, New Delhi (India)

[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- Part2 BOQ_BUDELLA_220kV/ Part2 BOQ_BUDELLA_66kV**
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.

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

SECTION-I

PROJECT

SECTION : 1

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 one new 220/66kV Gas Insulated Substation at Budella, 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 220/66kV switchyard including indoor SF6 gas insulated metal enclosed switchgear (GIS), three nos. 160 MVA Power Transformer with fire protection system (NIFPES), one no. 220kV, 50 MVAR Shunt Reactor. 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.. Lead sheath shall not be allowed in 66kV XLPE cable. Indoor & outdoor End Termination Boxes. Connection of 220kV GIS with transformers, 220kV Line and shunt reactor will be through GIS duct and SF6 to Air bushing. The Bus Duct/cable connection should be such that it is possible to remove transformer for repair/maintenance conveniently. Connection of 66kV GIS with 160MVA Power Transformer will be made through 66kV XLPE cable minimum two run of suitable size, connection of 66kV cable with the 66kV bushings of transformer will be made through Al/Cu bus-bar. The scope of work also covers the 66kV GIS feeder bays termination on H-Pole outdoor arrangement through 66 KV 1x1000 sq. mm cable (single run from 66kV GIS to H-Pole) for outgoing feeder termination. The 66kV XLPE Power cable is of copper conductor. Bidder shall also ensure GIS compatibility for line feeder/cable termination and provide the ancillary equipment required for the same. 11kV Cable (from Metering Cubicle onward) inside the substation 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. 220kV SYSTEM

The 245kV SF6 gas insulated switch gear shall have double bus bar arrangement with 11 bays (3 No. transformer bays + 1 No. Reactor bays + 6 No. feeder bays + 1 No. bus coupler). There shall be provision for 3 no. future bays with adaptor in the GIS building. The SF6 gas insulated switchgear rated for 220kV, 3-phase, 50 HZ shall be of the indoor metal-enclosed type, comprising of following items:

(A) Double bus bar arrangement, 3 phase (isolated) units, 245kV, 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 voltage transformers/PTs.
c. 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) 245kV, 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 multi ratio, 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) 245kV, Transformer/Reactor Circuit Breaker Bay Modules for 160MVA 220/66/11KV Power Transformer bay/ 220kV, 50MVAR Shunt Reactor Bay, each comprising of:

a. One 1600 A, 3-phase, SF_6 gas insulated circuit breaker, complete with operating mechanism.
b. Three 5-core multi ratio, single phase current transformers.
c. Three 3-phase, single pole, group operated isolator switches (1600A), 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. GIS Bus duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc as required.
f. Local control cubicle (if required).

(D) 245kV, Transmission Line 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 multi ratio, 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 SF_6 type Surge Arrestor (single phase).
h. GIS duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
i. Local control cubicle (if required).

(E) 245kV, 1600A, 40kA for 1 Second, SF6 Gas insulated Bus Duct (GIB) for Transformer/ Line feeder/Reactor 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 equipment.

Scope of works also includes 216 kV, 10 kA conventional outdoor type Lighting Arrestor (L.A.), Steel for support structure, ACSR Conductor, Hardware Fittings.

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.

II. 66kV System

72.5kV SF_6 gas insulated switch gear shall have double bus bar arrangement with the following bays:-

S. No	Bay type	Number of bay(s)
1	Transformer/ I/C bays	03
2	Bus-coupler	01
3	feeder bays.	14
5	Total	18

There shall be provision for 5 no. future bays with adaptor in the GIS building. 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), Three -phase or single phase encapsulated 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. Interconnecting wiring/piping

f. Grounding, support structures and platforms
g. Local control cubicle (if required).

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

a. One 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 2500A, 3-phase, single pole, group operated isolator without earthing switch, complete with manual and motor driven operating mechanisms.
d. One 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 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 SF6 gas insulated Surge Arrester.
g. Suitable provision for testing of cable.
h. SF_6 ducts for connection with power transformer through SF6/XLPE cable termination.
i. GIS Cable(s) termination enclosure suitable for connecting 66kV XLPE cable with accessories (The cable shall be designed by the bidder considering 110% continuously loading of 66kV side of the 160MVA Transformer). It shall be minimum two run per phase for 66kV transformer incomer bay.
j. Gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
k. Local control cubicle (if required).

(D) Outgoing 72.5kV Line 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 SF6 type Surge Arrester (single phase).
h. Suitable provision for testing of cable.
i. GIS Cable terminal connection with enclosures suitable for connecting 1x1000 sq.mm XLPE cable and accessories. However, actual size shall be finalized during detailed engineering.

j. Gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
k. Local control cubicle (if required).

(E) The scope of work also covers connection of 66kV GIS with 160MVA Power Transformer through single phase SF6 / XLPE cable minimum two run per phase. The 66 kV cable shall be designed by the bidder considering 110% continuously loading of 66kV side of the 160MVA Transformer including indoor, outdoor termination and connection with 66kV bushings of transformer through Al/Cu bus-bar. The outdoor type Lightening Arrestor (L.A.) 60KV 10KA, with surge/discharge counter, milli-ampere meter and suitable terminal connectors etc shall also be in the scope of work.

(F) The scope of work also covers the 66kV GIS feeder bays termination on H-pole outdoor arrangement through 66kV 1x1000 sq. mm. cable including indoor & outdoor termination (single run from 66kV GIS to H-Pole) & H-Pole for outgoing feeder termination.

III. The scope includes supply, erection, Testing & Commissioning of 03 nos. 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. The RTCC panel shall be placed inside the DTL control room or as per the requirement of site in-charge.

IV. Complete sub-station automation system based on IEC 61850 including hardware and software for remote control station, relay and protection system along with associated equipments and kiosk for following bays (bay as defined in technical specification, section _ sub-station automation):

- 220kV: 11 bays + provision of 3 future bays with adaptor
- 66 kV : 18 bays + provision of 5 future bays with adaptor

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.

V. Complete relay and protection system.

VI. Bus post Insulators, insulator strings and hardwares, clamps & connectors, terminal connector, Conductor, earth wire and earthing materials, tubular conductor, spacers, cable supporting angles/channels, Cable trays & covers, Junction box, buried cable trenches etc.

VII. One no. 1000kVA, 11kV/433V LT Transformer having 170kVp BIL at 11kV side including bushings, accessories and first filling of oil & One no. 1000KVA, 11kV/433V LT Transformer having 95kVp BIL at 11kV side including bushings, accessories and first filling of oil.

VIII. Fire Detection, Alarm & Protection for GIS room and control room building, DG Set etc. (refer Annexure-VIII).

IX. Air Conditioning System as per specification in section substation automation system.

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

XI. LT switchgear.

XII. 250KVA Outdoor Silent type DG Set.

XIII. 220V Batteries & Battery Chargers.

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

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

XVI. Complete lighting and illumination of the installation. This shall include the illumination for GIS Building, control room building including street lights (if any). The specification for control room GIS building illumination shall be as per Annexure-IV.

XVII. Provision of CCTV camera for complete supervision of 220kV/66kV GIS hall, main entrance gate of substation, battery charger room, LT room, outdoor camera for monitoring of transformers 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.

XVIII. Special Equipments for testing and maintenance.

XIX. Bidder shall arrange suitable provision for testing of 220kV and 66kV cables after isolation from the main GIS. Provision for space for termination of cable/ Overhead line shall be kept during designing stage.

XX. Purchaser's site office and stores are in the scope of the bidder along with adequate illumination.

XXI. Bidder has to submit a 'Model' of the substation before starting actual work at site.

XXII. Mandatory Spares.

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

XXIV. 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.

XXV. The scope of work shall cover in complete conformity with the specifications, the followings:-

A single line schematic of the 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.

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

XXVII. All civil works pertaining to foundations for transformers, accessories and NIFPES rail track, soak pit & sump pit, fire resistant wall, grating etc. shall be in the scope of bidder. The watch and ward of complete site shall be in the scope of bidder.

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

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

i. **Detailed survey and Soil Investigation.**

ii. **Design, Engineering and civil work for:**

a. Buildings for control room and well furnished GIS hall as per details in Section civil works. Each GIS hall shall be provided with EOT crane and the requirement of crane shall be as per clause no. 23.0 of section GIS.
b. DTL site office (Porta cabin with furniture and AC) and store.
c. Foundation of 160 MVA Power Transformers, accessories and NIFPES including rail track, soak pit, sump pit, fire protection wall, grating etc.
d. Foundation of 50 MVAR Shunt Reactor, accessories and NIFPES including rail track, soak pit, sump pit, fire protection wall, grating etc.
e. Foundation of 1000KVA LT transformers.
f. Foundation of 250KVA DG set.
g. Foundation of 220kV & 66kV Surge Arrester.
h. All civil works associated with erection of SF6 gas insulated metal enclosed switchgear including their foundation.
i. Foundation for lighting poles, panels & control cubicles of equipments wherever required.
j. Foundation for H Pole, Lattice and pipe structures.
k. RCC in foundation including earth work in excavating disposal of surplus earth PCC, RCC, reinforcement steel for structures and equipments.
l. All roads including all crossings.
m. RCC frame boundary wall with brick panneling including gate for complete substation.
n. Land Filling.
o. Site surfacing (gravelling) and anti weed treatment of complete switchyard area with provision of anti-termite treatment in control room building.
p. Cable trenches including all types of crossings (including power cable trench).
q. Substation fencing along with gates.
r. Rain Water harvesting.
s. Drainage system in the substation including storm water drainage.
t. Pump house building

u. Lighting cum lightening mast with fixtures
v. Transformer fire walls
w. Demolition/Dismantling of existing building, boundary wall, fencing, Tree cutting, disposal of malba, Petty work etc.
x. Car/Sctoor Parking
y. 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 The Bidder shall keep the provision of service bays for increasing the length of GIS room to meet the future requirement, keeping the width of the building same. GIS building size shall be frozen after considering the requirement of three nos. 220kV GIS future bays with adaptor and five nos. 66kV GIS future bays with adaptor of reputed make & size.

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.

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.

3.8 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.

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
Budella	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

6.1 220/66kV Budella GIS Sub-station (DTL) is a new Gas Insulated Substation. For 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.

6.2 The auxiliary transformers of rating 1000KVA shall be used to feed the substation

auxiliaries.
The 1000 KVA, 11/0.433 kV (170kVp - BIL) auxiliary transformer shall be connected through overhead conductor to the tertiary of any one of the 160 MVA power transformers and shall be located near the power transformer while another 1000KVA (95kVp - BIL) auxiliary 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 purpose.

7.0 ORDER OF PRECEDENCE OF DIFFERENT SECTIONS OF TECHNICAL SPECIFICATION

For the purpose of present scope of work, technical specification shall consist of following sections 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)

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, 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 is 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)

The tertiary winding shall be suitable for connection to LT transformer for auxiliary supply. The details of equipment associated with loading tertiary winding are enclosed as Annexure-III.

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 220kV system shall be suitable for system fault current of 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 220kV and 66kV in respective GIS hall. The enclosure shall be air-conditioned and requirement of air-conditioning shall be as detailed in section Sub-station Automation System.

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 The specification of 66kV XLPE cable required for interconnection between 66kV side of power transformer to 66kV GIS hall is enclosed as Annexure-VI. The formation and the other details shall be finalized during detailed engineering.

12.7 As 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 both GIS during detailed engineering.

12.8 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.

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

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

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

12.12 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/equipments shall be as per TS.

Annexure-I

MANDATORY SPARES FOR GAS INSULATED SWITCHGEAR (GIS)

	220kV & 66 kV GIS Spares	**Quantity**
1.	Cable end termination connection & enclosure, compatible with the main Circuit	1 set (1-ph)
2.	SF6 gas Pressure Relief Devices, 03Nos. of each type	2 sets
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
4.	Coupling device with pressure gauge for connecting Gas handling plant including GIS & Cylinder both	2 sets
5.	Rubber Gaskets, "O" Rings and Seals for SF6 gas of each type	1 set
6.	Molecular filter for SF6 gas with filter bags	20% of total quantity
7.	All types of Control Valves for SF6 gas of each type	1 set
8.	SF_6 gas	20% of total quantity
	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.	
9.	For 3 Phase Enclosure	2 Nos.
10.	For Single phase enclosure	3 Nos.
11.	Bus Support insulator of each type for 3 phase/single phase enclosure.	5% of installed/ used population
12.	SF6 to air bushing of each type rating including fixing arrangement	3 No.
	220 KV SF6 CIRCUIT BREAKER	
13.	Circuit Breaker pole complete of each type & rating complete with interrupter, main circuit, enclosure and Marshalling Box with operating mechanism	3 Nos.
14.	Fixed, moving and arcing contacts including insulating nozzles 3 Nos. of each type/rating of CB	1 set (3 No.)
15.	Rubber gaskets, `O' rings and seals for SF6 gas of each type	1 set
16.	Trip coil assembly with resistor as applicable, 3 Nos. of each rating of CB	2 sets
17.	Closing coil assembly with resistor as applicable, 3 Nos. of each rating of CB	2 sets
18.	Corona rings/cover if applicable	1 set
19.	Relays, Power contactors, push buttons, timers & MCBs etc of each type & rating	1 set
20.	Closing valve assembly, 3 Nos. of each type	2 sets
21.	Trip valve assembly, 3 Nos. of each type	2 sets
22.	Auxiliary switch assembly, 3 Nos. of each type	1 set

23.	Operation Counter, 3 Nos. of each type	1 set
24.	Rupture disc, 3 Nos. of each type	1 set
25.	Spring operated closing mechanism, 1 Nos. of each type, if applicable	1 set
	For Hydraulic Operated Mechanism, if applicable	
26.	Hydraulic operating mechanism with drive motor, 3 Nos. of each type	1 Set
27.	Hydraulic filter, 3 Nos. of each type	1 Set
28.	Hose pipe, 3 Nos. of each type	1 Set
29.	N2 Accumulator, 3 Nos. of each type	1 Set
30.	Pressure transducer, 3 Nos. of each type	1 Set
31.	Valves 3 Nos. of each type	1 Set
32.	Pipe length (copper & steel) 3 Nos. of each size & type	1 Set
33.	Pressure switches 3 Nos. of each type	1 Set
34.	Pressure gauge with coupling device, 3 Nos. of each type	1 Set
35.	Hydraulic oil	20% of total qty. used
36.	Pressure Relief Device, 3 Nos. of each type	2 Set
	66 KV SF6 CIRCUIT BREAKER	
37.	Three phase, Circuit Breaker interrupting chamber complete with all necessary apparatus.	1 no. of each rating
38.	Rubber gaskets, 'O' rings and seals	1 set
39.	Trip coils with resistor.	3 nos.
40.	Closing coils with resistor	3 nos.
41.	Relays, Power contactors, push buttons, timers & MCB etc.	1 set
42.	Closing valve assembly (3no. of each type)	1 no.
43.	Trip valve assembly (3no. of each type)	1 no.
44.	Auxiliary switch assembly	1 no.
45.	Operation Counter	1 no.
46.	Rupture disc/diapharm	1 no.
	220KV GIS Isolator	
47.	Complete set of 3 nos. of single phase / one no. of 3-phase dis-connector including main circuit, enclosure, driving mechanism.	1 Set
48.	3 no. of single phase / one no of 3-phase Earthing switch including main circuit, enclosure, driving mechanism.	1 Set
49.	Copper contact fingers for dis-connector male & female contact – for one complete (3 phase) dis-connector of each type and rating.	1 Set
50.	Copper contact fingers for earthing switch male & female contacts, for one complete (3 phase) earthing switch of each type and rating	1 Set
51.	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
52.	Push button switch.-each type, as applicable	1 Set

53.	Limit switch and Aux. Switches for complete 3 phase equipment	1 Set
54.	Motor with gear assembly for complete 3 phase equipment	1 Set
55.	For isolator	3 Set
56.	For earth switch	1 Set
57.	Hinge pins for complete 3 phase equipment	1 Set
58.	Relays, Power contactors, resistors, fuses, push buttons & MCBs (complete for one 3 phase equipment)	3 no
59.	Aux. switch assembly (complete) with 10 NO & 10 NC OR more contacts for both isolator & earth switch	1 Set
	66 KV GIS ISOLATORS & E/Switch	
60.	Three ph, Disconnecting Switch internal parts, complete with all necessary gaskets, mounting hardware, etc.	1 set.
61.	Three ph, Disconnecting Switch operating mechanism, complete with all necessary connecting apparatus.	1 set.
62.	Three ph., Grounding Switch internal parts, complete with all necessary gaskets, mounting hardware etc	1 set.
63.	Three ph., Grounding Switch operating mechanism, complete with all necessary connecting apparatus.	1 set.
	220KV GIS CURRENT TRANSFORMER	
64.	Complete CT of each type and rating with packing.	2 Nos.
65.	Secondary bushing of each type	2 Set
	66KV GIS CURRENT TRANSFORMER	
66.	Single phase current transformers of each rating with packing.	no. of each rating
	220 kV GIS Voltage Transformer	
67.	Complete PT of each type and rating	1 No.
	66 kV GIS Voltage Transformer	
68.	Three phase VT complete with all Gaskets and mounting hardware.	1 no. of each rating
	220kV GIS SURGE ARRESTOR	
69.	Complete L.A. of each type and ratings with insulating base, terminal connector, , Surge counter & accessories	1 No.
	66kV GIS SURGE ARRESTOR	
70.	Complete L.A. including insulating Base with Surge counter & accessories.	1 no.
	DG Set	
71.	Set of Fuel filter (each type)	1 set
72.	Solenoid Coil Assembly	1 No.
73.	Self Starter assembly with clutch engaging and disengaging arrangements complete with motors	1 No.

74.	Lube Oil pressure safety control)	1 No.
75.	High water temp. safety control	1 No.
76.	Diode	1 No.
	BATTERY	
77.	Spare Battery Cell	5 No.
78.	Terminal connectors with nuts & bolts	10 No.
	BATTERY CHARGER	
79.	Set of control cards (All PCB cards)	1 set
80.	Set of relays	1 set
81.	Set of contractor	1 set
82.	Micro-switches (if applicable)	1 set
83.	Filter Capacitor	1 set
84.	Three phase full wave bridge rectifier (Thyristor/Diode)	1 set
85.	Set of wound resistor (if applicable)	1 set
86.	Set of switches	1 set
87.	Potentiometer	1 set
88.	Fuses of Thyrister with indicator	1 set
	Relay & Protection Spare (for each voltage class)	
	Breaker Relay Panel	
89.	Breaker failure Relay	1 No
90.	Trip Circuit Supervision Relay	2 No
91.	Self Reset Trip Relay of each type (if applicale)	1 No
92.	Timer Relay of Each type (if applicale)	1 No
93.	DC Supervision Relays (if applicale)	1 No
	Line Protection Panel Equipments Spares	
94.	Main 1 Numerical Distance Relay (Excluding External Trip Relays)	1 Set
95.	Main 2 Numerical Distance Relay (Excluding External Trip Relays)	1 Set
	Transformer Protection Panel	
96.	Transformer Differential Protection Relay Including all AUX. CTs (if applicale)	1 No
97.	Restricted Earth Fault Protection Relay with Non Linear Resitor (if applicale)	1 No
98.	Backup Protection Relay with Three O/C and E/F Element	1 No
99.	Over Fluxing Relay (if Stand alone)	1 No
100	CVT selection relay (if stand alone)	1 No
101	Over Load Relay with Timer (if Stand Alone)	1 No
	Sub-station Automation System Spare	
102	Bay Control Unit (of each type)	1 No
103	Ethernet Switch of Each type	1 No
104	optical cable with end terminations of each length/type	5 set
105	**Fire Fighting System**	1 LS
106	**Illumination System**	1 LS
107	**LT Switchgear**	1 LS

Annexure-II

List of Drawings for 220/66kV Gas Insulated sub-station Budella

1. Tentative Single Line Diagram of 220/66kV GIS Sub-station **(Annexure-IIA).**
2. Tentative Layout Plan of 220/66kV GIS Sub-station - Land Area and Location **(Annexure-IIB)**.
3. Tentative SAS Architecture (In section-13: Substation Automation,)

Annexure-III

TECHNICAL PARAMETERS FOR TERTIARY LOADING EQUIPMENTS FOR 160 MVA TRANSFORMER

A. **36kV, outdoor type, SF6 Circuit Breaker Technical Parameters**

a) Rated Current (A) – 630
b) Insulation level - BIL- 170kVpeak
c) Short time rating – 31.5KA for 1 sec.
d) The circuit breaker shall be provided with the provision of local and remote operation.

B) 33kV, outdoor type, Current Transformer Technical Parameters

a) Ratio: 400-200-100/1-1-1A
Core-I Metering
Core-II PS class
Core-III PS class
b) Insulation level - BIL- 170kVpeak
c) Short time rating – 31.5KA for 1 sec.
d) Class - 0.2S – metering
e) VA burden - 20 each

C) 11kV, outdoor type, Potential Transformer Technical Parameters

a) Ratio - 11kV/√3 / 110V/√3/110V/√3.
b) Insulation level - BIL- 170kVpeak
c) Class - 0.2 – metering
3P - open delta protection
d) VA burden - 20 each

D) 33kV, outdoor type, isolator with earth switch Technical Parameters

a) Isolator shall be horizontally mounted MOM type with local and remote operation.
b) Insulation level - BIL- 170kVpeak
c) Short time rating – 31.5KA for 1 sec.

E) 11 kV Surge Arrester

The rating of surge arrester shall be finalized during detailed engineering.

F) Control & Relay protection scheme

The control & relay panel for tertiary shall be mounted either in 33kV incomer panel or in separate panel. Tertiary control shall also be monitored through sub-station automation system, however, various items are required for control & relay panel is as follows:-

i) One Multifunction Meter.
ii) One Static Tri- vector meter 0.2 Class, ABT compliant.
iii) One Control switch for circuit breaker operation.
iv) LED for C.B/ Isolator closed/ open position in red and green colour.
v) Alarm and LED for DC failure.
vi) One painted mimic bus equipped with symbols and semaphore indicators to represent breaker position.
vii) LED for auto trip in amber colour.
viii) LED blue coloured for C.B. spring charged condition (if required).
ix) DC supervision scheme.
x) Push button and bulb for on demand checking of trip circuit healthy for ON/OFF position with relay.
xi) Static O/C and E/F relay.
xii) Inverse characteristic Neutral unbalance voltage relay.
xiii) Bell operation on DC.
xiv) Buzzer operating on 230V A.C.
xv) Push button for alarm cancellation.
xvi) Test terminal block for testing of meters.
xvii) Set of auxiliary relays and tripping relays required to complete the scheme.
xviii) A.C failure relay.

G) The sub-station auxiliary supply is normally met through a system having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system

of any equipment, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation system shall also conform the parameters as indicated in the following.

Normal Voltage	Variation in Voltage	Frequency in Hz	Phase/Wire	Neutral connection
415V	+/- 10%	50 +/- 5%	3/ 4 Wire	Solidly Earthed.
240V	+/- 10%	50 +/- 5%	1/2 Wire	Solidly Earthed.
220V	190V to 240V	DC	2 wire	Isolated System

Combined variation of voltage and frequency shall be limited to +/- 10%.

Annexure-IV

LIGHTING SPECIFICATION

A. GENERAL

1. GIS BUILDING

The GIS Building main halls will be illuminated using enclosed type high bay, luminaries having 250 watt metal halide fixtures along with surface mounted 1x60W GLS down lighters for emergency areas. Use of LED based low power consumption luminaries to achieve desired lux level specified can also be used as finalized during detailed engineering.

2. CONTROL ROOM LIGHTING

i. Control room area will be illuminated using mirror optics luminaries, which have superb glare control, the luminaries will have Cat II mirrors. Philips TBS 088 / 236 C5 HF or equivalent.

ii. In addition to mirror optics luminaries CFL down lighter with turbo louvers will be used. The luminaries would be suitable for 2XPL 16 Watt Lamp.

iii. For non false ceiling areas, the illumination will be carried out using 2x28 Watt lamps with industrial reflector Philips TMS 122 / 228 HF or equivalent.

iv. DC Emergency Lighting in non false ceiling areas to be carried out with surface mounted down lighters.

v. For all areas necessary exit sign lights and minimum 4 nos portable emergency lights will be provided.

vi. Use of LED based low power consumption luminaries to achieve desired lux level specified can also be used as finalized during detailed engineering.

3. Following Average Lux Levels will be maintained :

S. No.	Description	Lux	Uniformity
i.	Control Room	350 Lux	0.8
ii.	GIS Building	200 Lux	0.7
iii.	Offices	300 Lux	0.8
iv.	Indoor areas other	150 Lux	0.7

4. Control :

Sufficient number of occupancy and light level sensors shall be provided subject to following minimum requirement:

Sl. No.	Area	No. of Occupancy Sensor	No. of Light Level Sensor
1	Control Room	1	1
2	Conference Room	1	1
3	Room For Engineers	4	---
4	Room for Non-executive	1	---
5	S/Stn. In-charge Room	1	---
6	Electronic Lab	1	1
8	220kV GIS Hall	---	4
9	66kV GIS Hall	---	4

No occupancy sensor and light level sensors are envisaged for ACDB room, DCDB room, Lobby, Corridor and DG set. Each light level sensor shall be provided to measure and regulate lighting. The light level sensor shall be used to achieve bank switching. Each occupancy sensor shall be used for indoor use with time delay programmable in the minimum range of 1 sec. to 2 Hour to control the illumination in the area.

B. Technical specifications for LED Luminaries for Control Room, GIS Building ETC. Illumination

1. SCOPE

This specification covers the general requirements of design, engineering, and manufacture, assembly, testing at manufacturer's works, packing and delivery at site of the energy efficient LED

outdoor lamps along with associated LED drivers, fixtures and other accessories for switchyard lighting in Substations.

2. APPLICABLE STANDARDS & CODES

LED Street Light shall be designed, manufactured and tested in accordance with the latest applicable Indian Standard and IEC standard as listed below –

Standard Code	Standard Description
IS 16101 : 2012	General Lighting -LEDs and LED modules – Terms and Definitions
IS16102(Part 1) 2012	Self-Ballasted LED Lamps for General Lighting Services, Part 1 Safety Requirements
IS16102(Part 2) 2012	Self-Ballasted LED Lamps for General Lighting Services, Part 2 Performance Requirements
IS16103(Part 1) 2012	Led Modules for General Lighting, Part 1Safety Requirements
IS16103(Part 2) 2012	Led Modules for General Lighting, Part 2 Performance Requirements
IS15885(Part2/Sec13)	Safety of Lamp Control Gear , Part 2 Particular Requirements , Section 13 dc. or ac. Supplied Electronic Control gear for LED Modules
IS16104 : 2012	d.c. or a.c. Supplied Electronic Control Gear for LED Modules -Performance Requirements
IS16105 : 2012	Method of Measurement of Lumen Maintenance of Solid State Light (LED) Sources
IS16106 : 2012	Method of Electrical and Photometric Measurements of Solid-State Lighting (LED) Products
IS 16107(Part 1)2012	Luminaries Performance ,Part 1 General Requirements
IS 16107(Part 2)2012	Luminaries Performance, Part 2 Particular Requirements, Section 1 LED Luminaries
IS 16108 : 2012	Photo biological Safety of Lamps and Lamp Systems
IS 10322 : 2012	Luminaries: Part 5 Particular requirements, Section 3 Luminaries for road and street lighting
IEC 62612	Self-ballasted LED lamps for general lighting services for voltage above 50 V — Performance requirements
IEC : 60598-2-3	Particular requirements - Luminaries for road and street Lighting
IEC 62471	Photo biological safety of lamps and lamp systems
IEC 62778	Application of IEC 62471 for the assessment of blue light hazard to light sources and luminaries
IEC 61000-4-5	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
IEC/PAS 62717	Performance requirements – LED modules for general lighting
IEC/PAS 62722	Performance requirements – LED luminaires for general lighting

Material conforming to other internationally accepted standards, which ensure equal or better quality than the standards mentioned above would also be acceptable. In case the bidder who wishes to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Four copies of such standards with authentic English translations shall be furnished along with the offer.

3. CLIMATIC CONDITIONS:

The equipment covered under this specification is for outdoor installation and the climatic conditions that are prevailing at the sites in Delhi.

1.	Reference ambient temperature:	43.3 º C as per IS 9676
2.	Maximum ambient air temperature	50ºC
3.	Maximum daily average ambient temp	40^{o}C
4.	Maximum Relative Humidity	100%
5.	Minimum Relative Humidity	10%
6.	Average annual rainfall	750 mm
7.	Average no. of rainy day	50
8.	Average no. of thunderstorm days per annum	40

9.	Altitude	Not exceeding 300 meters
10.	Rain months	June to Oct.
11.	Wind pressure as per IS 875	195 Kg/Sq. meters up to 30 meters

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.

4. Technical Design & construction Parameters:

S.No.	Technical Particulars	Required technical parameters	
A	**Fitting (Luninairs)**	**LED Switch Yard Lighting**	
1.	Distribution	Type-II	
	Usage hours	Dusk to dawn (12 hours)	
2.	Lens Type	Polycarbonate	
	Beam angle	120 Degree-min	
3.	Working Humidity	**10-100% RH 1**	
	Working temperature	**-10 to 50 °c**	
4.	Wattage (System wattage)	100W ± 5%	150W ± 5%
5.	Luminary efficacy as per LM-79	>100 Lumen/watt	>100 Lumen/watt
6.	Minimum Lumens of Fitting	Minimum 12000Lumens	Minimum 15000 Lumens
7.	Pole entry dia	50-60 mm	50-60mm
8.	Luminaries protection	Class 1	
9.	Maximum variation allowed in luminary light output (lumen) throughout in the input operating voltage range	The voltage variations/fluctuations in the specified voltage range shall not impinge upon the lumen it produces. Maximum variation +/-2% is allowed in luminary light output (lumen) throughout in the input operating voltage range.	
10.	Input Voltage	240 Volts +/- 10%	
11.	Input Frequency	50Hz +/-3%	
12.	Operating voltage range	120-270V	
13.	Power Factor	≥0.95	
14.	Overall total harmonic distortion	<10% as per EN 55015 or EN 61000-3-2	
15.	Surge protection	≥10kv inbuilt or "5KV internal (inbuilt) and 5KV external" with NABL Lab test report	
16.	Index of protection level for optical & control gear	IP 66	
17.	Impact resistance	≥IK07	
18.	Housing	Single piece Corrosion free High Pressure aluminum die cast with manufacturer's embossed/engraved. The luminaries shall be built in such a way that it can withstand wind speed of150kmph. NABL accredited lab report supporting the same shall be furnished by the manufacturer.	
19.	Driver Housing	Integral	
20.	The luminaries should meet the standard	IEC 60598-1	
21.	Cover/Glass	UV stabilized poly carbonate/Toughened glass	
22.	Screw/faster & clamps	Stainless Steel	
23.	Type Tests report as per IS : 10322 Part 5 sec-3/IEC : 60598-2-3	From NABL accredited TPL (IP classification is IP 66, INSITU/Junction temp measurement shall be part of Thermal test)	
24.	Test report as per LM79/IS:16106	From ILAC/MRA/NVLAP/KOLAS/EPA/NABL accredited TPL (IP classification is IP 66)	

25.	Test report for IK07	As per IS 10322
26.	Test report with summary for compliance as per tender parameters (Operating voltage, Constant light output, Luminous flux per watt, CCT, CRI, Uniformity calculation, P.F, Wattage.	For LED parameters like lumen per watt, CCT, CRI, Beam Angle from LED Manufacturer or TPL.
27.	LM80/IS:16105 report	From ILAC/MRA/NVLAP/LOLAS/EPA/NABL accredited Manufacturer or TPL.
28.	Conformation standards of luminaire (Test reports of luminaire)	The luminaire should conform to IEC 60598/IS:10322 The luminarie should be tested as per IEC 60598-2-3:2002/IS:10322 Part 5 Sec-3 standards and following test reports should be submitted from NABL certified TPL TEST REPORT as per IS:10322 part 5 Sec-3/IEC:60598-2-3: Heat Resistance Test, Thermal Test, Ingress Protection Test, Drop Test. Electrical/Insulation Resistance Test, Endurance Test, Humidity Test, Photometry Test (LM79 report), Vibration Test.
B)	**LED**	
1)	Single LED chip for a single category/wattage of product.	Single LED chip is allowed for a single category/wattage of product, mixing of chip is not allowed for single product.
2)	LED Test Report	For LED parameters like Lumen per watt, CCT, CRI, Beam Angle from ILAC/MRA/NVLAP/KOLAS/EPA/NABL accredited Manufacturer or TPL
		LM 80/IS:16105 report from ILAC/MRA/NVLAP/KOLAS/EPA/NABL accredited Manufacturer or TPL
		IEC 62471 and assessment of blue light as per IEC/TR 62778-Ed.1.0
3)	Type of LED	Discrete high power LED with individual lens >1W and <3W
4)	Color Rendering Index (CRI)	>70
5)	CCT	≥ 5700K as per ANSI Bin
6)	Junction temperature	Tj≤85˚ provided Luminary housing temperature rise should not be more than 25^{U} C over ambient temperature after 48 hours continuous operation.
7)	LED Efficacy	>135lm/W
8)	Life expectancy	≥ 60,000 hours at 70% lumen maintenance (LM70)
9)	LED should meet the standard	IEC 62471 2006-07 (photo biological safety of lamps and lamp systems)LM-80 and Assessment of blue light as per IEC/TR 62778.
10)	Light distribution	LED with secondary lens
C	**LED Driver**	
1)	Efficiency	≥85%
2)	Make of Driver	Similar to manufacturer make
3)	LED Driver Test Report	Type Tests report as per IS:15885-Part 5 Sec-13, IS: 16104
		Test Report as per tender specification (Driver Efficiency, >85% THD, < 10% Surge Protection > 10KV)
4)	Life of Driver	≥ 50000 hours
5)	Surge Voltage Protection	≥ 10kv inbuilt or “5KV internal (inbuilt) and 6KV

		external"
6)	Driver Current (Ampere)	≥ 350MA ≤1000mA
7)	Protection	Over voltage, short circuit, open circuit and Reverse polarity, Environmental. Potted with flame retardant thermal potting compound. CE Making, ENCE, RoHS Compliance, UT
8)	Construction	
9)	Driver Certification	
10)	Driver Approval	BIS approved driver with R Number certificate to submitted.
D	**Body & Other Parameters**	
1)	Type of housing (Material & Const.)	Single piece Corrosion free aluminum High Pressure die cast with manufacturer's Embo'ssed/engraved.
2)	Type of Cover/Glass	Toughened glass/UV stabilized Polycarbonate cover
3)	Type of heat Sink	Pressure die cast
4)	IP Protection Class	IP -66
5)	Finish	Polyester Power coated
6)	Screw/fastener & clamps	Stainless steel
7)	Product qualities	The luminaries shall be supplied with lable, giving indication of serial number, model and system lumen pack, nominal CCT, wattage of fitting, Date of Manufacturer, and other labeling details as per IS.
E	**Documents to be submitted**	
1)	5 year Guarantee Certificate	From Manufacturer/OEM.
2)	Test reports (LM 79, LM 80, Type Test Report, Technical Data Sheet, IP	From NABL accredited Third party lab covering NIT specifications.
3)	Copy of Technical Catalogues	
4)	Details of Service Centres	
5)	Photometric Report of fitting	LM 79 report from NABL Lab.
6)	Ref. of IS/IEC (if any) for type test	IS-10322 (Part 5/Sec 3)

5. NAME PLATE & MARKING:

Followings shall be clearly engraved/embossed on the die cast housing of LED Luminaries Housing:

a. Rated voltage or voltage range (marked 'V' or 'Volt');
b. Rated current (marked A' or 'Ampere');
c. Rated wattage (marked 'W' or 'Watts');
d. Rated frequency (marked in 'Hz')
e. Power factor
f. Rated lumen
g. Indian/International Standards to which it is
h. Manufactured
i. Month and year manufacture
j. Customer name as DTL
k. Fitting serial number
l. DTL PO no and date
m. Guarantee period

Following information shall be printed on the Control gear Driver Name plate:-

a. Operation Voltage range
b. Output voltage
c. Guaranteed period
d. DTL PO no. & date
e. Customer name as Delhi Transco Ltd.

6. TESTS:

The LED light must be of type tested from CPRI/ERDA/NABL/Equivalent accredited laboratory in accordance with IS 16102, IS 16103 and IS 16107 (PART-1,PART-2 2012) and reports shall be furnished along with the tender.

All Routine Tests, Acceptance tests shall be carried out in accordance with the relevant IS/IEC with latest in the presence of purchaser representative if so desired by the purchaser.

7. DRAWINGS, DATA & MANUALS TO BE SUBMITTED (FOR INFORMATION ONLY)

7.1	To be submitted along with bid	The bidder has to submit the following documents: a. Catalogues of the selected LED and Luminaire fittings. b. Guaranteed Technical Particulars c. General arrangement drawing of the LED light d. Calculation documents to substantiate choice of the LED and the Luminaire fittings. e. Verifiable Type Test Certificate of the LED and its luminaire carried out on identical Design and type of the unit of the same rating f. An illustrated literature on the LED giving technical information on the operational details and the current ratings, short circuit ratings, derating factors for different types of installation, packing date, weights and other relevant information.
7.2	After award of contract, seller has to submit mentioned drawings for buyer's Approval (A) /Reference (R)	The bidder has to be submit the following documents: a. Guaranteed Technical Particulars b. Calculations to substantiate choice of electrical, mechanical component size / ratings c. General arrangement drawing of the LED street light d. Programme for production & testing e. Detailed installation and commissioning instructions f. Quality Assurance plan
7.3	Submittals required prior to dispatch	a. Inspection and test reports, carried out in manufacturer's work b. Test certificates of all bought out items c. Operation and maintenance instruction as well as trouble shooting charts / manuals.

8. WARRANTY/GUARANTEE PERIOD

The full luminary shall be guaranteed against manufacturing defects, material, workmanship and design for the period of **05 years** from date of receipt of material. The guarantees for replacement of materials/accessories shall be provided free of charge at purchasers premises..The guarantee will be without prejudice to certificate of inspection or material receipt note issued by DTL.

Guarantee Technical particular of LED Luminaries:

S.No.	Technical Particulars	To be submitted by Bidder
A	**Fitting (Luminaries)**	
1)	Make	
2)	Manufacturing address	
3)	Model No.	
4)	Distribution	
5)	Usage hours	
6)	Lens Type	
7)	Beam angle	
8)	Working Humidity	
9)	Working temperature	
10)	Wattage (System wattage)	

11)	Luminary efficacy as per LM-79	
12)	Minimum Lumens of Fitting	
13)	Pole entry dia	
14)	Luminaries protection	
15)	Maximum variation allowed in luminary light output (lumen) throughout in the input operating voltage range	
16)	Input Voltage	
17)	Input Frequency	
18)	Operating voltage range	
19)	Power Factor	
20)	Overall total harmonic distortion	
21)	Surge protection	
22)	Index of protection level for optical & control gear	
23)	Impact resistance	
24)	Driver Housing	
25)	The luminaries standard	
26)	Type Tests report as per IS : 10322 Part 5 sec-3/IEC : 60598-2-3	
27	Test report as per LM79/IS:16106	
28	Test report for IK07	
29)	Test report with summary for compliance as per tender parameters (Operating voltage, Constant light output, Luminous flux per watt, CCT, CRI, Uniformity calculation, P.F, Wattage.)	
30	LM80/IS:16105 report	
31	Conformation standards of luminaire (Test reports of luminaire)	
B	**LED**	
1)	Make of LED	
2	Type of LED	
3	Model No. of LED	
4	Wattage of LED	
5	Number of LED used	
6	Color Rendering Index (CRI)	
7	CCT	
8	Junction temperature	
9	LED Efficacy	
10	Life expectancy	
11	LED Ref standard	
12	Light distribution	
13	Driving Current	
C	**LED Driver**	
1)	Efficiency	
2)	Make of Driver	
3)	LED Driver Test Report	
4)	Life of Driver	
5)	Model No. of Driver	
6)	Surge Voltage Protection	
7)	Driver Current (Ampere)	
8)	Protection	
9)	Construction	
10)	Driver Certification	
11)	Driver Approval	
D	**Body & Other Parameters**	
1)	Type of housing (Material & Const.)	
2)	Type of Cover/Glass	
3)	Type of heat Sink	
4)	IP Protection Class	
5)	Weight of fitting	

ANNEXURE-V

TECHNICAL SPECIFICATION FOR 66kV XLPE CABLE

1.0 TECHNICAL REQUIREMENTS

1.0.1 The cable shall be from the manufacturer who must have designed, manufactured, type tested and supplied in a single contract at least 1 (one) km of single core, 66kV or higher grade XLPE insulated cable which must be in satisfactory operation for at least 2 (two) years on the date of bid opening.

1.0.2 The XLPE insulated, HT cable shall be manufactured & tested in accordance with the IS 7098 Part-III and shall also conform to the requirements of internationally accepted applicable IEC standards for construction and testing. The terminating accessories shall conform to latest relevant IEC.

1.0.3 The cable shall be 66 kV grade, single core, un-armoured, stranded compacted Copper conductor, core screening by a layer of semiconducting tape followed by a layer of semiconducting compound, cross linked polyethylene (XLPE) dry cured insulation, insulation screening with semiconducting compound extruded directly over the insulation, longitudinal sealing by a layer of non woven tape with water swellable absorbent over insulation screen, metallic sheath of such metal/material (except lead/ lead alloy) designed to meet the requirement of the system short circuit rating of 31.5 KA for 1 sec and provide radial moisture barrier & outer jacket of extruded black colored PVC alternatively, PE with anti-termite protection and conforming to the technical particulars of specification.

1.0.4 The construction of cable shall generally conform to the description mentioned at sl no.1.0.2 of the specification. Bidder may offer necessary layers such as separation tape, binder tapes etc additionally as per their manufacturing practices for meeting required performance of the offered cable. The bidder shall enclose with the bid, drawing showing cross section of the cable. The conductors screen (non-metallic semi-conductive) shall be extruded in a single one-time process to ensure homogeneity and absence of voids.

1.0 Type Tests:

2.0.1 The cable shall conform to all type, routine and acceptance tests listed in the relevant IS/IEC.

2.0.2 The cable should have been type tested for all type tests as per latest relevant IEC /IS: 7098 (Part-3) – 1993 including amendments for XLPE insulated HT cable and its report shall be submitted to employer for its acceptance.

2.0.3 The bidder shall submit type test reports for all type test as per clause no. 11.3.2, latest relevant IEC including amendments for employer's acceptance for accessories for 66kV XLPE cable.

3.0 Rating

The cable size shall be suitable to carry the load current at 66 KV continuously followed by a 10% overloading capacity for two hours without exceeding the maximum conductor temperature of 90°C as per latest relevant IEC (The manufacturer shall specify such final temperature which shall ensure that there is no loss of life of the cable insulation). The cable rating size shall be based on loading of 2 Nos. three phase circuits at an ambient temperature of 50°C and soil temperature of 35°C. A complete set of experimentally verified data and calculations made; in arriving at the conductor rating shall be enclosed with the offer.

4.0 Cable Laying and Termination:

66kV, XLPE insulated cable shall be laid from 160MVA transformer to GIS in buried cable trench. The formation and other details shall be finalized during detailed engineering. Single point bonding system shall be employed along with sheath voltage limiters (SVL) if required, to limit the standing voltage to 65V. Laying route along with cable length shall be planned to keep provision of a future cable joint in all cables by providing S bend.

ANNEXURE-VI

TECHNICAL SPECIFICATION OF 33kV CURRENT TRANSFORMER OF RATIO 400-200-100/1-1-1 A for TERTIARY LOADING of 160MVA POWER TRANSFORMER

1.0 **GENERAL**

1.1. The 33 KV Current Transformer shall be out door, of Ratio 400-200-100/1-1-1A complete with terminal connectors.

1.2. The Technical features and construction details of each current transformer shall be in accordance with the requirement stated herein under.

1.3. The equipment quoted under this specification shall conform to the standards specified below unless otherwise specified, the equipment shall conform to the latest applicable IS/IEC.

2.0 STANDARDS

2.1. The design, manufacture and performance of the equipment provided under this specification shall comply with the standards given in the clause 2.2.

2.2

Indian Standard No.	Title
a) IS-2705 (part I to V)	: Specification for current Transformer
b) IS-4201	: Application guide for current Transformer.
c) IS-2099/ IS-5621	: High voltage porcelain Bushings/Hollow Column insulators.
d) IS-731	: Insulator for O/H Power line
e) IS-335	: New insulating oil for transformer and switchgear.
f) IS-9676	: Reference ambient temperature

3.0 SYSTEM PARAMETER

The 33 KV system parameters are as follows:

a) Nominal system voltage:	33 KV
b) Highest system voltage:	36 KV
c) Frequency:	50 Hz.
d) Earthing of the system:	solidly grounded
e) Insulation level:	
i) Impulse voltage withstand	170 KV (P)
ii) Power frequency withstand	70 KV (rms)
f) Short time current rating and its duration	31.5 KA for 1.0 Second

4.0 TECHNICAL PARTICULARS OF CURRENT TRANSFORMERS

4.1. 33 KV C.T. of ratio 400-200-100/1-1-1 A

CORE – I : METERING

a) Secondary Current	1 Amp.
b) Purpose	Metering
c) Rated output	20 VA
d) Class of Accuracy	0.2S
e) Instrument security factor	≤ 5

CORE – II: BACK UP PROTECTION (O/C & E/F)

a) Secondary Current	1 Amp.
b) Purpose	O/C & E/F Protection
c) Min. Knee point voltage VK	$40(R_{ct}+8)$ V
	(Rct.-Resistance of secondary winding)
d) Class of Accuracy	PS
e) Max. exciting current at VK/2	30 mA

CORE – III: TRANSFORMER DIFFERENTIAL PROTECTION

a) Secondary Current	1 Amp.
b) Purpose	Transformer differential
c) Class of Accuracy	PS
d) Min. Knee point voltage VK	$40(R_{ct}+8)$ V
	(Rct.-Resistance of secondary winding)
e) Max. exciting current at VK/2	30 mA

6.0 CONSTRUCTION DETAILS

6.1. The current transformers shall be oil immersed and self cooled outdoor type suitable for the specified services indicated, completed in all respects and in accordance with best engineering practice design and workmanship.

6.2. The core shall be of high grade non ageing, electrical silicon laminated steel of low hysteresis loss high permeability to ensure high accuracy at normal and over current conditions and shall produce undistorted secondary current under transient conditions at all ratios.

6.3. The oil immersed CT shall be hermetically sealed to eliminate breathing and to prevent air and moisture and shall be provided with a pressure relieving device capable to releasing abnormal internal pressure. C.T. shall be provided with oil level gauge, and necessary arrangement for replacing the oil shall be provided.

6.4. The current transformers shall be suitable for simultaneous 100% full load continuous rating of the winding.

6.5. The ratio changing taps shall be provided only on the secondary winding of the C.T.

6.6. The current transformer cores to be used for metering and instrumentation shall be of accuracy class specified and suitable for commercial and industrial metering. The Saturation factor of this core shall be low enough not to cause any damage to measuring instruments in the event of maximum short circuit current.

6.7. Current transformers cores to be used for protective relaying purposes shall be of accuracy class specified, suitable for distance protection, pilot wire protection, differential protection, restricted earth fault protection, over current and earth fault protection. Over current and earth fault for a maximum saturation factor as specified for the highest setting.

6.8. The secondary terminals shall be brought out in a weather proof terminal box (with degree of protection IP55) on the side of the current transformer and shall be accessible through a removable cover. The secondary tap shall be adequately reinforced to withstand normal handling without damage. Suitable cable glands shall be provided to accommodate purchaser's control cables.

6.9. The maximum permissible temperature rise of the windings over the ambient shall not exceed 50^0C.

6.10. The magnetising curve for each core shall be furnished with the tender.

6.11. The secondary terminals shall be provided with short circuiting and earthing arrangements at the terminal block.

6.12. The C.T.s shall be suitable for horizontal as well as vertical transportation.

6.13. The Instrument security factor at all ratios shall be less than 5 for metering cores.

6.14. The C.T. shall be suitable for high speed auto-reclosing.

7.0 INSULATION OIL:

The quality of insulating oil in each transformer shall be best available and the complete specification of the oil shall be furnished in the tender. The current transformers offered shall be hermetically sealed completely filled with insulating oil. The insulating oil shall conform to the latest Indian Standard specification No. 335.

8.0. BUSHINGS / INSULATORS:

i) a) Porcelain used in bushing/Insulator manufacture shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might effect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

b) Glazing of the porcelain shall be of uniform brown colour free from blisters, burrs and similar other defects. Bushings shall be designed to have ample insulation, mechanical strength and rigidity for the conditions, under which they will be used.

ii) When operating at normal rated voltage there will 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 bushings/ Insulator when operating at the normal rated voltage.

iii) All iron parts shall be hot dip galvanized and all joints shall air tight. Surfaces of the joints shall be trued up, porcelain parts by grinding and metal parts by machining. Bushing/ Insulator design shall be such as to ensure a uniform compressive pressure on the joints.

iv) The creepage distance of the bushing /Insulator shall in no case be less than 25mm/KV, suitable for heavily polluted atmosphere.

v) Bushing/ Insulator shall be tested for type tests and routine tests in accordance with stipulation of IS-2099/ IS-5621 Routine as well as type tests reports in conformity with IS-2099/ IS-5621 shall be furnished to the purchaser.

vi) Parameters of Bushings/Insulators:

a)	Rated Voltage	: 36 KV
b)	Impulse withstand voltage	: 170 KVp
c)	Power frequency withstand voltage (dry & wet)	: 70 KV (rms)
d)	Total creepage distance	: 900 mm
e)	Pollution level	: Suitable for Heavily Polluted Atmosphere

9.0 TERMINAL CONNECTORS

9.1. The current transformer offered shall be supplied with indigenous rigid type, Die casted, bimetallic (wherever applicable) terminal connectors suitable for single/double/quad ACSR Zebra conductor as per requirement conforming to IS-5561 for maximum current rating of CT.

9.2. The Neutral current transformer offered shall be supplied with one no. rigid type bimetallic (wherever applicable) terminal connector suitable for connecting to twin 75x12 mm flat of station earth. Also one no. terminal connector for connection to transformer neutral and suitable for ACSR Zebra shall be supplied.

9.3. Suitable terminal connectors for earthing connections shall also be supplied.

10.0 TESTS

10.1 The copies of certificates of all type tests as stipulated in IS: 2705 shall be furnished along with the tender.

10.2 Each current transformer shall be subjected to routine tests as specified in IS: 2705 in the presence of Purchaser's representative if so desired by the Purchaser. All test reports should be submitted and should be approved by the purchaser before dispatch of the equipment

11.0 MARKING

11.1. Rating plate : As per IS-2705 (Part-I)

11.2. Terminal marking: As per IS- 2705 (Part. I)

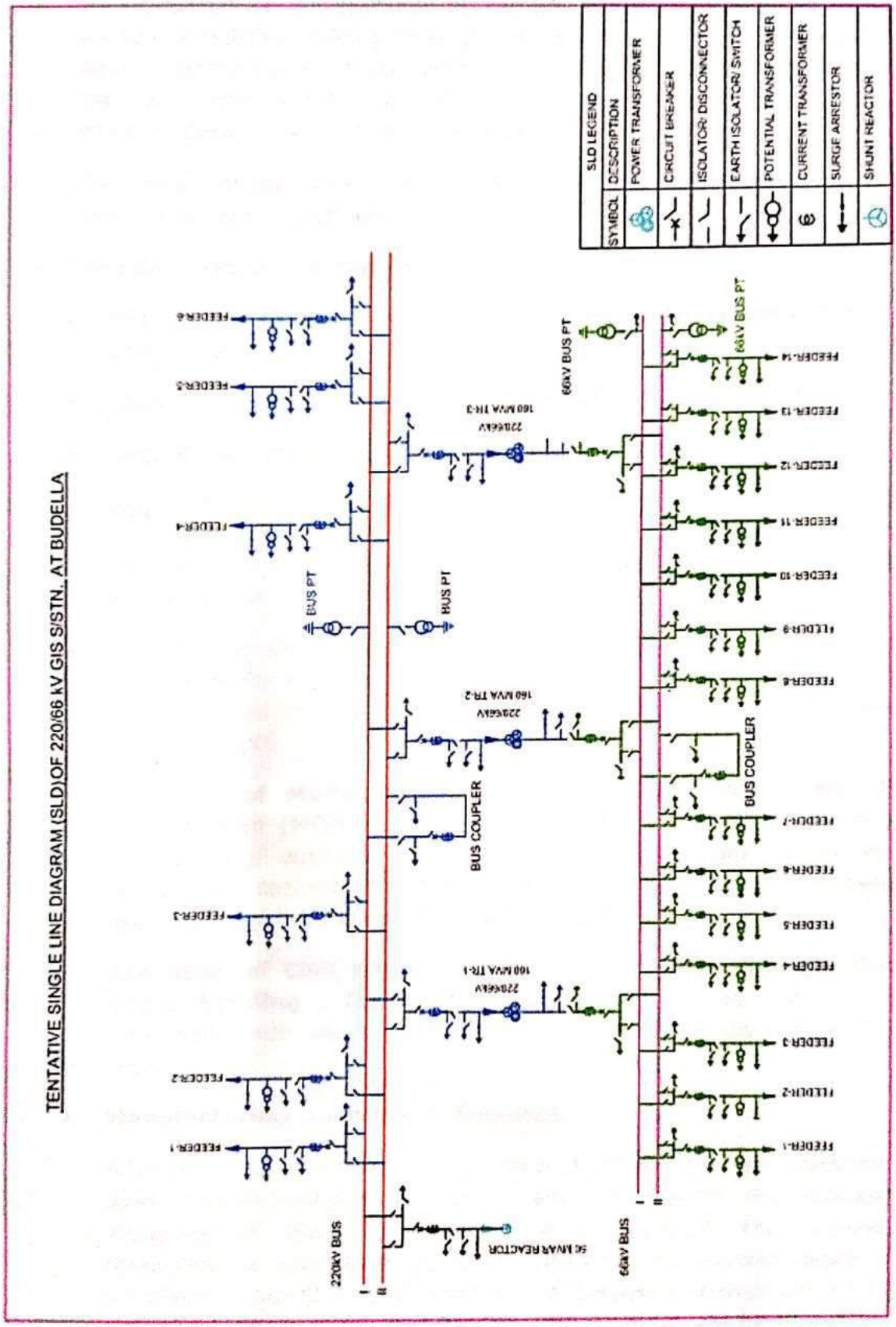
ANNEXURE-VII

Fire Detection and alarm System

This system shall be provided for control room building and Switchyard panel rooms of substations.

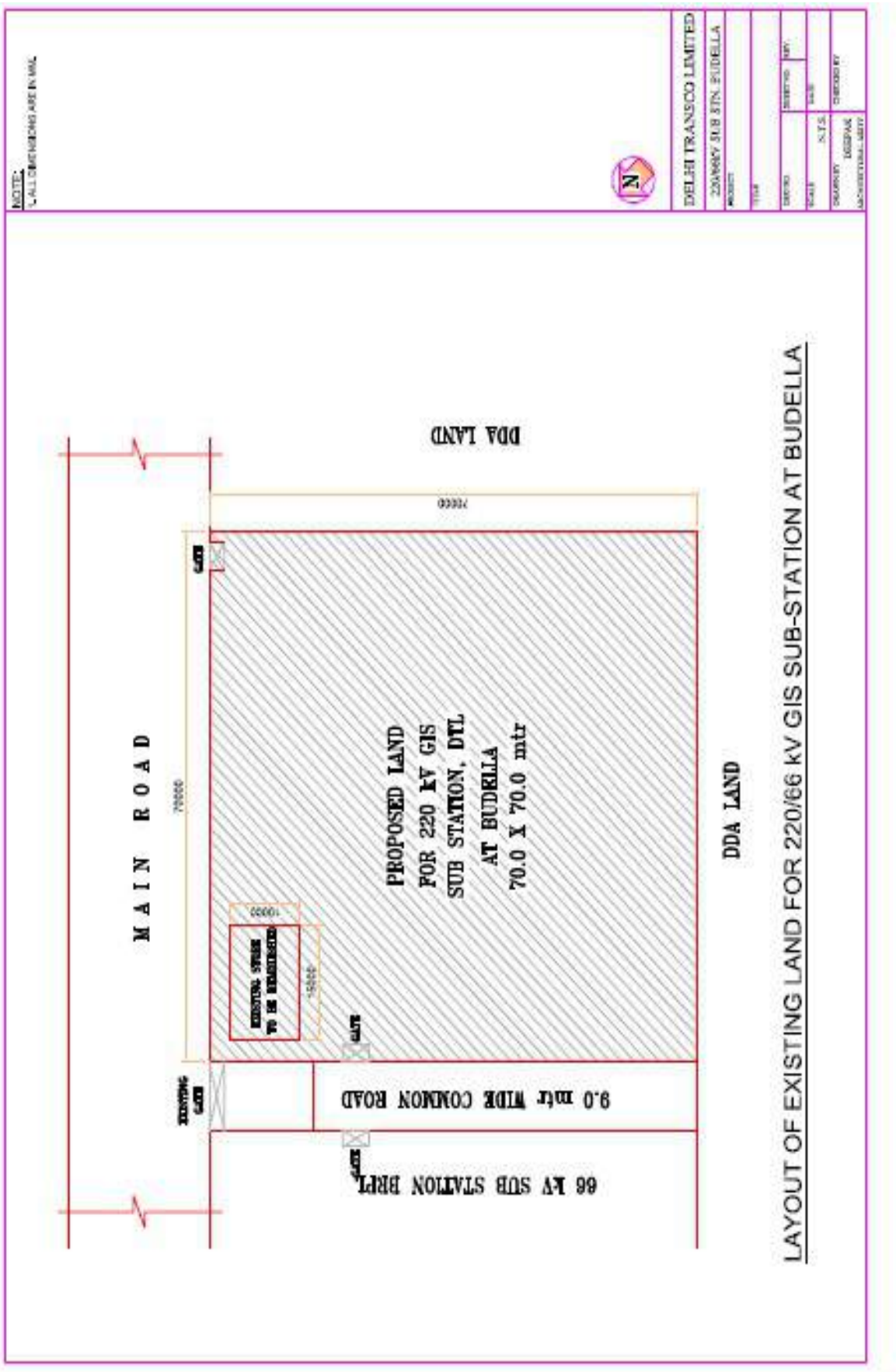
1. Suitable fire detection system using smoke detectors and/or heatdetectors shall be provided for the entire building, including corridor andtoilets. Fire detectors shall be located at strategic locations in variousrooms of the building. Each Switchyard panel room shall be considered a separate zone. Adequate number of extra zones shall be provided forSwitchyard panel rooms for future bays identified in Single line diagram of the substation. The operation of any of the fire detectors/ manual call point should result in the following;
   a. A visual signal exhibited in the annunciation panels indicating the area where the fire is detected.
   b. An audible alarm sounded in the panel, and
   c. An external audible alarm sounded in the building, location of which shall be decided during detailed engineering.
   d. If the zone comprises of more than one room, a visual signal shall be exhibited on the outer wall of each room.
2. Each zone shall be provided with two zone cards in the panel so that system will remain healthy even if one of the cards becomes defective.
3. Coverage area of each smoke detector shall not be more than 80 m2 and that of heat detectors shall not be more than 40 m2. Ionisation type smoke detectors shall be provided in all areas except pantry room where heat detectors shall be provided. If a detector is concealed, a remote visual indication of its operation shall be provided. Manual call points (Break glass Alarm Stations) shall be provided at strategic locations in the control room building. All cabling shall be done through concealed conduits.
4. Cables used should be exclusively for fire detection and alarm system and shall be 2Cx1.5sq.mm Cu. cables. Un-armoured PVC insulated FR cables conforming to IS 1554 (Part 1) shall be used.

SINGLE LINE DIAGRAM



Scanned by CamScanner

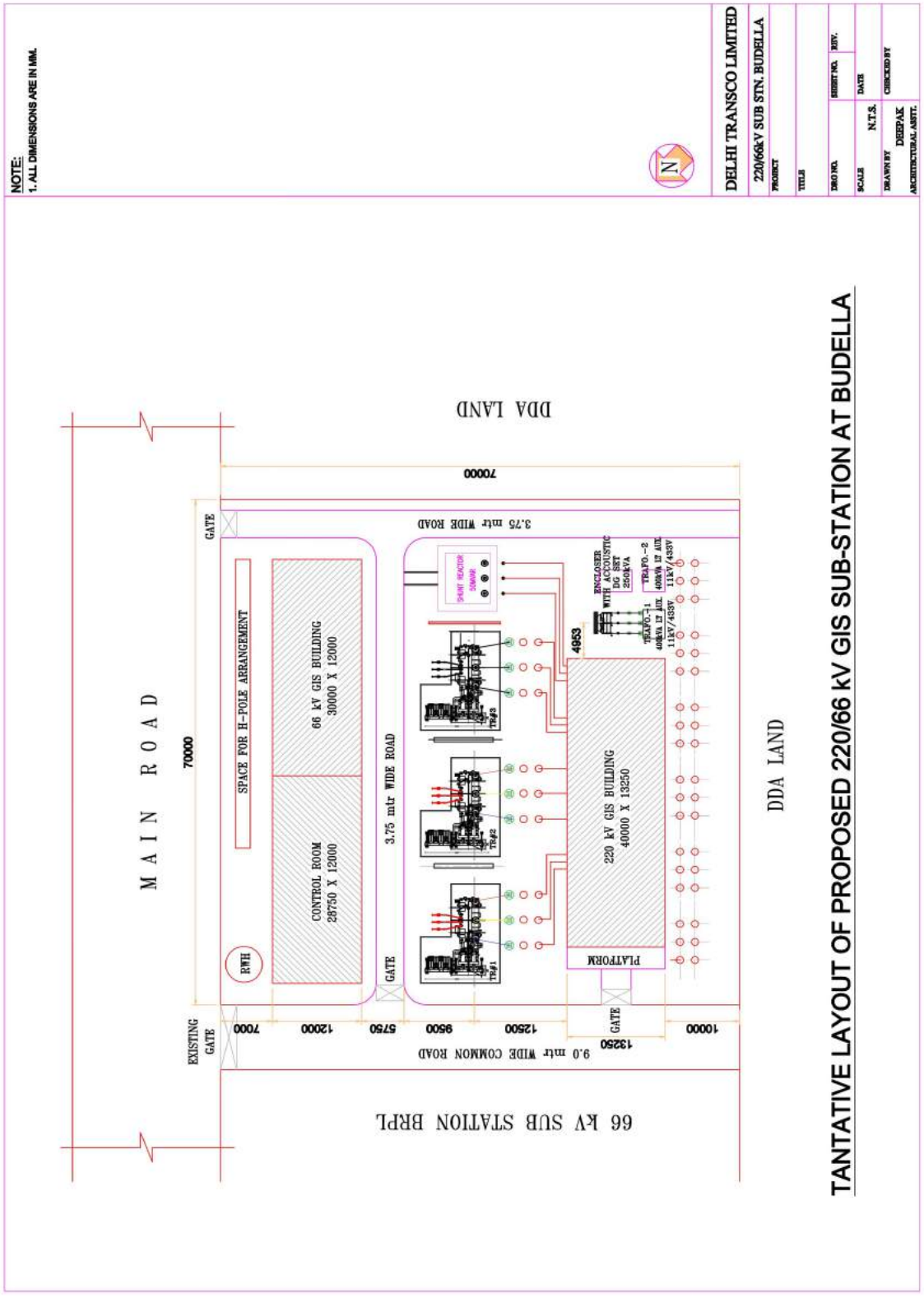
Existing Layout

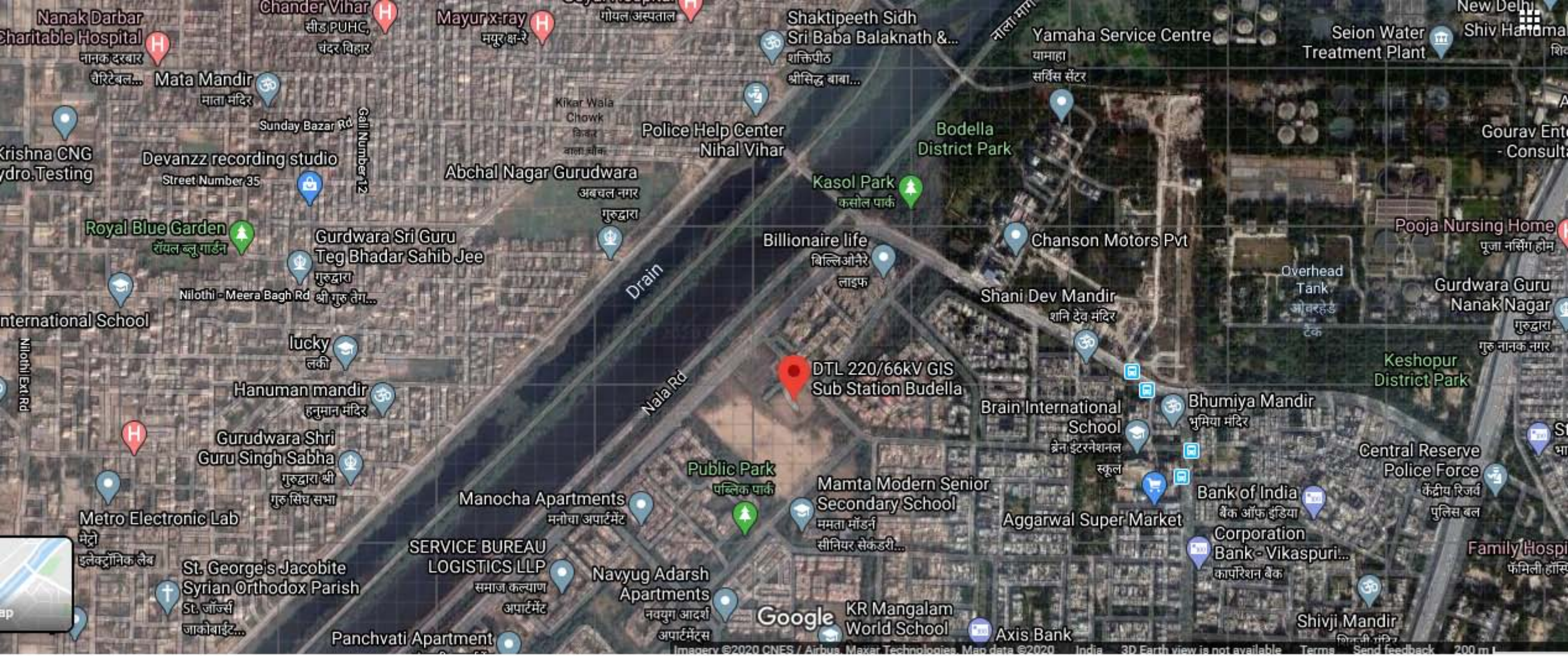


8. DRAWING AND DESIGN

Tentative layout for establishment of 220/66kV GIS substation and proposed SLD.

TENTATIVE LAYOUT




Nanak Darbar Charitable Hospital
नानक दरबार चैरिटेबल...
Chander Vihar
सीडब्ल्यूपीएच, चंदर विहार
Mayur x-ray
मयूर क्ष-रे
Shaktipeeth Sidh Sri Baba Balaknath &...
शक्तिपीठ श्रीसिद्ध बाबा...
Yamaha Service Centre
यामाहा सर्विस सेंटर
Seion Water Treatment Plant
Shiv Hanuma
Mata Mandir
माता मंदिर
Sunday Bazar Rd
Gali Number 12
Kikar Wala Chowk
Police Help Center Nihal Vihar
Bodella District Park
Gourav Ente - Consulta
Krishna CNG ydro.Testing
Devanzz recording studio
Street Number 35
Abchal Nagar Gurudwara
अबचल नगर गुरुद्वारा
Kasol Park
कसोल पार्क
Pooja Nursing Home
पूजा नर्सिंग होम
Royal Blue Garden
रॉयल ब्लू गार्डन
Gurdwara Sri Guru Teg Bhadar Sahib Jee
गुरुद्वारा श्री गुरु तेग...
Nilothi - Meera Bagh Rd
Billionaire life
बिल्लिओनैरे लाइफ
Chanson Motors Pvt
Drain
Overhead Tank
ओवरहेड टैंक
Gurdwara Guru Nanak Nagar
गुरुद्वारा गुरु नानक नगर
nternational School
Shani Dev Mandir
शनि देव मंदिर
lucky
लकी
Nilothi Ext Rd
Nala Rd
DTL 220/66kV GIS Sub Station Budella
Keshopur District Park
Hanuman mandir
हनुमान मंदिर
Brain International School
ब्रेन इंटरनेशनल स्कूल
Bhumiya Mandir
भुमिया मंदिर
Gurudwara Shri Guru Singh Sabha
गुरुद्वारा श्री गुरु सिंघ सभा
Public Park
पब्लिक पार्क
Mamta Modern Senior Secondary School
ममता मॉडर्न सीनियर सेकंडरी...
Central Reserve Police Force
केंद्रीय रिजर्व पुलिस बल
Manocha Apartments
मनोचा अपार्टमेंट
Bank of India
बैंक ऑफ इंडिया
Metro Electronic Lab
मेट्रो इलेक्ट्रॉनिक लैब
Aggarwal Super Market
Corporation Bank - Vikaspuri...
कार्पोरेशन बैंक
Family Hospi
फैमिली हॉस्पि
SERVICE BUREAU LOGISTICS LLP
समाज कल्याण अपार्टमेंट
St. George's Jacobite Syrian Orthodox Parish
St. जॉर्ज्स जाकोबाईट...
Navyug Adarsh Apartments
नवयुग आदर्श अपार्टमेंट्स
Google
KR Mangalam World School
Axis Bank
Shivji Mandir
Panchvati Apartment
Imagery ©2020 CNES / Airbus, Maxar Technologies, Map data ©2020
India
3D Earth view is not available
Terms
Send feedback
200 m

Annexure_BOQ_220kV GIS_BUDELLA_TABLE

Pre Bid Tie up for,

Design, Engineering, Supply, Erection*, Testing & Commissioning of 220kV GIS for 220/66kV Sub-Station at Budella, New Delhi (India) on turnkey basis.

*** - only supervision of Erection will be in bidder's scope.**

Sl. No.	BOQ DESCRIPTION
A	**220kV GIS for 220/66kV GIS Sub-station at Budella, Delhi**
A.1	Annexure_BOQ_BUDELLA_MAIN & INSTRUMENTS
A.2	Annexure_BOQ_BUDELLA_SPARE
A.3	Annexure_BOQ_BUDELLA_SERVICES

Annexure_BOQ_220KVBUDELLA_MAIN & INSTRUMENTS

Sl. No.	Item Description	Unit	Qty.	Remarks
1	**Supply- GIS: 220kV, 50kA for 1sec, Gas Insulated Switchgear (GIS) as per TS**			
1.01	SUPPLY- GIS: 220KV, 1600 A, SF6 TRANSFORMER FEEDER BAY MODULE	SET	3	Module description as per Technical Specification, Cl. 3.0, (I), (C) of Section Project
1.02	SUPPLY- GIS: 220KV, 1600 A, SF6 REACTOR FEEDER BAY MODULE	SET	1	Module description as per Technical Specification, Cl. 3.0, (I), (C) of Section Project
1.03	SUPPLY- GIS: 220KV, 1600 A, SF6 GIS LINE FEEDER BAY MODULE	SET	6	Module description as per Technical Specification, Cl. 3.0, (I), (D) of Section Project
1.04	SUPPLY- GIS: 220KV, 2500 A, SF6 BUS BAR MODULE	SET	2	Module description as per Technical Specification, Cl. 3.0, (I), (A) of Section Project
1.05	SUPPLY- GIS: 220KV, 2500 A, SF6 BUS COUPLER FEEDER BAY MODULE	SET	1	Module description as per Technical Specification, Cl. 3.0, (I), B of Section Project
1.06	SUPPLY- GIS : 220KV, 1600 A, SINGLE PHASE SF6 TO AIR BUSHING OUTSIDE GIS HALL (INCLUDING SF6 GAS, SUPPORT STRUCTURE & HARDWARES)	SET	30	GIB outside wall of GIS Hall shall be considered for mode of measurement. Any GIB inside GIS hall shall be considered as part of respective Feeder Bay and cost of the same shall be deemed to be included.
1.07	SUPPLY- GIS : 220KV, 1600A, SINGLE PHASE GAS INSULATED BUS DUCT OUTSIDE GIS HALL (INCLUDING SF6 GAS, SUPPORT STRUCTURE & HARDWARES)	MTR	350	GIB outside wall of GIS Hall shall be considered for mode of measurement. Any GIB inside GIS hall shall be considered as part of respective Feeder Bay and cost of the same shall be deemed to be included.
1.08	SUPPLY- GIS: SF6 GAS REQUIRED FOR PLACING GIS INTO SUCCESSFUL OPERATION	Lot	1	Complete in all respect in full compliance to technical specification and requirements, excluding SF6 Gas for GIB which is included in the scope of respective BOQ item.
1.09	SUPPLY- GIS: STRUCTURE MATERIAL INCLUDING FOUNDATION BOLTS, EMBEDDED ITEMS, RAILS AND/ OR OTHER MATERIALS ETC.	Lot	1	Complete in all respect in full compliance to technical specification and requirements, excluding support structure & hardware material for GIB which is included in the scope of respective BOQ item. In the event of changes in present scope, payment shall be made on pro-rata basis of number of circuit breaker bays only.
1.10	SUPPLY- GIS: EARTHING MATERIALS INCLUDING HIGH FREQUENCY EARTHING, AS APPLICABLE)	Lot	1	
2	**Supply- GIS: Testing & Maintenance Instruments as per TS**			
2.01	SUPPLY- GIS: TESTING & MAINTENNACE INSTRUMENTS: SF6 Gas filling and evacuating plant	Set	1	Please refer Section-2, clause 28 and relevant annexure for compelet details.
2.02	SUPPLY- GIS: TESTING & MAINTENNACE INSTRUMENTS: SF6 Gas Analyser	Set	1	Please refer Section-2, clause 28 and relevant annexure for compelet details.
2.03	SUPPLY- GIS: TESTING & MAINTENNACE INSTRUMENTS: SF6 gas leak detector	Set	1	Please refer Section-2, clause 28 and relevant annexure for compelet details.
2.04	SUPPLY- GIS: TESTING & MAINTENNACE INSTRUMENTS: Gas masks	Nos.	10	Please refer Section-2, clause 28 and relevant annexure for compelet details.
2.05	SUPPLY- GIS: TESTING & MAINTENNACE INSTRUMENTS: Partial Discharge Monitoring System	Set	1	Please refer Section-2, clause 28 and relevant annexure for compelet details.
2.06	SUPPLY- GIS: TESTING & MAINTENNACE INSTRUMENTS: Contact resistance meter	Set	1	Please refer Section-2, clause 28 and relevant annexure for compelet details.
2.07	SUPPLY- GIS: TESTING & MAINTENNACE INSTRUMENTS: Circuit Breaker operational Analyzer	Set	1	Please refer Section-2, clause 28 and relevant annexure for compelet details.
3	**Supply- GIS: Special Tools & Tackles as per TS**			
3.01	SUPPLY- GIS: Deployment of all special tools and tackles required for erection, testing, commissioning and maintenance of equipment	Set	1	Please refer Section 1- Annexuire Section Project, clause no. 9 for complete details

Annexure_BOQ_220KVBUDELLA_MANADATORY SPARES

Sl. No.	Item Description	Unit	Qty.	Remarks
4	**Spares-GIS: Manadtory Spares for 220kV, 50kA for 1sec, Gas Insulated Switchgear (GIS) as per TS**			
4.01	SUPPLY- GIS: SPARES: 220KV, GIS- Single phase, Cable end termination connection & enclosure, compatible with the main Circuit	Set	1	
4.02	SUPPLY- GIS: SPARES: 220KV, GIS- SF6 gas Pressure Relief Devices (03 nos. of each type)	Set	2	
4.03	SUPPLY- GIS: SPARES: 220KV, GIS- SF6 Pressure gauge cum switch OR Density monitors cum switch as applicable (3 nos. of each type) (1 set complete for 1 bay + bus bar, Bus duct+ CB)	Set	1	
4.04	SUPPLY- GIS: SPARES: 220KV, GIS- Coupling device with pressure gauge for connecting Gas handling plant including GIS & Cylinder both	Set	2	
4.05	SUPPLY- GIS: SPARES: 220KV, GIS- Rubber Gaskets, “O” Rings and Seals for SF6 gas of each type	Set	1	
4.06	SUPPLY- GIS: SPARES: 220KV, GIS- Molecular filter for SF6 gas with filter bags (20% of total quantity)	Lot	1	
4.07	SUPPLY- GIS: SPARES: 220KV, GIS- All types of Control Valves for SF6 gas of each type	Set	1	
4.08	SUPPLY- GIS: SPARES: 220KV, GIS- SF6 gas (20% of total quantity)	Lot	1	
4.09	SUPPLY- GIS: SPARES: 220KV, GIS- 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- For 3 phase Enclosure	Nos.	2	
4.10	SUPPLY- GIS: SPARES: 220KV, GIS- 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- For single phase enclosure	Nos.	3	
4.11	SUPPLY- GIS: SPARES: 220KV, GIS- 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- Bus Support insulator of each type for 3 phase/ single phase enclosure (5% of installed/ used population)	Lot	1	
4.12	SUPPLY- GIS: SPARES: 220KV, GIS- 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- SF6 to air bushing of each type rating including fixing arrangement	Nos.	3	
4.13	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Fixed, moving and arcing contacts including insulating nozzles	Nos.	3	
4.14	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Circuit Breaker pole complete of each type & rating complete with interrupter, main circuit, enclosure and Marshalling Box with operating mechanism (3 nos. of each type/ rating of CB)	Set	1	
4.15	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Rubber gaskets, `O' rings and seals for SF6 gas of each type	Set	1	
4.16	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Trip coil assembly with resistor as applicable (3 nos. of each rating of CB)	Set	2	

Annexure_BOQ_220KVBUDELLA_MANADATORY SPARES

Sl. No.	Item Description	Unit	Qty.	Remarks
4.17	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Closing coil assembly with resistor as applicable (3 nos. of each rating of CB)	Set	2	
4.18	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Corona rings/ cover if applicable	Set	1	
4.19	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Relays, Power contactors, push buttons, timers & MCBs etc of each type & rating	Set	1	
4.20	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Closing valve assembly (3 nos. of each type)	Set	2	
4.21	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Trip valve assembly (3 nos. of each type)	Set	2	
4.22	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Auxiliary switch assembly (3 nos. of each type)	Set	1	
4.23	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Operation Counter (3 nos. of each type)	Set	1	
4.24	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Rupture disc (3 nos. of each type)	Set	1	
4.25	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- Spring operated closing mechanism, if applicable (1 nos. of each type)	Set	1	
4.26	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- For Hydraulic Operated Mechanism, if applicable- Hydraulic operating mechanism with drive motor (3 nos. of each type)	Set	1	
4.27	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- For Hydraulic Operated Mechanism, if applicable- Hydraulic filter (3 nos. of each type)	Set	1	
4.28	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- For Hydraulic Operated Mechanism, if applicable- Hose pipe (3 nos. of each type)	Set	1	
4.29	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- For Hydraulic Operated Mechanism, if applicable- N2 Accumulator (3 nos. of each type)	Set	1	
4.30	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- For Hydraulic Operated Mechanism, if applicable- Pressure transducer (3 nos. of each type)	Set	1	
4.31	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- For Hydraulic Operated Mechanism, if applicable- Valves (3 nos. of each type)	Set	1	
4.32	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- For Hydraulic Operated Mechanism, if applicable- Pipe length (copper & steel) (3 nos. of each size & type)	Set	1	
4.33	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- For Hydraulic Operated Mechanism, if applicable- Pressure switches (3 nos. of each type)	Set	1	

Sl. No.	Item Description	Unit	Qty.	Remarks
4.34	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- For Hydraulic Operated Mechanism, if applicable- Pressure gauge with coupling device (3 nos. of each type)	Set	1	
4.35	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- For Hydraulic Operated Mechanism, if applicable- Hydraulic oil (20% of total qty used)	Lot	1	
4.36	SUPPLY- GIS: SPARES: 220KV, Circuit Breaker- For Hydraulic Operated Mechanism, if applicable- Pressure Relief Device, (3 nos. of each type)	Lot	1	
4.37	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Complete set of 3 nos. of single phase / one no. of 3-phase disconnector including main circuit, enclosure, driving mechanism.	Set	1	
4.38	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- 3 no. of single phase / one no of 3-phase Earthing switch including main circuit, enclosure, driving mechanism.	Set	1	
4.39	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Copper contact fingers for dis-connector male & female contact for one complete (3 phase) dis-connector of each type and rating.	Set	1	
4.40	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Copper contact fingers for earthing switch male & female contacts, for one complete (3 phase) earthing switch of each type and rating	Set	1	
4.41	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Open / Close contactor assembly, timers, key interlock for one complete (3 phase) dis-connector and (3 phase) earthing switch of each type and rating	Set	1	
4.42	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Push button switch.-each type, as applicable	Set	1	
4.43	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Limit switch and Aux. Switches for complete 3 phase equipment	Set	1	
4.44	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Motor with gear assembly for complete 3 phase equipment for Isolator	Set	3	
4.45	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Motor with gear assembly for complete 3 phase equipment for Earth Swicth	Set	1	
4.46	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Motor with gear assembly for complete 3 phase equipment for Earth Swicth	Set	1	
4.47	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Hinge pins for complete 3 phase equipment	Set	1	
4.48	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Relays, Power contactors, resistors, fuses, push buttons & MCBs (complete for one 3 phase equipment)	Nos.	3	
4.49	SUPPLY- GIS: SPARES: 220KV, Isolator & Earth Switch- Aux. switch assembly (complete) with 10 NO & 10 NC OR more contacts for both isolator & earth switch	Set	1	
4.50	SUPPLY- GIS: SPARES: 220KV, Current Transformer- Complete CT of each type and rating with packing.	Nos.	2	

Annexure_BOQ_220KVBUDELLA_MANADATORY SPARES

Sl. No.	Item Description	Unit	Qty.	Remarks
4.51	SUPPLY- GIS: SPARES: 220KV, Current Transformer- Secondary bushing of each type	Set	1	
4.52	SUPPLY- GIS: SPARES: 220KV, Voltage Transformer- Complete PT of each type and rating	Nos.	1	
4.53	SUPPLY- GIS: SPARES: 220KV, Surge Arrestor- Complete LA of each type and ratings with insulating base, terminal connector, Surge counter & accessories	Nos.	1	
5	**Spares-GIS: Reference Unit Price for addition/ deletion of supply items of 220kV, 50kA for 1sec, Gas Insulated Switchgear (GIS) as per TS**			
	Unit Prices of Individual Equipment included here or in mandatory spares 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	SUPPLY- GIS: SPARES: 220KV, SINGLE PHASE BUS BAR	Mtrs	1	Complete in all respect.
5.02	SUPPLY- GIS: SPARES: 220KV, GIS METALLIC ENCLOSURE	Kgs	50	
5.03	SUPPLY- GIS: SPARES: 220KV, EXPANSION BELLOWS/ JOINTS	Set	1	For Single Phase of any type and any rating.
5.04	SUPPLY- GIS: SPARES: 220KV, TEE BEND	Set	1	For Single Phase of any type and any rating.
5.05	SUPPLY- GIS: SPARES: 220KV, ANGLE BEND	Set	1	For Single Phase of any type and any rating.
5.06	SUPPLY- GIS: SPARES: 220KV, L-BEND	Set	1	For Single Phase of any type and any rating.

Annexure_BOQ_220KVBUDELLA_SERVICES

Sl. No.	Item Description	Unit	Qty.	Remarks
6	**Services- GIS: 220kV, 50kA for 1sec, Gas Insulated Switchgear (GIS) as per TS**			
6.01	SERVICES- GIS: SUPERVISION OF ERECTION: 220KV, SF6 GIS BAY MODULE	SET	11	Supervision of erection of GIS system, complete in all respect including LCC and other accessories. It also includes supervision of unloading & verification of materials for proper storage at site. GIS bay having GIS circuit Breaker is counted as Bay Module.
6.02	SERVICES- GIS: TESTING & COMMISSIONING: 220KV, SF6 GIS BAY MODULE	SET	11	Testing and commissioning of complete GIS system, is to be executed by venfor. All testing instruments, kits, T&P etc. are to be arranged by contractor on returnable basis. Please refer relevant section of technical specification for details. GIS bay having GIS circuit Breaker is counted as Bay Module.
6.03	SERVICES- GIS : 220KV, SUPERVISION OF ERECTION OF 1 PHASE, SF6 TO AIR BUSHING	SET	30	
6.04	SERVICES- GIS : 220KV, TESTING & COMMISSIONING OF 1 PHASE, SF6 TO AIR BUSHING	SET	30	
6.05	SERVICES- GIS : 400KV, SUPERVISION OF ERECTION OF 1 PHASE GAS INSULATED BUS DUCT	MTR	350	Single-phase Bus duct.
6.06	SERVICES- GIS : 400KV, TESTING & COMMISSIONING OF 1 PHASE GAS INSULATED BUS DUCT	MTR	350	Single-phase Bus duct.
6.07	SERVICES- GIS: SF6 GAS REQUIRED FOR PLACING GIS INTO SUCCESSFUL OPERATION	Lot	1	
6.08	SERVICES- GIS: FINAL SUCCESSFUL HV/ POWER FREQUENCY TESTING OF GIS INCLUDING ARRANGING OF HV TEST KIT ALONG WITH OPERATOR	Lot	1	Carrying out successful HV/ Power Frequency Testing of complete GIS as per IEC including Arrangement of HV Test kit (on returnable basis) shall be in scope of bidder, which includes charges HV test kit with operator, accessories & tools required for completion of HV testing. Bays may be commissioned separately.
6.09	SERVICES- GIS: INSULATION CO-ORDINATION STUDIES GIS SYSTEM COMPLETE	LOT	1	Insulation Coordination system report includes VFTO report.
7	**Services-GIS: Reference Unit Price for addition/ deletion of supply items of 220kV, 50kA for 1sec, Gas Insulated Switchgear (GIS) as per TS**			
7.01	SERVICES- GIS : REFERENCE UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR SUPERVISION OF ERECTION OF GIS	MAN-DAY	10	Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by BHEL.
7.02	SERVICES- GIS : REFERENCE UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR TESTING & COMMISSIONING OF GIS	MAN-DAY	10	Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by BHEL.
7.03	SERVICES- GIS : REFERENCE UNIT OF GIS INDIVIDUAL ITEM/ EQUIPMENT - HIRING CHARGES OF HV TEST KIT WITH OPERATOR	LOT	1	Additional HV test kit charges including charges of operator, HV test kit, accessories & tools required for completion of HV test (Dielectric Test after installation of GIS). This item is executed only if repetition/ additional HV Test is required by BHEL i.e. post successful
8	**Services-GIS: Training of customer/ owner Personnel as per TS**			
8.01	Service: Training- Training in Design, Manufacturing and Testing of equipment/ GIS being supplied at manufacturer's works/ facility	MAN-DAY	120	Please refer Section 1- Annexuire Section Project, clause no. 12 for complete details

Annexure_BOQ_66KV GIS_BUDELLA_TABLE

Pre Bid Tie up for,

Design, Engineering, Supply, Erection*, Testing & Commissioning of 66kV GIS for 220/66kV Sub-Station at Budella, New Delhi (India) on turnkey basis.

*** - only supervision of Erection will be in bidder's scope.**

Sl. No.	BOQ DESCRIPTION
B	**66kV GIS for 220/66kV GIS Sub-station at Budella**
B.1	Annexure_BOQ_BUDELLA_MAIN & INSTRUMENTS
B.2	Annexure_BOQ_BUDELLA_SPARE
B.3	Annexure_BOQ_BUDELLA_SERVICES

Annexure_BOQ_66KVBUDELLA_MAIN & INSTRUMENTS

Sl. No.	Item Description	Unit	Qty.	Remarks
1	**Supply- GIS: 66kV, 31.5kA for 1sec, Gas Insulated Switchgear (GIS) as per TS**			
1.01	SUPPLY- GIS: 66KV, 2000 A, SF6 GIS LINE FEEDER BAY MODULE	SET	14	Module description as per Technical Specification, Cl. 3.0,(II), (D) of Section Project
1.02	SUPPLY- GIS: 66KV, 2500 A, SF6 BUS COUPLER FEEDER BAY MODULE	SET	1	Module description as per Technical Specification, Cl. 3.0,(II), (B) of Section Project
1.03	SUPPLY- GIS: 66KV, 2500 A, SF6 INCOMER/ TRANSFORMER FEEDER BAY MODULE	SET	3	Module description as per Technical Specification, Cl. 3.0,(II), C of Section Project
1.04	SUPPLY- GIS: 66KV, 3000 A, SF6 BUS BAR MODULE	SET	2	Module description as per Technical Specification, Cl. 3.0,(II), A of Section Project
1.05	SUPPLY- GIS: SF6 GAS REQUIRED FOR PLACING GIS INTO SUCCESSFUL OPERATION	Lot	1	Complete in all respect in compliance to technical specification and requirements. Excluding SF6 Gas for GIB which is included in the scope of respective BOQ item.
1.06	SUPPLY- GIS: STRUCTURE MATERIAL INCLUDING FOUNDATION BOLTS, EMBEDDED ITEMS, RAILS AND/ OR OTHER MATERIALS ETC.	Lot	1	Complete in all respect in compliance to technical specification and requirements.
1.07	SUPPLY- GIS: EARTHING MATERIALS INCLUDING HIGH FREQUENCY EARTHING, AS APPLICABLE)	Lot	1	Complete in all respect in compliance to technical specification and requirements.
2	**Supply- GIS: Special Tools & Tackles as per TS**			
2.01	SUPPLY- GIS: Deployment of all special tools and tackles required for erection, testing, commissioning and maintenance of equipment	Set	1	Please refer Section 1- Annexure Section Project, clause no. 9 for complete details

Annexure_BOQ_66KVBUDELLA_MANADATORY SPARES

Sl. No.	Item Description	Unit	Qty.	Remarks
3	**Spares-GIS: Manadtory Spares for 66kV, 31.5kA for 1sec, Gas Insulated Switchgear (GIS) as per TS**			
3.01	SUPPLY- GIS: SPARES: 66KV, GIS- Single phase, Cable end termination connection & enclosure, compatible with the main Circuit	Set	1	
3.02	SUPPLY- GIS: SPARES: 66KV, GIS- SF6 gas Pressure Relief Devices (03 nos. of each type)	Set	2	
3.03	SUPPLY- GIS: SPARES: 66KV, GIS- SF6 Pressure gauge cum switch OR Density monitors cum switch as applicable (3 nos. of each type) (1 set complete for 1 bay + bus bar, Bus duct+ CB)	Set	1	
3.04	SUPPLY- GIS: SPARES: 66KV, GIS- Coupling device with pressure gauge for connecting Gas handling plant including GIS & Cylinder both	Set	2	
3.05	SUPPLY- GIS: SPARES: 66KV, GIS- Rubber Gaskets, “O” Rings and Seals for SF6 gas of each type	Set	1	
3.06	SUPPLY- GIS: SPARES: 66KV, GIS- Molecular filter for SF6 gas with filter bags (20% of total quantity)	Lot	1	
3.07	SUPPLY- GIS: SPARES: 66KV, GIS- All types of Control Valves for SF6 gas of each type	Set	1	
3.08	SUPPLY- GIS: SPARES: 66KV, GIS- SF6 gas (20% of total quantity)	Lot	1	
3.09	SUPPLY- GIS: SPARES: 66KV, GIS- 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- For 3 phase Enclosure	Nos.	2	
3.10	SUPPLY- GIS: SPARES: 66KV, GIS- 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- For single phase enclosure	Nos.	3	
3.11	SUPPLY- GIS: SPARES: 66KV, GIS- 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- Bus Support insulator of each type for 3 phase/ single phase enclosure (5% of installed/ used population)	Lot	1	
3.12	SUPPLY- GIS: SPARES: 66KV, GIS- 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- SF6 to air bushing of each type rating including fixing arrangement	Nos.	3	
3.13	SUPPLY- GIS: SPARES: 66KV, Circuit Breaker- Three phase, Circuit Breaker interrupting chamber complete with all necessary apparatus (1 no. of each rating)	Set	1	
3.14	SUPPLY- GIS: SPARES: 66KV, Circuit Breaker- Rubber gaskets, ‘O’ rings and seals	Set	1	

Annexure_BOQ_66KVBUDELLA_MANADATORY SPARES

Sl. No.	Item Description	Unit	Qty.	Remarks
3.15	SUPPLY- GIS: SPARES: 66KV, Circuit Breaker- Trip coils with resistor	Nos.	3	
3.16	SUPPLY- GIS: SPARES: 66KV, Circuit Breaker- Closing coils with resistor	Nos.	3	
3.17	SUPPLY- GIS: SPARES: 66KV, Circuit Breaker- Relays, Power contactors, push buttons, timers & MCB etc.	Set	1	
3.18	SUPPLY- GIS: SPARES: 66KV, Circuit Breaker- Closing valve assembly (3no. of each type)	Set	1	
3.19	SUPPLY- GIS: SPARES: 66KV, Circuit Breaker- Trip valve assembly (3no. of each type)	Set	1	
3.20	SUPPLY- GIS: SPARES: 66KV, Circuit Breaker- Auxiliary switch assembly	Set	1	
3.21	SUPPLY- GIS: SPARES: 66KV, Circuit Breaker- Operation Counter	Set	1	
3.22	SUPPLY- GIS: SPARES: 66KV, Circuit Breaker- Rupture disc/ diapharm	Set	1	
3.23	SUPPLY- GIS: SPARES: 66KV, Isolator & Earth Switch- Three ph, Disconnecting Switch internal parts, complete with all necessary gaskets, mounting hardware, etc.	Set	1	
3.24	SUPPLY- GIS: SPARES: 66KV, Isolator & Earth Switch- Three ph, Disconnecting Switch operating mechanism, complete with all necessary connecting apparatus	Set	1	
3.25	SUPPLY- GIS: SPARES: 66KV, Isolator & Earth Switch- Three ph., Grounding Switch internal parts, complete with all necessary gaskets, mounting hardware etc	Set	1	
3.26	SUPPLY- GIS: SPARES: 66KV, Isolator & Earth Switch- Three ph., Grounding Switch operating mechanism, complete with all necessary connecting apparatus	Set	1	
3.27	SUPPLY- GIS: SPARES: 66KV, CT- Single phase current transformers of each rating with packing (3 nos. of each rating)	Set	1	
3.28	SUPPLY- GIS: SPARES: 66KV, Voltage transformer- Three phase VT complete with all Gaskets and mounting hardware (1 nos. of each rating)	Set	1	
3.29	SUPPLY- GIS: SPARES: 66KV, Surge Arrestor- Complete LA including insulating Base with Surge counter & accessories	Set	1	

Annexure_BOQ_66KVBUDELLA_MANADATORY SPARES

Sl. No.	Item Description	Unit	Qty.	Remarks
4	**Spares-GIS: Reference Unit Price for addition/ deletion of supply items of 66kV, 31.5kA for 1sec, Gas Insulated Switchgear (GIS) as per TS**			
	Unit Prices of Individual Equipment included here or in mandatory spares 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			
4.01	SUPPLY- GIS: SPARES: 66KV, SINGLE PHASE BUS BAR	Mtrs	1	Complete in all respect.
4.02	SUPPLY- GIS: SPARES: 66KV, GIS METALLIC ENCLOSURE	Kgs	50	
4.03	SUPPLY- GIS: SPARES: 66KV, EXPANSION BELLOWS/ JOINTS	Set	1	For Single Phase of any type and any rating.
4.04	SUPPLY- GIS: SPARES: 66KV, TEE BEND	Set	1	For Single Phase of any type and any rating.
4.05	SUPPLY- GIS: SPARES: 66KV, ANGLE BEND	Set	1	For Single Phase of any type and any rating.
4.06	SUPPLY- GIS: SPARES: 66KV, L-BEND	Set	1	For Single Phase of any type and any rating.

Annexure_BOQ_66KVBUDELLA_SERVICES

Sl. No.	Item Description	Unit	Qty.	Remarks
5	**Services- GIS: 66kV, 31.5kA for 1sec, Gas Insulated Switchgear (GIS) as per TS**			
5.01	SERVICES- GIS: SUPERVISION OF ERECTION: 66KV, SF6 GIS BAY MODULE	SET	18	Supervision of erection of GIS system, complete in all respect including LCC and other accessories. It also includes supervision of unloading & verification of materials for proper storage at site. GIS bay having GIS circuit Breaker is counted as Bay Module.
5.02	SERVICES- GIS: TESTING & COMMISSIONING: 66KV, SF6 GIS BAY MODULE	SET	18	Testing and commissioning of complete GIS system, is to be executed by venfor. All testing instruments, kits, T&P etc. are to be arranged by contractor on returnable basis. Please refer relevant section of technical specification for details. GIS bay having GIS circuit Breaker is counted as Bay Module.
5.03	SERVICES- GIS: SF6 GAS REQUIRED FOR PLACING GIS INTO SUCCESSFUL OPERATION	Lot	1	
5.04	SERVICES- GIS: FINAL SUCCESSFUL HV/ POWER FREQUENCY TESTING OF GIS INCLUDING ARRANGING OF HV TEST KIT ALONG WITH OPERATOR	Lot	1	Carrying out successful HV/ Power Frequency Testing of complete GIS as per IEC including Arrangement of HV Test kit (on returnable basis) shall be in scope of bidder, which includes charges HV test kit with operator, accessories & tools required for completion of HV testing. Bays may be commissioned separately.
5.05	SERVICES- GIS: INSULATION CO-ORDINATION STUDIES GIS SYSTEM COMPLETE	LOT	1	Insulation Coordination system report includes VFTO report.
6	**Services-GIS: Reference Unit Price for addition/ deletion of supply items of 66kV, 31.5kA for 1sec, Gas Insulated Switchgear (GIS) as per TS**			
6.01	SERVICES- GIS : REFERENCE UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR SUPERVISION OF ERECTION OF GIS	MAN-DAY	10	Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by BHEL.
6.02	SERVICES- GIS : REFERENCE UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR TESTING & COMMISSIONING OF GIS	MAN-DAY	10	Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by BHEL.
6.03	SERVICES- GIS : REFERENCE UNIT OF GIS INDIVIDUAL ITEM/ EQUIPMENT - HIRING CHARGES OF HV TEST KIT WITH OPERATOR	LOT	1	Additional HV test kit charges including charges of operator, HV test kit, accessories & tools required for completion of HV test (Dielectric Test after installation of GIS). This item is executed only if repetition/ additional HV Test is required by BHEL i.e. post successful

SECTION-II

GAS INSULATED SWITCHGEAR

SECTION: 2

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 andthermal 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 connectors 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 gasdensity 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 the insulation 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: 62 271-1 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 timings 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 perfromed 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.
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.

f) 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 by passed 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 as per 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 IEC specification 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 con tacts for al l t he w indings. The secondary t erminals of the VT's sh all b e terminated to preferably stud type non-disconnecting terminal blocks in the secondary boxes via the fuse.

e) The v oltage transformer s hould be thermally and dielectrically sa fe w hen the se condary 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 a nd Voltage Transformer s hould ha ve be en t ype t ested and s hall 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 ov er v oltage t est f or 66kV a nd above v oltage 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 c o-ordination an d selection of surge arrestor**: The c ontractor shall be fully responsible for c omplete i nsulation c o-ordination of s witchyard i ncluding G IS. C ontractor shall car ry out de tailed studies an d design calculations t o evolve t he r equired parameters locations, ene rgy capa bility et c. of surg e arrestors such that a dequate p rotective m argin is available be tween peak i mpulse, surge and pow er frequency discharge voltages and BIL of the p rotected requirement. The l ocations of surge a rrestors show n in single line di agram i s indicative onl y. I f t he con tractor f eels t hat at s ome m ore l ocations t he su rge ar restors 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 a ll n ecessary s tudies and the r eport s hall d etail the l imits o f a ll equipment pa rameters w hich could affect t he i nsulation co-ordination. The r eport s hall a lso detail the characteristics of the surge arrestor and shall demonstrate that the selected arrestor's protective and w ithstand l evels, discharge and coordinating currents and arrestor ratings and comply with the requirement of this specification.

The c ontractor s hall a lso consider i n the s tudies the ope n c ircuit breaker cond ition, fast transients generated by s low ope ration o f di sconnecting s witches. The s tudy r eport a nd de sign 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 & 36 kV 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.
The surge arresters are being provided to protect the followings whose insulation levels are indicated in the table given below:-

Equipment	**Lightning impulse(kVp) for 420 kV system**	**Swicthing surge(kVp) for 420 kV system**	**Lightning impulse(kVp) for 245 kV system**	**Lightning impulse(kVp) for 72.5 kV system**	**Lightning impulse(kVp) for 36 kV system**
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 of withstanding 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 bays 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 lighting fixture 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 space heater 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 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 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 units 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 ut most 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 on site 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, on line PRPD (phase resolved PD) and on line short time trende tc. 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 PD from 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 level of 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 of hourly/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) PD alarm (abnormal PD activity indicating a r isk of failure) & b) P D system fail alarm to be connected to SAS.

o) **Real Time Display:** The PDM system should have the facility of Real Time display, which will 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 sensor identification and location a long 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 trend plots/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 and time 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**: The factory & site tests format to be submitted for approval. The format 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 specific area 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 upto 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	---	----	----

S.No.	Details	Unit	400kV	220kV	66kV	33kV
7.	Switching impulse withstand voltage (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	ms	3.3	3.3	--	--

S.No.	Details	Unit	400kV	220kV	66kV	33kV
	opening)					
	-Between poles (for closing)	ms	5	5	---	--
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	kVp	900	--	--	--

	circuit breaker contacts open:					
	-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 l ine terminals and ground	kVp	1425	1050	650	170
6	Switching im pulse withstand voltage (250/2500µs) -between l ine terminals ground (dry& wet)	kVp	1050	--	--	--
7	One m inute pow er frequency withstand voltage -between l ine terminals and ground	kVrms	630 (dry only)	460	275	75
8	One m inute pow er frequency withstand voltage of s econdary 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 a t V k 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 vol tage a s well a s ope rating time of r elay 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 vol tage a s well as ope rating time of r elay 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

S.No.	Details	Unit	400kV System	220kV System	66kV System	33kV System
	-measurement	%	99 to 101	99 to 101	99 to 101	NA
13.	High frequency capacitance for entire carrier frequency range	%	80 to 150% of rated capacitance	80 to 150% of rated capacitance	80 to 150% of rated capacitance	NA
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

(Annexure -6)

SYSTEM PARAMETERS

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/GIS equipments. 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 limits 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 B ack of SF6 gas	The kit shall have the inbuilt facility of pumping back the measured SF6 gas to the equipment being tested.
Test L eads and accessories	Complete se t o f H oses, pipes, coup ling, valves et c. f or m easurement (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 e quipment a long w ith c omplete a ccessories m ust 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 t est k it sh all be co mpatible for E MI/EMC/safety env ironment 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 f rom NABL accr edited lab or i nternationally r eputed 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 t heir ow n 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 k it ne eds t o be sh ifted t o supplier's w orks for r epairs w ithin warranty/guaranty pe riod, 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.	Pump back 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	

SECTION-III

GENERAL TECHNICAL REQUIREMENTS

SECTION : 3

GENERAL TECHNICAL REQUIREMENTS (GTR)

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.

2.6 The contractor shall design the system maintaining all the statutory clearances for both indoor and outdoor equipments as per relevant standards and norms. Contractor shall also design the building with sufficient working space for ease of operation and maintenance activities.

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 equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, re-strike 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 and protective relays 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 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	220 kV System	66kV System	33 kV System
1.	System operating voltage	220kV	66kV	33kV
2.	Rated frequency	50Hz	50Hz	50Hz
3.	No. of phase	3	3	3
4.	Rated Insulation levels			
	i) Full wave impulse withstand voltage (1.2/50μs)	1050 kVp	325kVp	170 kVp
	ii) One minute power frequency dry and wet withstand voltage (rms)	460kV	140kV	70kV
5.	Corona extinction voltage	156kV	-	-
6.	Max. radio Interference voltage for frequency b/w 0.5MHz and 2 MHz at 156kV rms for 220kV system	1000 μV	-	-
7.	Minimum creepage distance	25 mm/kV (6125 mm)	25 mm/kV (1812.5 mm)	25 mm/kV (900 mm)
8.	Min. clearances			
i)	Phase to phase	2100mm	630mm	320mm
ii)	Phase to earth	2100mm	630mm	320mm
iii)	Sectional clearances (These clearances are mentioned for air clearance)	5000 mm	3000mm	3000mm
9.	Rated short circuit current for 1 sec. duration	40 kA	31.5kA	31.5 kA
10.	System neutral earthing	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)-I 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 –		

(A)-II For 220/33/11 kV Power Transformer

Voltage ratio (kV)	**220/33/11**
Rated frequency (Hz)	50
Max. Design Ambient Temp. (°C)	50

Windings		220kV	33kV	11kV
(i) System Fault level (kA)		40	31.5	18.35
(ii) 1.2/50 µsec. impulse withstand voltage kVp		±1050	±170	±170
(iii) One minute power frequency voltage kV rms		±460	±70	±70
(iv)	Winding connection	Star	Star	delta
(v)	Neutral	- Solidly grounded -		
(vi)	Insulation	- Solidly grounded -		
(vii)	Vector Group	- YN yn0 d11 -		

(B) For 245 kV, 72.5kV & 36kV Circuit Breaker and Isolator

Rated voltage kV (rms)	**245**	**66**	**36**
Rated frequency (Hz)	50	50	50
No. of Poles	3	3	3
Design ambient temperature (°C)	50	50	50

Rated insulation levels :

1) Full wave impulse withstand voltage (1.2/50 µsec.)

- between line terminals and ground	± 1050 kVp	±325 kVp	±170 kVp
- between terminals with circuit breaker open	± 1200 kVp	±375 kVp	±195 kVp
- between terminals with isolator open	± 1200 kVp	±375 kVp	±195 kVp

2) One minute power frequency dry and wet withstand voltage

- between line terminals and ground	460 kV (rms)	±140 kVp	±70kV (rms)
- between terminals with circuit breaker open	530 kV (rms)	As per IEC	As per IEC
- between terminals with Isolator open	530 kV (rms)	As per IEC	As per IEC

3) Max. radio interference voltage (µV) for frequency between 0.5 MHz and 2 MHz in all positions of the equipments.	1000 (at 156 kV rms)	-	-

4) Minimum creepage distance :-

Phase to ground (mm)	6125	1812.5	900
Between CB Terminals (mm)	6125	1812.5	900

5) System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed

6) Seismic acceleration - 0.3g horizontal -

7) Rating of Auxiliary Contacts	- 10 A at 220 V DC -
8) Breaking capacity of Auxiliary contacts	2 A DC with circuit time constant of not less than 20 ms.

Auxiliary Switch shall also comply with other clauses of this chapter.

(C) FOR 245 kV, 72.5kV & 36kV CT/CVT/SA

Rated voltage kV (rms)	**245**	**72.5**	**36**
Rated frequency (Hz)	50	50	50
No. of poles	1	1	1
Design ambient temperature (°C)	50	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	±170 kVp
- for arrester housing	± 1050 kV peak	±325 kVp	±170 kVp
2) One minute power frequency dry and wet withstand voltage			
- between line terminals and ground for CT and CVT	±460 kV rms	±140 kVp	±70 kV rms
- for arrester housing	±460 kV rms	±140 kVp	± 70kV rms
3) Max. radio interference voltage (µV) for frequency between 0.5 MHz and 2 MHz in all positions of the equipment	1000 for CT/CVT 500 for SA (at 156 kV rms)		
4) Minimum creepage distance :-			
- Phase to ground (mm)	6125	1812.5	900
5) System neutral earthing	- Effectively earthed -		
6) Seismic acceleration	- 0.3g horizontal -		
7) Partial discharge for :-			
- Surge arrester at 1.05 COV	- Not exceeding 50 pc. -		
- for CT/CVT	- Not exceeding 10 pc. -		

(D) Technical Parameters of Bushings/Hollow Column insulators/support insulators:

	220 kV	**66kV**	**33 kV**
(a) Rated Voltage (kV)	245	72.5	36
(b) Impulse withstand voltage (Dry & Wet) (kVp)	±1050	±325	±170
(c) Power frequency withstand voltage (dry and wet) (kV rms)	±460	±140	±70
(d) Total creepage distance (mm)	6125	1812.5	900

(e) Pollution Class-III Heavy (as per IEC 71) and as specified Section-2 for all class of equipment

(f) Insulator shall also meet requirement of and IEC-815 for 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 from date of Comments required including both ways postal time).	Within3 (three) weeks
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	-do

	(one copy for each substation)	
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, leveling, 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 re-establish 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. If 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 and C & R panels 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 organization 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 and 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 at least 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 as per relevant IEC with latest amendments. The type tests conducted should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation 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 immmersions. 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	FIRE RED	Sky Blue

	–Air		
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 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 System	190V to240V	DC	-	Isolated 2 wire
50V (+) earthed	_	DC	_	2 wire system

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 & NEMA 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 terminals 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 wire	Galvanised mild steel shield

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 (250 mm Sub- Conductor spacing for 220 kV). 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 220 kV class clamps shall not be less than 156 kV 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. However, Spring return type actuator switch for ON/Off control are acceptable.

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 m V 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 nondisconnecting 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 mm 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.

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-61109.

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 at least 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 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 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 . m otor control c enter pane ls of t he t ype an d r ating b eing of fered w hich should b e i n 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 m ake or s hall be pr ocured f rom reputed m anufacturers and of pr oven de sign. At l east o ne 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 B atteries of t he t ype s pecified a nd being of fered, hav ing a c apacity of at l east 600 A H a nd 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 C hargers generally of the t ype of fered, with s tatic aut omatic v oltage r egulators 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, w hose t ransformers ar e of fered s hould ha ve d esigned, m anufactured, t ype tested including short circuit test as per IEC/IS or equivalent standards and supplied transformers of at l east 33 k V c lass of 800 k VA or hi gher. T he t ransformer should h ave be en i n s uccessful operation for at least 2 years as on the date of bid opening.

24.9 Fire Fighting System

Nitrogen I njection F ire Prevention a nd Extinguishing System s hall be used f or f ire pr otection 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.

24.10 Control and Relay Panels

24.10.1 The m anufacturer w hose C&R panels a nd protective r elay are of fered should have des igned, manufactured, tested, installed and commissioned C&R panels including protection relays which must be in satisfactory operation on 220 kV system for atleast 2 (two) years on the date of bid opening.

24.10.2 The C&R P anel f rom a manufacturer w hose have designed, manufactured, tested, installed a nd commissioned C &R pan els w hich are i n s atisfactory oper ation on 2 20 k V s ystem for at least 2 (two) years on the date of bid opening can also be offered, provided the protective relay schemes should be of fered f rom a Contractor who fully m eets t he r equirements s tipulated under c lause 24.10.1 abo ve. Further, i n s uch an event t he m anufacturer s hall f urnish 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.

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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 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.

4.0 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 immersed Transformers.
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)	-	Hexagon headbolts, screws and nuts of product grade C.
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 porcelain 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 low frequency 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 Refrigeration Compressor 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 Ventilation Fans
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 (Part-51)	-	Noise levels

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 – Roto dynamic 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 onstant speed mpression 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 (Latest Edition)	-	Standard on Antomatic Fire Detectors Fire Protection Manual by TAC
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

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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 building 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 ISO/R:89-1959 of Steel Wire
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 BS:215 (Part-II) overhead transmission purposes.

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 fluorescent 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 1to 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 650V(Part-2)	HRC Cartridge fuse links for voltage above
(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 (220kV and 33kV)**
    - GA drawing
    - GTP
    - Type test Reports
15. **CTs (220kV and 33kV)**
    - GA drawing
    - GTP
    - Type test Reports
16. **Surge Arrestors (216kV and 30kV)**
    - GA drawing
    - GTP
    - Type test Reports
17. **Isolators (220kV and 33kV)**
    - GA drawing
    - GTP
    - Type test Reports
18. **220kV Transformers (220/33/11kV)**
    - 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. **Control and Relay Panels**
    - GTP and technical literature
    - Type test report of Relays/Relays/Equipments
20. **Civil Works**

    Boundary wall

    Control Room Building
    - Structure Design, Foundation Design & Drg., Plinth Beam Design & Drg. and column Design & Drg. upto G.F. Level
    - Transformer foundation design/drawings
    - 220kV Tower foundation design/drawings.

ANNEXURE-A: COMPLIANCE CERTIFICATE OF TECHNICAL SPECIFICATION

The bidder shall confirm compliance to the following by signing and 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 deviations.

3. Only those technical submittals which are specifically asked for in Notice Inviting Tender (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 technical 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: DEVIATION/ CHANGE REQUEST OF TECHNICAL SPECIFICATION

Bidder shall list out all technical potential deviation/ change request (s) along with clause with respect to technical specifications.

Sl. No.	Page No.	Clause No.	Deviation	Reason/ Justification(s)

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: Bidder's Stamp & Signature

Annexure-Technical Qualifying Requirement

220kV/ 66kV Gas Insulated Switchgear with its accessories
Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Sub-Station with complete civil works & automation at Budella, New Delhi (India) on turnkey basis
Technical Specification: TB-PBTU-DTL-GIS-Part2

The bidder shall be Indian GIS manufacturer, who meet the requirement of Route-1 (Clause 1.1.A)/ Route-2(Clause 1.2)/ Route-3 (Clause 1.3), while fulfilling all additional requirements as per respective clauses,

Route-1:

1.1. A) The Bidder/ Manufacturer must have designed, manufactured, tested[$] (as per IEC or equivalent standard), supplied, supervised erection and commissioning of at least two (2) nos. GIS circuit breaker bays[*] of 220 kV or above voltage class in one (1) GIS substation or Switchyard during last seven (7[**]) years and these bays must be in satisfactory operation[#] for the last two (2) years **ending last day of month previous to the one in which tender is invited.**

OR

The Bidder/ Manufacturer must have designed, manufactured, tested[$] (as per IEC or equivalent standard), supplied, erected and commissioned at least two (2) nos. GIS circuit breaker bays[*] of 220 kV or above voltage class in one (1) GIS substation or Switchyard during last seven (7[**]) years and these bays must be in satisfactory operation[#] for the last two (2) years **ending last day of month previous to the one in which tender is invited.**

Performance certificate for satisfactory operation issued by the Power utility certifying the operation without any adverse remarks should be of last two (2) years ending last day of month previous to the one in which tenders are invited.

OR

Route-2:

1.2.) In case, the Bidder is not meeting the requirement stipulated in **Route-1 (clause 1.1A)** and above, he shall also be considered, provided he meets the following requirements,

a) The bidder must have established manufacturing and testing facilities in India for 220 kV or above voltage class GIS and must have manufactured at least one (1) no. 220 kV or above voltage Class GIS Circuit Breaker bay[*] based on the technological support of the Collaborator(s). Further the bidder must have either supplied or type tested the above GIS bay[*] as per IEC as on **ending last day of month previous to the one in which tender is invited,** provided further that the collaborator(s) of the bidder meets qualifying requirements as per para/ clause 1.1A mentioned above.

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Further, the bidder shall also submit the following along with the bid,

i) A legally enforceable undertaking (jointly with the Collaborator(s)) to guarantee quality, timely supply, performance and warranty obligations as specified for the equipment(s);
ii) A confirmation letter from the Collaborator(s) stating that the Collaborator(s) shall also furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s). This performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the bidder.
iii) A valid collaboration agreement for technology transfer/ license to design, manufacture, test and supply 66 kV or above voltage class GIS equipment in India.

OR

Route-3:

1.3.) In case, the Bidder is established as Subsidiary/ JVC/ Group company by its parent/ principal/ subsidiary/ **sister concern[##],** he shall also be considered, provided he meets the following requirements,

a) The bidder/ manufacturer must have established manufacturing and testing facilities in India for 220 kV or above voltage class GIS and must have manufactured at least one (1) no. 220 kV or above voltage Class GIS Circuit Breaker bay[•] based on the technological support of the parent/ principal/ subsidiary/ **sister concern[##]** company.

Further, the bidder must have either supplied or type tested the above GIS bay[•] as per IEC as on the **ending last day of month previous to the one in which tender is invited.** Provided further that the parent/ principal/ subsidiary/ **sister concern[##]** company of the bidder meets qualifying requirements as per para/ clause 1.1A mentioned above.

Further, the bidder shall also submit the following along with the bid,

i) A legally enforceable undertaking (jointly with the parent/ principal/ subsidiary/ **sister concern[##]**company) to guarantee quality, timely supply, performance and warranty obligations as specified for the equipment(s);
ii) A confirmation letter from the GIS manufacturer/ GIS Collaborator/ Parent/ Principal/ Subsidiary/ JVC/ Group/ **sister concern[##]**company etc. as applicable that they shall also furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s). This performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the bidder.
iii) A valid collaboration agreement for technology transfer/ license to design, manufacture, test and supply 220 kV or above voltage class GIS equipment in India.

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Annexure-Technical Qualifying Requirement

Note (s):

1. The offered GIS design should have been type tested as per relevant IEC with valid type test reports in line with CEA guidelines.

2. (#) Satisfactory operation means certificate issued by the Employer certifying the operation without any adverse remark.

3. (*) For the purpose of qualifying requirement, one no. of circuit breaker bay shall be considered as a bay used for controlling a line or a transformer or a reactor or a bus section or a bus coupler and comprising of at least one circuit breaker, one dis-connector and three nos. of single phase CTs / Bushing CTs.

4. In case bidder is a holding company, the technical experience referred to in Route-1, 2 and 3 above as the case may be, shall be of that holding company only (i.e. excluding its subsidiary/ group companies). In case bidder is a subsidiary of a holding company, the technical experience referred to in Route-1, 2 and 3 above as the case may be, shall be of that subsidiary company only (i.e. excluding its holding company).

5. (**) For the purpose of qualifying requirement, during the last seven years means that commissioning date is to be within a period of seven years ending last day of month previous to the one in which tender is invited.

6. In case bidder is qualifying through Route-1, type test reports of Collaborator/ Parent Company/ Subsidiary Company/ Group Company/sister concern## shall also be acceptable, for which a confirmation shall be furnished along with the bid as per format attached in the bidding documents.

7. ## Sister Concern of bidder means the company which has same parent as that of the bidder.

8. $ Tested means the design of the 66 kV GIS has been type tested as per IEC with validity as per CEA guidelines. Performance certificates submitted by the bidder shall be of the same design of GIS whether type tested or not. The offered GIS by the bidder shall also be of the same design.

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